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PROCEEDINGS

**WORKSHOP ON ENVIRONMENTAL
MANAGEMENT**

IN PULP AND PAPER INDUSTRIES

IN THE CZECH AND SLOVAK REPUBLICS

4 - 6 April 1995

organized by

United Nations Industrial Development Organization (UNIDO)

in co-operation with

Pulp and Paper Research Institute Bratislava

financed through a Special Purpose Contribution of
the Government of the Federal Republic of Austria

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CONCLUSIONS

1. The workshop has created a useful form to promote exchange and transfer of experience and information in environmental management and new cleaner production technologies among the participants from the pulp and paper industry, research institutes and national and international comments.
2. The participants of the workshop from both Republics actively discussed the subject of technical papers and presented their experience and planned activities in environmental fields.
3. The case studies and the technical papers presented by the industry representatives and consultants have shown, that the the industries in both Republics are aware of the necessity to improve the ecological situation since 1990. They are systematically introducing technological innovations to minimize the environmental impact of the industrial processes. Some of the mills are already approaching European standards. Following investment will be necessary to further improve the situation.
4. The discussions during the workshop confirmed that the environmental policy and strategy followed by Czech Paper Industry Association and by the pulp and paper sector in the Slovak Republic form a good base to introduce gradually environmental management in this sector.
5. The necessity was also confirmed to enhance the exchange and transfer of information from western countries to the pulp and paper sector in both republics.
6. It was also concluded that emission limits expressed in terms of emission load per ton of product are more adequate than expressed in terms of volume concentration of pollutants, especially in case of water emissions.

Recommendations

1. In order to introduce and/or up-date when required regulatory policy and adequate legislation as well as to establish realistic emission limits that could be achieved in the years to come, a close co-operation is required between the Government authorities concerned in both countries and the respective representatives of the pulp and paper industry.
2. The pulp and paper industry in both Republics should continue their efforts to improve the ecological situation at the mill's level, mainly through technological modernization and more efficient environmental management in order to be able to fulfill the requirements of the present and future European standards.
3. It would be highly useful to strengthen co-operation and exchange of information between the pulp and paper industries in both countries with Western economy countries, particularly neighbouring countries, to achieve optimal benefits in introducing environmental protection measures.
4. The Cleaner Production Centres in Czech and Slovak Republics should closely co-operate with specialized institutions such as sectoral research centres, technical associations of pulp and paper and wood industries, technical universities, etc. in promoting environmental projects in the pulp and paper sector in both countries.
5. UNIDO is requested to systematically transfer and up-date information on legislation, emission limits and environmental audits in the European Community to both Republics concerning pulp and paper sector. UNIDO is also requested to support environmental audit projects for individual pulp and paper mills in both countries including training programmes for environmental specialists and managers.
6. It is recommended that UNIDO will organize after a certain period of time, a second workshop to review and evaluate the progress achieved in environmental protection in the pulp and paper sector in both countries.

G. Donocik
CSPD/EUR
4 April 1995

Statement by G. Donocik at the opening of the Workshop on Environmental Management in Pulp and Paper Industry for Czech and Slovak Mills (4-6 April 1995; Bratislava)

Ladies and Gentlemen,

I am very pleased and honoured to convey the best greetings of the UNIDO General Director and the Director of the UNIDO European Programme to the participants of this workshop.

This Workshop that assembled representatives of practically all pulp and paper industries and research institutions from the Czech and Slovak Republic, is the first one in a series of Workshops and Seminars that UNIDO plans to organize in the countries of the Danube River Basin in the field of environmental management at the enterprise level. We are starting with the pulp and paper sector, but the workshops in other industrial sectors will be held in June 1995 in Ljubljana (Slovenia) for seven countries of this region (Bulgaria, Czech, Croatia, Hungary, Romania, Slovakia and Slovenia). A workshop on Sustainable Industrial Policy with emphasis on environmental aspects will be held in Bulgaria at the end of April for four countries (Bulgaria, Ukraine, Moldova and Romania) and a workshop on Environmental Management in Iron and Steel Industry for the Czech Metallurgical Plants is under preparation.

The common goal of these workshops is to improve the knowledge and skills of factory managers on environmental management methodologies and on new cleaner production technologies in order to improve the efficiency and effectiveness in reducing industrial pollution in the countries of the Danube River Basin including tributary rivers.

As you well know, manufacturing industries are largely responsible for the environmental pollution. For many years the environmental issues were either neglected completely or at best pollution abatement and proper waste management were marginalized. In order to improve the situation the countries of this region realized that an isolated effort will have very little impact. They knew, that there is a need to start integrated and well coordinated actions against environmental pollution originating from various sources such as municipal, agricultural, transport as well as industrial activities. To facilitate these joint efforts, the international organizations, some donor countries and the riparian countries of the region launched in 1992 a vast Environmental Programme for the Danube River Basin with the long term objective of achieving sustainable use and development of natural resources through protection and enhancement of environmental values and contribution to economic welfare and safeguard of public health.

The UNIDO workshop on Pulp and Paper is a part of this international strategy to assist these countries in pollution abatement. Thanks to the financial support of the Austrian Government and the support of the Slovak and Czech Governments and your own companies, we are able to organize this workshop. We hope that the issues that will be discussed according to the Agenda will help your companies to better evaluate the significance of environmental issues for the whole ecosystem in this region. Subsequently the outcome of this discussion should facilitate to introduce more efficient methodologies in managing environment programmes, as well as when required and financially viable to undertake technological innovation or modernization investment.

Few words about UNIDO. It is one of the youngest UN agencies established in 1967 with its major goal to help developing countries in their effort of industrialization. The share of developing countries in the overall world's industrial production is much below 20%. In the last ten years it has not increased through certain economies of the far east countries such as South Korea, Malaysia, Indonesia but also Brazil, Mexico in Latin America noticed a remarkable progress. Many countries, particularly in Africa are in fact not developing, they are stagnating.

UNIDO tries with our industrial development programmes to help these countries in their development. Our role is however catalytical, UNIDO stimulates and promotes technical cooperation but can not substitute the national effort required to overcome stagnation. Our programme concentrates on various fields of environmental protection and energy conservation but also many other fields such as investment promotion, industrial strategies and policies, promotion of small and medium scale enterprises institutional infrastructure, human resource development, enterprise rehabilitation and restructuring, privatization, industrial statistics and technological upgrading in all manufacturing industries starting from agro-based industries through chemical up to telecommunication and electronic industries.

Our technical cooperation delivery surpassed last year an equivalent of \$100 million. It is not much compared to the programmes of the World Bank or Regional Development Banks but it is delivered in the forms of grants not loans. Due to the nature of UNIDO assistance the impact of the UNIDO programmes is much higher than the figures say.

UNIDO is also active in the European Region. Traditionally close ties have been established with all the countries in transition. We observe with great interest the process of changes unprecedented in scale, departure from the command economy and promoting the market economy mechanisms and institutions. Sometimes the process is painful but we believe that the end result will bring a vast circle of the population real improvement of their standard of living. Last year gave already a real reason for satisfaction. In all countries of the Vyshegrad group e.g. Slovakia, Czech, Hungary and Poland the GNP grew by 3-5%. We hope that this year this positive trend will be strengthened.

Our programme of technical cooperation, though modest because it is much below 10% of all UNIDO technical assistance last year, concentrates in those areas of economic development which requires priority attention.

Priority fields are: industrial restructuring, investment promotion, environmental protection against industrial pollution, small and medium scale industries development and many others.

The cooperation with the Czech and Slovakia is two way oriented. Besides the UNIDO technical cooperation programme for the benefit of these two countries to facilitate process of changes and to improve environmental conditions for enterprise operation, both countries established with UNIDO Joint Committees under which the outreach activities are promoted with involvement of the Czech and Slovak expertise for the benefit of the developing countries. This two-way oriented cooperation is considered by UNIDO as a good example of mutually beneficial cooperation.

How UNIDO assistance is financed? We have such funds as UNDP IPF, SIS, Regular Budget, but also resources from PHARE, and special purpose contribution or Trust Fund of the donor countries such as for example this project co-financed by the Austria Government.

In conclusion, let me express Mr. Chairman my sincere wishes of fruitful and interesting discussions and the full use of the knowledge to be generated during this workshop in your daily work at the plant level and in your research institutions.

Jozef Zbořil, President.

Paper and Pulp Industry Association of the Czech Republic

**The Paper Industry and Environment
in the Czech Republic
Summary**

Paper industry = malefactor of the environment

A paste already overcome

Centrally planned economy - contradiction of limited funds.
exemptions

Modern manufacturing units erected with respect for ecology

Principal changes in the last years

More stringent legislation and mainly

Ecological consciousness of entrepreneurs and responsibility

Paper industry - co creator of environment

**Environment is in the centre of interest of the Paper and Pulp
Industry of the Czech Republic**

- ecological policy adopted by the paper industry

- the principle of sustainable development applied

Obligation for all member companies of the Association

Individual ecological policy of companies:

Sustainable paper cycle

How is this adopted in reality?

**ECOLOGICAL POLICY AND PRINCIPLE OF SUSTAINABLE DEVELOPMENT
IMPLEMENTED IN INDUSTRY**

Association: Influence on member companies - impact inside of the
Association

Influence to outside:

- PUBLIC/PRESS
- GOVERNMENT AUTHORITIES
- LEGISLATION AUTHORITIES
- INTERNATIONAL ORGANIZATIONS
- COORDINATION WITH OTHER ASSOCIATIONS

ECOLOGICAL POLICY OF THE PAPER AND PULP INDUSTRY ASSOCIATION

- Improved utilization of wood raw material
- Increase of waste paper share in products (increased paper recycling)
- Limitation of negative impact of paper industry on environment
 - both from basic technologies and utilities (energy)
- Gradual elimination of raw materials with negative impact on environment
- Limitation waste generation by modification of technology
- Initiation of improvement of ecological consciousness of associates and public
- Application of European quality a environmental management in the paper industry
- Evaluation of legislative influence, cooperating in modifications of legislative

WHAT WE HAVE ACHIEVED AND WHAT IS COMING
SEPAŠ ŠTETÍ - INVESTMENT ALREADY 1.69 BILLION CzCr
Improvement of waste water quality - reduction

BOD by 83%
COD by 74%
TSS by 82%
AOX by 61%

Problem solving by technology modification. not only "End of Pipe" treatment

- Washing and screening of pulp
- modification of bleaching
- displacement cooking
- ECF pulp manufacture

In near future : Oxygen delignification / TCF
Solid waste:

- New landfill area for 30 years
- Systematic decrease of waste generation
- Pressure on reuse possibilities

IMPROVEMENT OF QUALITY OF ATMOSPHERE

- Liquidation of obnoxious gases from the kraft pulp mill (1993)
In the future

- Finalization of electrostatic precipitator
- Modification of lime kiln technology
- Recovery boiler retrofitting

Solution of energy generation problems

- Gas - steam vs. clean solid fuels

BIOCELL Paskov mill

Most modern market pulp mill in the Czech Republic

Problem is low water flow of the recipient

Increased requirement on waste water quality requirements

Energy generation from natural gas - anthracite is a possibility

For the future :

Improvement of waste water treatment - investment 1 billion CzCr.

- Target value is 6 - 6.5 t COD/day
- Modifications of recovery boiler
- Peroxide bleaching (TCF pulp)
- Modification of evaporator
- Sludge incineration

JIP VĚTRNÍ - investment since 1990 487 mil CzCr.

Improvement in all basic areas

Increased care of environment in all companies of the group

WASTE WATERS

Finishing and start - up of biological treatment plant

Č. Krumlov

	1989	1994
BOD(t/a)	13.000	127
COD(t/a)	52.000	2.138
TSS(t/a)	5.000	487

Waste water treatment plant for surrounding communities as well - effect synergy

SUFFICIENT CAPACITY FOR FURTHER DEVELOPMENT

Other paper mills also within emission limits

- Reduction of sulphur dioxide emission from sulphite mill by 80%
- Natural gas fired boiler in Větrní : emissions
SO₂ up to 4.000 t/a
NO_x up to 530 t/a
fly ash 215 t/a

Contributions also in improvement of heat utilization economy
Specific Consumptions reduced by 25%

- Natural gas heating in Č. Řečice and Přibyslance

SOLID WASTES

- New landfill area Lověšice (cat. V) also for hazardous waste. capacity 450.000 m³. possibility up to 3 mil m³
- Decrease of fly ash (- 40.000 t/a)
- Utilization of bark and wood waste selling
- Target : utilization in agriculture

To reduce landfilling to 10 - 15.000 t/a i.e. by 80%

INCREASE OF FIBRE YELD FROM WOOD BY NEW TECHNOLOGY

Main objectives of environmental policy:

- Erection of new plant for manufacture of wood containing magazine papers
- To shut down the sulphite pulp mill
- To increase the share of recycled fibres
- To improve efficiency of energy generation and utilization
- To eliminate old ecological burdens

WHAT ARE THE PRESENT AIMS OF THE PAPER AND PULP INDUSTRY ASSOCIATION

- To intensify environmental policy - ecoefficiency
- Experimental verification of environmental management linked to ISO 9000
- To establish more realistic air emissions limits with regard to time and value
- To increase waste paper recycling
- To eliminate inconsistency of environmental legislation
- To introduce economical impact evaluation of legislation
- Cooperation on preparation of Waste Act and Packaging Act

DEVELOPMENT AND ENVIRONMENTAL SITUATION OF PULP AND PAPER INDUSTRY IN THE SLOVAK REPUBLIC

Karol Jirsák, František Šulek

Department of Wood Processing Industry, Slovak Ministry of Economy

Pulp and paper industry of the Slovak Republic is based on processing domestic raw material - wood, and secondary raw material - waste paper. In this branch, import demands for production consumption are below 10%, and production export achieves almost 60%. Thus, pulp and paper industry belongs to the branches contributing significantly to the creation of active foreign currency balance of Slovakia.

Overcoming of the effects of recession which had been reflected in negative manner in sale decrease and thus in production decrease on domestic and foreign markets has been shown in 1994 already by 30% increase of production in the branch compared to 1993, and by 34% export increase. In 1994, production of goods achieved 12.8 bln Slovak crowns, with 860 million Slovak crowns of profit (in 1993, a loss of -420 million Slovak crowns was reported). At present there are 14,000 working places within pulp and paper industry.

The importance of the position held by pulp and paper industry is documented in the Program Proclamation of the Slovak Government, stating - let me quote: "Within the branches of wood processing and consumer goods industries, the government will support development projects in pulp and paper industry in relation to higher valuation of domestic raw material base."

Similarly to industrial policy, strategic development goals have been determined, namely:

- stabilization of branches and increase of their capacity
- increase of export and competing ability of production

- decrease of energy-, raw material and material demands
- increased utilization of domestic raw materials with increased finalization
- efficient valuation of secondary raw materials.

These goals are completely projected into the conceptual materials of pulp and paper industry for the coming period.

The strategy of development within pulp and paper industry comes out from the available sources of domestic raw materials, from the existing production- and technical base and from real sales on home- and foreign markets.

The development of the branch will be aimed mostly at higher finalization of the products, at modernization, ecologization and higher efficiency of production.

In accordance with the world trend, production of pulps in Slovakia will be modernized by elements improving the ecological, quality and economic parameters of production.

In the pulping process, modified cooking procedures will be used, and in the pulp bleaching process the trend of replacing elemental chlorine by oxygen containing compounds or directly by oxygen is decisive. Avoiding chlorine is important from the commercial viewpoint as well because pulps containing a certain volume of chlorinated organic compounds reach lower realization prices on demanding foreign markets.

With respect to the existing capacities, the development of hygienic paper production can be considered as finished. The capacities had been built for the needs of the whole former CSFR, and about 80% of their production will have to be exported. Improved finalization and innovation of products give certain possibilities to developments in this sphere.

In the sphere of graphic papers production the paper machines will have to be modernized gradually, to utilize their capacity in an optimal manner and to improve the quality of the papers produced. A new capacity for the production of plastic coated papers is under consideration.

There is a certain problem in shortage of waste paper as the basic raw material for the production of hygienic papers and packaging materials. This problem has to be resolved by importing under unfavourable conditions.

To improve the situation in supplying the processing plants at Štúrovo, Žilina, Harmanec and Ružomberok, organization and legislative rules to promote paper recycling increase should be ensured in Slovakia. The pointless limiting regulations for importing waste paper should be changed.

The main problem with the legislative regulations limiting waste paper import is in incorrect classification of separated paper stock as waste. Evidently, basic raw material for the production of paper and board is concerned, defined by specific technical parameters, included in the scale of tax rates as a marketable item, and being bio-degradable it is not environmentally harmful.

In the interest of improving the level of packages produced, present production and technical base will be modernized and the assortment produced will be inovated.

The investment costs of development and environmental issues in the pulp and paper production branch are assumed to reach 15-20 billion Slovak crowns till 2005.

In pulp and paper industry, which is affecting adversely above all water and atmosphere by its techniques, integrated approach to the production process is emphasized, with full

consideration of the ecologic criteria. After restructurizing and modernization the plants evidently prefer environmentally clean techniques. Although more demanding as to investments and finances, they handle process ecology primarily and with lower requirements as to new machinery for the liquidation of the impurities produced.

As to the environmental effects, three pulp producing plants can be classified as medium pollution producers, namely Bukóza Vranov Inc., SCP Ružomberok, state enterprise and JCP Štúrovo Inc.

Pulp and paper industry is gradually reducing the ecological load upon individual environment components, above all water and atmosphere. Realization of environment-friendly techniques, e.g. the ecological and development action "Oxygen bleaching of pulp" in the SCP Ružomberok plant, has reduced the consumption of elemental chlorine to one half, and the following results were achieved in waste water pollution decrease:

BSK5	by 1,027 tons per year
CHSK	by 6,162 tons per year
soluble substances	by 1,043 tons per year.

At present, another modernization is being realized at the SCP Ružomberok plant - "Displacement Cooking Pulp". This technique will result in 40% decrease of waste water pollution in the BSK5 and CHSK parameters, and process hermetizing will result in reduced emissions of organosulphur compounds.

There are further important effects, namely reduced consumption of chemicals, reduced heat consumption during boiling and, above all, production of ECF (elemental chlorine free) pulp.

In accordance with the effective legislative regulations on environment, the JCP Štúrovo ecological program includes

investment, technical and organization measures related to the protection of atmosphere, water and waste treatment. A decisive action, finished in 1994, is represented by reconstruction and modernization of the paper machine No. 3 for the production of fluting, resulting, beside economic effect, in reduced consumption of technological water and reduced waste water contamination. After 1990, the plant has realized ecological projects with total costs of 550 mill. Slovak crowns, 65% of which were determined for atmosphere protection.

Modernizing and reconstruction of energy machinery was handled within the PHARE B.2/91 program as well, where the energy audit includes optimization of combustion regimes, the fuel base issues and reduction of production energy demands. Before 1998 ecological actions aimed at reduction of emissions from technological and energy sources will be realized, with overall costs of 334 mill. Slovak crowns.

The last one of the three decisive pollution producers, the Bukóza Vranov plant, is preparing a reconstruction and modernization of the pulp production technique which will guarantee the required parameters in the environmental sphere as well.

The crucial problem in environment protection remains in the financial resources required for the measures to be taken. More than 600 mill. Slovak crowns are assumed to be spent on purely ecological purposes in the pulp and paper branch before 1996, and about one billion Slovak crowns in the coming period till 2000.

Complete ecologization of the branch will require primarily to establish a system of economic tools, above all of the positively stimulating ones, as well as to determine the priorities for pollution treatment when specifying ecological acceptability of regions, to modify conditions for granting subsidies from the Environmental Fund etc.

During recent five years, approx. 30 legal standards related to environmental issues have been accepted. The Slovak government is preparing novelization of existing and/or accepting of new legislative regulations considering environmental law in the European Union countries. The following belong to the most important ones:

- Draft regulation of the Slovak government executing the Act on atmosphere protection (emission limits)
- Draft of the Act of the National Council of the Slovak Republic on the state environmental fund
- Novelization of the Act on fees for waste depositing
- Novelization of the governmental regulation on waste treatment
- Novelization of governmental regulation on specific special abilities required for the functions in state authority bodies related to environment
- Draft of the Act on waters and water use taxation
- Novelization of the Act on waste.

In 1993, the Project on cleaner techniques organized as an education program by the Norwegian and Slovak ministries of environment, the Slovak Ministry of Economy and the Faculty of Chemical Engineering was participated by three pulp and paper plants. At Bukóza Vranov Inc., SCP Ružomberok state enterprise and PT Žilina Inc. model projects on waste minimization and pollution prevention were worked at.

At present, the grant from the Swedish agency for international technical and economic aid (BITS) for the Slovak Ministry of Economy, as well as the resources collected by the enterprising sphere, are used to prepare a complete study aimed at waste paper problems. The goal of the study is in specifying the optimum procedure of improving waste paper collection and processing, as well as in the legislative issues and economic tools under the Slovak conditions for the coming years.

In relation to the conclusions of the UNO Conference on Environment and Development in Rio de Janeiro in 1992, and to the Conference on Environment in Europe (Luzern, April 1993) resulting in ecological action program for central and eastern Europe, the Proposal of strategies, principles and priorities of state environmental policy has been prepared. In 1994, these principles were included into the environmental policy of wood processing industry. Medium- and long-term goals defined in the above Proposal of strategies, principles and priorities of state environmental policy is being continuously implemented into the industrial policy of the Slovak Republic.

When judging the updates of existing and drafts of new legislative regulations related to environmental issues, the Slovak Ministry of Economy is fundamentally advocating the procedures respecting real conditions of the Slovak Republic and aiming at balance of environmental aims and of economic prosperity of Slovakia.

PAPER INDUSTRY IN THE SLOVAK REPUBLIC, POLICY AFTER THE
REGRESSION PERIOD

JuraĽ KuĽera

Vice-Chairman of the Union of Wood, Furniture,
Pulp and Paper Industry

The policy of pulp and paper industry development in the Slovak Republic after the recession period comes out from the analysis of production, marketing and development of the previous period, with emphasis on the favourable trends of quality and quantity indicators achieved in 1994.

Better utilization of capacities and thus efficiency of inland economics cannot be realized without handling the present financial situation of enterprising subjects. With respect to high credit debts of enterprises in both inland and foreign financial institutions, it does not seem real to solve this situation by further crediting from inland financial institutions. The entry of foreign capital appears as one of possible solutions, with not only investments but also operation capital concerned (both at present and within near future). According to forecasts, a dynamic growth of pulp and paper industry is expected in the world before 1998, after this year a decline is expected again. This fact should be considered when defining the strategic goals of the pulp and paper processing branch, to take maximum advantage of present advantageous conditions for efficient sale of our production on demanding foreign markets.

Despite expected growth of paper and board consumption, Slovak market will not be able to absorb the production of the branch. Thus, one of the strategic goals will be in ensuring competing ability of our production and in locating it on markets in advanced foreign countries. This goal will be stipulated not only by considerable improvement of the level of marketing, but

also by establishing and implementing a quality control system corresponding to the ISO 9000 standards. This will be possible only after the informatic level will increase and after information system hardware of a relevant level comparable with foreign standard will be provided.

Decreasing production and energy costs will be one of the decisive conditions of production efficiency improvement and of production process ecologization by decreasing the specific consumption of primary fuels. The costs problems should include the concept of emplyment as well, with the factor of productivity of labour considered, because in the coming years an increase of labour force costs has to be expected. The above steps should be realized as soon as possible, without considerable requirements of additional investments.

After the critical years of high credit burdens on enterprises (mostly in 1995-1996), inevitable modernization and ecologization of the existing production- and technical basis of the branch will become possible, with the development aimed mostly at increasing the share of added value through finalization and optimal assortment extending of the production, with permanent innovation of existing production programs. In late 90s, paper and board production of total volume of 550 thousand tons per year is expected in the Slovak Republic. This is the level of 1989, but after re-structurizing the assortment structure will be of different quality that the original one. The balance does not include the aim under preparation, namely extension of pulp production and introduction of the production of wood-free writing and printing papers in the Bukóza Vranov plant.

The inevitable condition for the achievement of the existing production programs as well as of the proposed development impulses is represented by sufficient raw material (wood and waste paper) supply for the production. With the wood material,

stable supplies as to volume, assortment and types should be achieved for pulp production at Ružomberok, Štúrovo and Vranov. Therefore cooperation with forest engineering institutions on the concept of growing and harvesting activities is necessary.

In connection with waste paper supply, legislative rules for collecting organization and control should be established definitely, with the aim of increasing the degree of recycling in the country. This is true about the legislative rules concerning waste paper import for existing processing capacities as well.

Coming out from expected financial situation of the enterprising subjects of the branch in the years to come, the absence of foreign capital in Slovak pulp and paper processing industrial plants would postpone strategic restructuring and ecologization of the branch after the horizon of 2000. The decisions as to needs and share of foreign participation will have to be taken after thorough analysis of individual enterprising subjects, especially in relation to the time factor, competing ability, present and future profits.

In the end I would like to inform you that Slovak pulp and paper industry is preparing and realizing a number of development and environmental activities at present, which are in accordance with the draft strategy till 2000 as well as with the water and air contamination limits specified by law. The investment action displacement cooking is now being realized at the Ružomberok plant, related both to the economical and environmental problems of sulphate pulp production. Modernization of semichemical pulp production at Štúrovo is under preparation. Negotiations with suppliers concerning pulp production and design of a new paper machine to produce writing and printing papers at Vranov are under way.

The primary strategic goal of Slovak paper and pulp industry is in the accommodation to external market conditions of world economy, where our branch is realizing the prevailing part of its production.

This goal requires timely and foresighted decisions during the fulfilment of strategic goals for which the primary pre-condition is represented by being well informed. And this can be achieved only by joining existing European structures and organizations in all spheres of activity, namely scientific, technical, standardization, commercial, environmental etc. spheres. The first steps have already been done in this direction.

The question of the joining of Slovak pulp and paper industry into supra-national associations by fusions, acquisitions etc. remains open.

Wilhelm Hantsch-Linhart

(Agiplan, Wien, Austria)

Introduction

The contribution to the this UNIDO workshop for Pulp and Paper Industry consists of three chapters. Chapter 1 gives an overview on the emission legislation in Europe and future trends or regulations. Chapter 2 covers recent developments on Environmental Management Systems and Environmental Auditing. It is based on the British Standard BSI 7750, on the International Standard (currently available as a committee draft) ISO 14.000 and on the Council Regulation #1836/93 of the Council of the European Union. Chapter 3 summarizes the developments in pollution abatement technologies in the fields of waste water treatment, air pollution control and waste management.

- Emission regulations in Europe and future trends

The most important environmental regulations cover the three categories

air pollution

water discharge and effluent limitations and

solid waste management.

These three categories will be covered using examples from different countries, as it is not possible to give an detailed analysis of the European environmental legislation within the framework of this seminar. However, the participants are invited to ask their questions either during the presentation or afterwards.

In regards of air pollution standards, Germany has been the trendsetting country within the European Community. In Germany, environmental legislation is developed on both the federal and state levels. On the federal government level, the Federal Emission Control Act (BImSchG) is the legislative base for control of pollution. Under this Act, various regulations for air, waste water and solid waste pollution control have been established.

The Technical Instruction on Air Pollution Control (TA Luft) is the most important administrative regulation to implement the BImSchG. These technical instructions are binding on the administrative authorities. The regulations in TA Luft stipulate the detailed technical demands and emission limits of air pollutants in order to reach the objectives of BImSchG. TA Luft applies to new plants and also includes regulations on the retrofitting of existing plants specifying the periods within which the plant must be brought within the emission levels required for a new plant.

The main emissions to the air in the pulp and paper industry come from power boilers or from incineration plants. Depending on the fuels used and on the size of the boiler, there are different limits for sulphur dioxide, particulates and nitrogen dioxides.

Emission limits for particulate emissions vary between 150 mg/m³ for boilers with less than 5 MW and 50 mg/m³ for boilers with more than 50 MW. Boilers burning solid fuels (5 to 50 MW) are limited to 400 to 500 mg/m³ for SO₂. This will also be a limit in new EU regulations. The limit for oil burning is 1.700 mg SO₂/m³, which is comparable to Czech and Slovak regulations. NO_x is limited to 1.700 mg/m³ for sulfite recovery boilers and with 300 - 500 mg/m³ for 20 - 50 MW boilers using solid fuels. The burning of oil and gas results in limits of 200 - 450 mg/m³ for sizes from 1 to 100 MW.

The Water Resources Policy Act (WHG) forms the framework for the regulations on both the direct and indirect discharge of effluents. The current situation of water legislation is determined by an amendment to the Water Resources Policy and to the Waste Water Levy Act (AbwAG).

A number of ordinances of federal states have already been harmonized to these laws and most federal ordinances and administrative regulations have been adopted by the federal states.

Up until 1986, the requirements for conditions of effluents prior to their discharge into wastewaters could only be stipulated as minimum requirements based on the "generally recognized rules of technology." As a result of the 1986 amendment in WHG, the Federal Government is also empowered to stipulate requirements which are based on the "Best Available Technology" (BAT) in cases where the effluent contains hazardous substances.

The technical regulations related to "generally acknowledged rules of technology," and BAT technology are defined by the Federal Government in the General Administrative Regulations. The regulations specify the branch-specific minimum requirements of discharged waste water quality. As the legislative demands of WHG also apply to the production methods themselves, the Federal Government has prepared lists of measures concerned as "generally acknowledged rules of technology" and "state of the art technology" in the pulp industry.

The concept of Best Available Technology is also one main item in the EU directive "Integrated Pollution Prevention and Control". BAT emphasizes or:

- the use of low waste technology,
- comparable processes or methods which have recently successfully tried out,
- technological advances and changes in scientific knowledge and understanding,
- the nature and volume of the emissions concerned,
- the consumption of raw materials and energy,
- the furthering of recycled substances used within the process.

The concept of BAT is a major shift within the framework European environmental legislation. In the US the Pollution Prevention Act from 1990 is aimed towards similar goals.

In Sweden, the most important environmental legislation is based on The Environment Protection Act of 1969 and the Environment Protection Ordinance of 1989. This legislation aims at preventing water and air pollution, noise and other disturbances by practical and economical achievable means.

The Act includes rules which define the conditions upon which a polluting activity may be permitted. The basic principle is that disturbances must be prevented where this is practically feasible, and that unnecessary disturbances should not be tolerated under any circumstances.

These general principles are implemented mainly through a comprehensive system of licensing. The construction, expansion or other alteration of certain types of facilities requires a permit, while notification will be sufficient for minor pollution sources.

The Natural Resources Act of 1987 contains basic regulations on the conservation and development of natural resources, special regulations for certain geographical areas, and regulations concerning Government approval of permits for certain classes of industrial development.

This Act stipulates that the location of an industrial facility which affects the conservation of the country's land and water resources in a vitally important manner is subject to Government approval. New pulp and paper mills belong in this classification.

Disposal of chemicals is regulated by the Ordinance on Hazardous Waste (1986). This Ordinance applies to certain types of chemicals, such as solvents, oil waste, acid and alkaline waste, heavy metals, PCB and pesticides. Disposal, transportation or exportation of these substances is not allowed without special permission.

The Swedish forest industry and the authorities have jointly funded environmental research programs since 1970. The results of these projects have been used as a common basis of knowledge, both by industry and by environmental authorities in developing guidelines for environmental policies. The Ministry of Environment and Energy has the overall responsibility for environmental questions and policy at the Government level. An Environmental Advisory Committee provides the Government with advice and information. The National Environmental Protection Board (Naturvardsverket) is the central administrative authority in the environmental sector. The Licensing Board for Environmental Protection and the County Administration Boards are responsible for licensing according to the Environment Protection Ordinance.

The main responsibility for environmental protection at the regional level is with the County Administration Boards. Under the Environment Protection Act and the Health Protection Act, these county administration boards have been given the authority and responsibility for regional supervision of environmental protection.

In the ten-year program prepared by the Environmental Protection Board in 1992, the Board defines three levels of emissions from the pulp and paper industry processes. These levels represent the current discharge level, the Best Available Technology level and a future potential discharge level.

This program is aimed towards the reduction from a current level of 1 - 4 kg sulphur per ton of air dried pulp (containing 10 percent moisture) to a BAT standard of 1 - 1,5 kgS/ADt and to a future Potential of 1 kg S /ADt, where the largest reduction potential is found in the recovery boiler and the incineration of Non Condensable Gases.

Again: it was Germany which has set stringent minimum requirements for pulp and paper effluents. As Germany has no kraft pulp production the requirements were only set for sulfite pulp production and for paper production including mechanical pulping. For sulfite pulping the COD is set at 70 kg/ADt, BOD at 5 kg/ADt, AOX at 1 kg/ADt and Toxicity at a level of 2. For paper production also TSS is limited at 50 mg/l, COD between 2 and 9 kg/ADt, BOD between 1 to 3 kg/ADt, Nitrogen at 10 mg/l, total phosphorus at 3 mg/l and AOX at 0,04 kg/ADt or lower.

TSS stand for Total suspended Solids and measures the dry mass of solids which are retained on a specific filter after filtration. COD stands for the Chemical Oxygen Demand test, that measures the total organic carbon. The Biochemical Oxygen Demand (BOD) test is defined as the amount of oxygen required by living organisms engaged in the utilization and stabilization of organic matter present in the wastewater during a certain time period, typically five or seven days. It measures the biodegradable organic carbon. When comparing BOD figures, it should be noted that in Scandinavia, BOD is measured during a 7 day period while other areas measure a 5 day BOD. AOX (Adsorbable Organic Halide) compounds are formed in the bleaching process when chlorine or chlorine-based chemicals are used for bleaching. Toxicity determines a dilution factor using specific kind of fish as a testing animal. NH₃-N and Total P stand for nitrogen and phosphorous content of the wastewater.

In Sweden, organic material discharge is regulated mostly as COD, while BOD is the predominantly regulated parameter for organic matter in the U.S., Canadian and Finnish mills. Most mills in Finland have phosphorus limitation in their permits. In other areas only a few mills may have limitations for nutrient discharges. AOX discharges are regulated in the Scandinavian countries and in most Canadian provinces. Two U.S. states (Washington and Oregon) have issued permits with AOX limits. The current AOX limits for bleach kraft vary between 0,3-1,5 kg/ADt. The averaging period is, however, different in Scandinavia (annual average) and North America (monthly or even daily averages).

The future developments in the field of wastewater regulations are determined by several international organizations and regulatory bodies. Two of them are mentioned in this context the US Environmental Protection Agency and the Nordic Council of Ministers.

The future trend in Scandinavia will be affected by regulations issued by the European Union (not promulgated as of this date) and agreements by Nordic countries, as well as other international organizations. In 1993, the Nordic Council of Ministers proposed general limits on AOX, COD, phosphorous and nitrogen on all Scandinavian mills by the end of this century. The limits proposed by EPA are more stringent than those proposed by the Nordic Council of ministers.

In the sector of waste management Germany has issued, as in other fields of pollution control, very stringent regulations. The legally binding obligation to avoid waste relates

on the one hand to the introduction of low waste industrial production processes and on the other hand to the promotion of the manufacture of low waste products.

Waste avoidance in production processes includes, for instance, recycling and recovery of active ingredients (chemicals, water, oils, and solvents) in production processes.

"Low waste Products" refers to the obligation of the producers to take on responsibility for the products they make. This obligation means that products should, as far as possible, be designed in such a way that, in their manufacture and use, waste generation is avoided and that, at the end of their life cycle, as high a level of environmentally sound disposal as possible is guaranteed.

This goes together with the permanent increasing prices for waste disposal on landfills. Therefore, this waste legislation represents the consistent implementation of the polluter pays principle.

Air Emission Limits According to TA Luft in Germany

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Air Emission Parameters	mg/Nm ³
Particulate	
Boilers < 5 MW	250
Boilers 5 - 50 MW, Oil	80
Boilers 5 - 50 MW, other Fuels	50
SO₂	
Boilers 5 - 50 MW, Solid Fuel	400 - 500
Boilers 5 - 50 MW, Oil	1.700
NO_x, as NO₂	
Boilers, Sulfite Recovery	1.700
Boilers 20 - 50 MW, Solid Fuel	300 - 500
Boilers 1 - 100 MW, Oil or Gas	700 - 450

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Best Available Technologies According to the EC Directive emphasizes on

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- The use of low waste technology
- Comparable processes or methods which have recently successfully tried out
- Technological advances and changes in scientific knowledge and understanding
- The nature and volume of the emissions concerned
- The consumption of raw materials and energy
- The furthering of recycled substances used within the process

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Emission Levels of Sulfur from Pulp and Paper Mills (according to the Swedish Environmental Protection Board)

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Process	Current Level in Sweden kgS/ADt	BAT kgS/ADt	Future Potential kgS/ADt
Kraft Recovery Boiler			
w/ Scrubber	0,1-0,2	0,1	< 0,1
w/o Scrubber	0,5-0,2	0,5	0,1
Lime Kiln			
w/o Non Condensable Gas	0,03-0,05	0,03	<0,03
w/ Non Condensable Gas	0,1-0,3	0,1	<0,1
Power Boilers		0,4-0,5	<0,3
Non Condensable Gas Incineration	0,1-0,3	0,1	<0,1
Weak Non Condensable Gas (Fugitive Emissions)	0,1-0,4	0,1	<0,1
Total Emissions in Kraft Mills	1-4	1-1,5	1

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Minimum Requirements for Discharge of Effluents from Pulp and Paper Production in Germany

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Production	TSS mg/l (1)	COD kg/ADt	BOD kg/ADt	NH3-N mg/l (2)	Total P mg/l (3)	AOX kg/ADt (4)	Toxicity (5)
Sulfite Pulping		7 (1)	5				3 (5)
Paper Production							
Woodfree, un sized	5 (1)	3	3	25	1 (3)	1 (4)	0,4 (5)
Woodfree, sized	5 (1)	6	7	25	1 (3)	1 (4)	0,4 (5)
Low freeness papers	5 (1)	9	3	25	1 (3)	1 (4)	0,4 (5)
Woodfree coated	-	7 (1)	-	25	1 (3)	1 (4)	0,4 (5)
Mechanical papers	-	7 (5) (4)	-	25	1 (3)	1 (4)	0,4 (5)
100% secondary fibers	-	5	-	25 (15)	1 (3)	1 (4)	0,4 (5)

1) Unnecessary in the case of biological treatment
 2) For effluents exceeding 500 m³/day
 3) For effluents exceeding 1000 m³/day
 4) 5 kg/t only in the case of high TMP content or peroxide bleaching
 5) 50 mg/l if specific effluent amount is below 10 m³/day
 6) Values may be higher under certain conditions
 7) 0,02 kg/t in the case of subsequent biological effluent treatment
 8) If = dilution factor

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Proposed Wastewater Emission Limits by EPA and Nordic Council of Ministers for Bleached Kraft Mills

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Area	TSS kg/ADt	BOD5 kg/ADt	COD kg/ADt	AOX kg/ADt	Color kg/ADt	Tot. P g/ADt	Tot. N g/ADt
Existing Mills:							
EPA	1.9	2.2	25	0.2	76	See Limit	See Limit
Nordic	See Limit	See Limit	70	0.4	See Limit	40	200
New Mills:							
EPA	0.383	0.365	N/A	N/A	25k	See Limit	See Limit
Nordic	N/A	N/A	15	0.2	N/A	20	150

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Principles of the solid waste legislation in Germany

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- As a matter of priority, waste is to be avoided.
- Where avoidance is not possible, waste is to be recovered as its component substances or as energy.
- Where recovery is also impossible, waste must be disposed of in an environmentally friendly way.

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Legislation, standards, and
institutions in relation to water

Ing. Erika Gašperiková, Ministry of the Environment of the SR

It is not necessary to emphasize to the expert public that the water law history is of a long tradition in our country. The previous generations were aware of irreplaceability of water for all human activities, and that is why water legislation with modern elements was developed as early as in Austria-Hungary monarchy. These laws were effective until the year 1955, when a new Act on water management No 11/1955 of Collection of Laws (Coll.) was adopted. The Act No 138/1973 of Coll. (Water Act) is effective to date. The primary role of this Act is the care for purity of surface and ground water. It provides a principle, according to which protection, conservation, and efficient use of water has to be taken into account during any surface and ground water handling. Its application in practice has shown, however, that no matter how good and progressive the Act was, it cannot improve purity of surface water by administrative means alone.

For the purpose of evaluating water quality in water courses, especially due to the impact of waste water, systematic monitoring of water quality was introduced in Slovakia in 1963.

In recent years, water quality in Slovakia has been monitored in 290 profiles, which are situated on 106 water courses. Monitoring is related to the most important stretches of water courses, where the courses suffer the most severe impact of waste water from significant sources of pollution.

The basic manner of evaluating surface water quality in Slovakia is rating in 5 categories of purity (1-st category: water very clean, up to 5-th category: water very severely polluted).

The scope of analyses and quality rating is being carried out in six groups of indicators (oxygen regime, principal physical and chemical indicators, heavy metals, biological and microbiological indicators, and radioactivity indicators). The most general evaluation of surface water quality is focussed on oxygen regime indicators group.

At present we can state that the situation in development of surface water quality is unacceptable, despite the fact that in the recent years the overall amount of pollution discharged into waters has been reduced. The positive changes that we have registered in the recent years in quality of several stretches of surface courses are due to the reduction of pollution discharged from point sources. These changes result from a gradual reduction in production, as well as implementation of necessary technical and technological measures in production, from closing down ecologically unsuitable productions, and from operations of new or expanded waste water treatment plants.

For example, closing down pulp production in Gemerská Hôrka had a positive impact on water quality in the Slaná river (in the oxygen regime from the 5-th category to the 2-nd category). Due to closing down pulp production in Žilina, the public sewerage discharged into the Váh river 140t BOD₅ in 1993, while in 1992 the amount of organic pollution in terms of BOD₅ was 995.5t. Pulp and paper plant in Štúrovo discharged into the Danube river organic pollution in BOD₅ terms 1350.2t in 1993, while in 1990 it was 6774.7t. Reduction in pollution discharged by pulp and paper industry is shown in the Table:

Discharged pollution - pulp and paper industry

Indicator	unit	1990	1991	1992	1993
amount of the waste water	1000 m ³ /d	216.4	138.4	143.6	107.8
BOD	1000 kgC ₅ /d	29.0	17.0	13.5	5.2
CHOD	1000 kgO ₂ /d	98.5	55.2	63.8	14.9
Insol. solids	1000 kg/d	34.5	38.9	13.3	8.1

Even though the pollution discharged into rivers has decreased in the recent years, we cannot be satisfied with current situation. It is a result of insufficient attention paid to waste water treatment in the last decades.

A thorough application of responsibility of individual waste water generators is the essential measure towards correcting the current unfavourable situation. The first step was cessation of granting governmental consents (exceptions) to discharges of waste water differently than under the Act.

By the Resolution of the Government No 82/1991, all exceptions on waste water discharge differently than under the law were cancelled.

New conditions were created for assessment of waste water discharge by adoption of the Governmental Decree No 242/1993 of Coll., which constitutes indicators of the acceptable level of water pollution. The Decree introduced emission standards in line with the EU legislation. This piece of legislation is based on needs for comprehensive protection of water ecosystems, while the emphasis is placed on preventive measures in the direction of gradual improvements of water quality in water courses.

The values of emission indicators of pollution take into account the current technological level of waste water treatment in our country. At present the emission values of pollution indicators are not set for all industries. They are set for municipal and sewage water, as well as for 29 industries of manufacturing and food production. The emission limits are going to be gradually supplemented.

Emission limits for pollution are established by two values: one for the present time, effective until the year 2004 and the other - more stringent, effective from the year 2005. This piece of legislation places a big responsibility on water management

authorities, and it also emphasizes their expertise, since the emission limits are set in the form of a threshold value that must not be exceeded and the water authority according to the local conditions can set the values even more stringent. If pollution of waste water exceeds the acceptable level determined by the Governmental Decree, which establishes indicators of acceptable water pollution, the water authority is obliged to decide whether it will allow continuation of its discharging. If the authority allows temporary discharging of waste water, in its decision it must set the conditions of such discharging. Under the Act of the National Council of the Slovak Republic (NC SR) No 238/1993 of Coll., such an arrangement is of a transitory nature, and the water authority will determine the period of validity of such temporary permit, which can be at the latest until September 30, 2002.

For the paper and pulp industry, the emission limits for discharged waste water are set as follows:

Pulp production:		until Dec.31, 2004	from Jan.1, 2005
BOD ₅	mg/l	100	50
Insol. solids	mg/l	100	50
C OD-Cr	mg/l	500	250

Paper production:

BOD ₅	mg/l	50	40
Insol. solids	mg/l	60	40
C OD-Cr	mg/l	250	200

The target standards of emission at the recipient for surface water for specific organic substances are published in methodological instructions for the Governmental Decree No 242/1993 of Coll.. For adsorbable organically bound halogens (AOX) this value is 0.05mg/l.

As for the legislation related to the economic tools of water protection, the law on fees/rates for the environment is being drafted, a part of which will also be fees for discharging waste water into surface waters.

At present, a new water act has been drafted, in which new social and economic conditions in our country are reflected, and which applies new principles and standards for protection of waters that are being applied in the developed countries.

The major problem in capital investments aimed at water protection, is the lack of financial resources. The Ministry of the Environment administers the State Fund for the Environment of the SR (SFE SR), which, however, is only a supplementary fund and it is impossible for it to cover all the financially intensive ecological constructions. Currently the SFE SR provides funding first of all on completion of sewerage and waste water treatment plants in smaller municipalities that have very limited financial resources for such constructions. Under new economic conditions it is not possible to expect of the government to deal with comprehensive waste water treatment. The responsibility for polluting is currently being taken over by polluters.

At the international level, the water pollution is being dealt with under the international Environmental Programme for the Danube River Basin that is sponsored by the European Union and foreign banks. The first phase of the Programme, which identified the sources of pollution and set priorities for affected areas, has already taken place. Analyses of the current condition of the environment in the Danube subbasins - formed by its major tributaries - were carried out. In the second phase, the projects that were agreed upon in the first phase will be developed. They will include production restructuring, introduction of new technologies, and support to investment plans with foreign capital assistance in the form of loans.

In conclusion I would like to mention that the Government of the SR adopted the „Strategy, principles, and priorities of the national environmental policy“, in the framework of which there are main objectives set for protection of waters. One of the principal objectives is to improve the quality of surface water courses down

to the 2-nd category for the water supply courses, and to 3-rd category for other surface courses. This objective can only be achieved step by step, and through a joint effort of waste water generators and state administration bodies.

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**LEGISLATION RELATING TO AIR PROTECTION
IN THE SLOVAK REPUBLIC**

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Through the passage of the Act no. 309/1991 Coll.¹⁾ on the Protection of Air from Pollutants (the Air Act), new principles governing air protection started to be formed in 1991 year. This Act is the principal substantive law on air protection in the Czech and the Slovak Republics, thus constituting a basis for other legislation relating to air protection. The legal framework for air protection is not yet complete in the Slovak Republic. The laws being issued are harmonized with the directives of the Council of European Union. So far the following legislation has been passed and taken effect:

Act no. 309/1991 Coll. on the Protection of Air from Pollutants (the Air Act) as amended by the Act no. 218/1992 Coll. and the Act of the National Council of SR no. 148/1994 Coll. (the full wording is available in the Act no. 31/1995 Coll.);

Act of the Slovak National Council no. 134/1992 Coll. on State Administration of Air Protection as amended by the Act of the National Council of SR no. 148/1994 Coll. (the full wording is available in the Act no. 32/1995 Coll.);

Act of the Slovak National Council no. 311/1992 Coll. on Fees Charged on account of Air Pollution;

Action of the Federal Committee for Environment no. 309/1991 Coll. on Air Protection from Pollutants of 1 October 1991;

Regulation of the Slovak Committee of Environment no. 407/1992 Coll. whereby the schedules categorizing pollution sources and pollutants as well as their limits are laid out and details on the specification of emission limits for existing air pollution sources are enacted;

Regulation of the Ministry of Environment of SR no. 111/1993 Coll. on issuing experts' reports in matters of air protection or wastes, appointing persons authorized to issue these reports and on certifying the qualifications of these persons, as amended by the Regulation of the Ministry of Environment of SR no. 53/1995 Coll.;

Regulation of the Ministry of Environment SR no. 112/1993 Coll. on specifying areas that need special air protection and on operating smog alert and control systems.

The said legislation supports air protection. In doing so, it mainly draws on the following principles:

- in producing/importing/forwarding/selling equipment, products and material that - when consumed or dumped - pollutes or may pollute air, any producer

/importer/forwarder/seller must elect a solution that supports air protection;

- in constructing new facilities that may become a source of air pollution, or in upgrading already existing facilities, so called best available technologies must be elected, while considering adequacy of the cost of their acquisition and operation;
- defined and specified are emission limits on air pollution at both source and recipient and imposed thereby is an obligation on the part of source operators to comply with these emission limits and general operating conditions and to permanently operate a source in line with the approved operating conditions;
- From the time they are put into operation, newly built sources of air pollution must comply with the emission limits earmarked for new sources. As for already existing sources, air protection authorities set individual emission limits as well as periods within which these sources must reach the emission limits imposed on new sources. The period within which these limits for new sources will have to be achieved by already existing sources, could have been set at no later than 31 December 1998. Following that period all large and middle-sized sources will have to observe the emission limits that are earmarked for new sources of air pollution;
- obligations with respect to the operation of a source and compliance with emission limits also apply to operators of mobile sources;
- completion of new constructions and implementation of new technologies that will become a source of air pollution or alterations to their use or operation may only be carried on with the approval of air protection authorities;
- in reviewing and approving structures of air pollution sources or making alterations as to their use and operation, a system has been established that makes it possible for air protection authorities to request expert's opinion on the object under approval. Expert reports may only be prepared by experts with theoretical and practical background authorized to that end by the Ministry of Environment of the Slovak Republic;
- air protection authorities are empowered and obliged to shut down or cut back the operation of a pollution source as long as this source is not operated in compliance with conditions regulated thereby;
- in areas that need special air protection, authorities involved in air protection are allowed to put forward more stringent requirements on air protection support;
- air pollution is subject to fee liability depending on the amount and harmfulness of exhausted pollutants;
- failure to meet obligations on the part of source operators is sanctionable.

Under the Act of the SMC no. 134/1992 Coll. on State Administration of Air Protection as amended by the Act of NC

SR no. 148/1998 Coll., state administration in the area of air protection in the Slovak Republic is effected by the following authorities:

- a) Ministry of Environment of the Slovak Republic;
- b) Slovak Environmental Inspection;
- c) offices of environment;
- d) municipalities.

The Ministry of Environment of the Slovak Republic is an authority of the central government and it oversees the administration by the government of matters related to air protection and it is the main body to carry on state supervision. It is also vested with other powers of an authority of government.

The Slovak Environmental Inspection is a technical and regulatory body through which the Ministry of Environment of the Slovak Republic carries on state supervision in matters of air protection. The Inspection makes audits of the sources of air pollution and upon the establishment of any default it proposes corrective action and imposes fines.

In conducting its business it co-acts with offices of environment and municipalities and it provides to them technical assistance, especially in relation to approving proposals, projects, actions and applications that impact on air and the specification of emission limits for existing sources.

Regional offices of environment direct activities of regional offices of environment and they are an appellate authority in matters on which district offices of environment and municipalities have passed a judgment within a first-degree administrative proceedings. They are authorized to issue generally binding ordinances in matters of air protection within their jurisdiction and they are also vested with some first-degree decision-making powers such as cutting back or shutting down the operation of a large or middle-sized pollution source if the merits of a case would substantiate such action.

38 regional offices of environment have been set up in the Slovak Republic, of which 7 are authorized to administer air-protection affairs on behalf of the government. They are: the Office of Environment of the capital of SR Bratislava, the Regional Office of Environment Bratislava - the rural area, ROE Nitra, ROE Žilina, ROE B. Bystrica, ROE Poprad, and ROE Košice-rural area.

District offices of environment, as a first-degree authority of the government in matters of air protection, are vested with full powers with respect to large and middle-sized sources of pollution. These powers mainly consist in giving approvals to the establishment and operation of sources, auditing; taking corrective action; deciding on fees and imposing fines.

44 of 121 district offices of environment in SR are authorized to administer air-protection affairs on behalf of the government. These 44 offices are grouped from among district offices of environment in each district town; district offices of environment in each district of Bratislava and the District Office of Environment of Ružomberok and Brezno towns.

By operation of law the execution of state administration

over small sources of pollution has been on a full scale vested in municipalities. They possess the powers needed to that end.

According to the categorization of pollution sources, the production of pulp and its derivatives falls under large sources and the production and treatment of paper falls under middle-sized sources. Ensuing from that is an obligation on the part of these groups of sources to observe the respective emission limits.

To new sources in the pulp and paper industry general emission limits are applicable, while to some technologies specific emission limits apply that are set forth by the Action of the Federal Committee of Environment of 1 October 1991 (that supplements the Air Act) and by the Regulation of the Slovak Committee for Environment no. 407/1992 Coll.

The specific emission limits set on the incineration by new pollution sources of liquor from their pulp production are as follows:

- sulfite and neutral sulfite processes:

solid pollutants (SP)	-	100 mg/m ³
SO ₂	-	700 mg/m ³
NO _x as NO ₂	-	400 mg/m ³
H ₂ S	-	40 mg/m ³

- kraft process:

solid pollutants	-	100 mg/m ³
SO ₂	-	450 mg/m ³
NO _x as NO ₂	-	300 mg/m ³
compounds containing reduced sulphur as H ₂ S	-	20 mg/m ³

The said emission limits apply to moist gas under normal conditions at an 11% oxygen content.

As for other pollutants let out from these technologies or other sources of air pollution in pulp and paper industry, generally binding emission limits shall apply.

Emission limits which are generally binding on new sources, refer to concentrations in moist gas under the normal conditions of 101.32 kPa and zero degrees centigrade.

SP	-	200 mg/m ³ at the mass flow of less than 2.5 kg/hr
	-	150 mg/m ³ at the mass flow of more than 2.5 kg/hr
SO ₂	-	2500 mg/m ³ at the mass flow of more than 20 kg/hr
NO _x as NO ₂	-	500 mg/m ³ at the mass flow of more than 10 kg/hr
CO	-	800 mg/m ³ at the mass flow of more than 5 kg/hr

The group of gaseous inorganic pollutants:

Br and its compounds as HBr
F and its compounds as HF
Chlorine
HCN
H₂S

at the mass flow of more than 100 g/hr, the sum total of concentrations of these substances in a carrier gas must not

exceed the limit of 10 mg/m³.

The group of gaseous inorganic pollutants:

NH₃
inorganic chlorine compounds as HCl

at the mass flow of more than 500 g/hr, the sum total of concentrations of these substances in a carrier gas must not exceed the limit of 50 mg/m³.

For the group of pollutants (organic gases and vapours) including mercaptan and thioethers, it holds that at a mass flow of more than 100 g/hr, the sum total of concentrations of these substances in a carrier gas must not exceed the limit of 20 mg/m³.

NOTES BY TRANSLATOR

¹) Coll. = abbreviated form of "Collection of Laws"
(= "Digest of Laws")

Legislative norms for waste management, especially for waste landfilling valid in the Slovak Republic

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In the Slovak Republic is produced annually 34 mil. t of wastes.

The control of the waste management is in the Slovak Republic a relatively new problem. Until 1991 did not exist any special legal standart concerning with wastes. In 1991 entered into force the Act No. 238/1991 D.A. on Waste, in which were given the basic rights and duties of state authorities and the duties of legal and natural persons in waste handling. In the mentioned act the waste is defined as an article that is to be disposed of by its generator, or a movable asset that has to be disposed of (eliminated) for health and environmental reasons. According this act the legal and natural persons are responsible for waste handling and shall reduce waste production to a minimum level.

In handling waste, everyone shall protect people's health and the environment and, simultaneously, create conditions for waste recycling and disposal. Legal and natural persons are allowed to landfill or dispose of waste in such areas, objects and facilities only that have been designed for this purpose.

The generator of wastes has a duty to:

- elaborate a waste management programme on a scope prescribed by a special regulation and submit it to the responsible state authority for approval,
- accumulate the waste produced according to its types and secure it from deteriorating, misappropriating and any other undesired escape,

- accumulate hazardous waste separately according to its type, designate it in a prescribed manner and handle it in accordance with special regulations,
- report on the production, amount, character and method of recycling or disposal of special waste to the responsible state authority depending on his seat; the scope and appropriate measures are specified in Procedural Regulations,
- utilize waste as a source of secondary raw materials or power, for one's own activities in particular; offer non-used waste to someone else,
- secure waste disposal in case it cannot be used,
- keep on file the types and amounts of produced waste, its dumping, recycling or disposal; the scope and appropriate measures are specified in Procedural Regulations,
- allow an access of regulatory authorities into areas, rooms and facilities, and, if required, provide all documents and true and full information concerning their waste management activities,
- include data on the way of use of discardable parts of products or containers as a source of secondary raw materials or power, or a recommended way of disposing them in the accompanying documents, on the container or in enclosed instructions for use.

The Act No. 238/1991 D.A. was followed by another legal norms:

- The Procurement of the Federal Committee for Environment, part 69/1991 D.A., which announces the Categorization and Catalogue of Waste

- The Act of SNC No. 494/1991 D.A., on Waste management state administration
- The SCE Public notice No. 76/1992 D.A. on Waste management programs
- The Act of the SNC No. 309/1992 D.A. on Charges for waste deposits
- The Regulation of the Government of the Slovak Republic No. 605/1992 D.A. of Recording of waste
- The Regulation of the Government of the SR No. 606/1992 D.A. on waste disposal
- The Public notice of the ME SR No. 11/1993 D.A. SR on Emitting of expert statements in matters of air protection of in matters of waste, on assignment of persons authorized to emit expert reports and on verification of professional liabilities of these persons.

Catalogue of Waste contains list of wastes and theirs code numbers. In this document are given also categories of wastes, i.e. other (O), special (S) and hazardous (H).

In pulp and paper industry are mostly generated following types of wastes:

Code	Type	Category
17101	Bark	O
17102	Chunks, chips, solid block waste	O
17103	Sawdust, wood shavings	O
18101	Sludge arising from cellulose production	O
18102	Residues arising from chemical regeneration in cellulose production	S
18401	Residues arising from paper production (broke)	O
18402	Sludge arising from paper production	O
18404	Sludge arising from cellulose fibre production	O
18701	Scrap of paper and cardbord	O
18707	Waste paper	O

31301	Fly ash and dust	H
31305	Coal and coke ash	H
31306	Wood ash	O
31307	Coal cinders and clinker	S
31314	Solid reaction products arising from flue gas cleaning from power plants except gypsum	H
31315	Gypsum arising from desulphurization of flue gas from power plants	S
52708	Sulphite spent liquor	S
94101	Sedimentary sludge	O
94102	Sludge arising from water softening	O
94103	Sludge arising from water clarification	O

Some of these wastes is possible to re-use, bark, sawdust etc. should be used as source of energy, but for many wastes generated in pulp and paper industry the final disposal is required. The main method of waste disposal in our country is the landfilling.

The conditions of waste disposal are given in the Regulation of the Government of the SR No. 606/1992. In this Regulation are given duties of waste producer and duties of operator of disposal facility.

The special prescriptions for landfilling contain Paragraphs 17 - 27. In this part of the Regulation are defined the waste, which must not be landfilled:

- liquid waste, unless kept in closed containers,
- explosive waste,
- containers containing gases under pressure,
- materials reacting violently in contact with water, mainly by developing heat or gases,
- self-igniting materials and Class I combustibles,
- waste which may spread infectious diseases¹⁶⁾ or mass sickness of animals,
- non-decontaminated waste from health care institutions,

- waste containing harmful substances in excess of the amounts shown in Appendix 3 to this Regulation (see below).

According to the Regulation, landfills are divided into three construction classes depending on the leachability class of the waste they are permitted to accept. The construction design of the landfill sealing system is defined by this Regulation, in dependence on the landfill site subground.

Landfills of the first construction class may be used to landfill waste whose leachate quality does not exceed the Class I. limit values. Waste whose leachate, after having been treated in compliance with Paragraph 21 of this Regulation fails to meet requirements of Leachability Class I. may not be landfilled in these landfills.

Landfills of the second construction class may accept waste whose leachate quality does not exceed the Leachability Class II. limit values.

Landfills of the third construction class may accept waste whose leachate quality does not exceed the Leachability Class III. limit values.

Waste whose leachate is classified as Leachability Class IV. shall be treated with the objective that its aqueous leachate would, after such treatment, meet at least the requirements specified for Leachability Class III.

In case the leachate quality of waste failed to meet at least the requirements for Leachability Class III. even after being treated and the waste cannot be disposed of by other methods, it shall be landfilled on specially designated landfill.

Leachate in the context of this Regulation is defined as solutions of substances, dissolved in deionized water and prepared by leaching of one part of dry matter with ten parts of water at $20\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ in the course of 24 hours.

Generators shall classify waste by the quality of the leachate into four leachability classes in accordance with Appendix 4 to this Regulation (see below).

Leachate of Leachability Class I. must not exceed the values specified in Table 1 of Appendix 4 to this Regulation. Should the underground water into which water from waste landfills has been leaked show inferior quality with respect to one or more parameters specified in the above Table, then such parameters are decisive for the classification of waste to the Leachability Class I. Non-leachable waste cannot be included into this class.

Leachate of Leachability Class II. shall not exceed values shown in Table 2 of Appendix 4 to this Regulation. Leachability Class II includes leachate from waste exceeding the limit values shown in this table in three parameters at most, with the exception of those to whom Note 2 is applicable. Leachate of Leachability Class II may be released into surface recipients after mechanical treatment.

Leachate of Leachability Class III. shall not exceed values shown in Table 3 of Appendix 4 to this Regulation. Leachate Class III includes leachate from waste exceeding the limit values shown in this table in three parameters at most, with the exception of those to whom Note 2 is applicable.

Waste whose leachate cannot be classified as Leachability Class III shall be classified as Leachability Class IV.

Appendix 3 to the No.606:1992 (Digest) Regulation of the
government of the Slovak republic

Limit concentrations of substances in waste

Parameter	Limit value (mg/kg O.D. matter)
Sum of polycyclic aromatics	100
Sum of polychlorinated biphenyls	100
Extractable halogenated organics (extract)	100
Cyanides, easily liberated	10,000
Sum of hydrocarbons (mineral oil) (hexane extract)	50,000
Benzene, toluene, xylenes	5,000
Phenols	10,000
Mercaptan	1,000
Mercury	3,000
Arsenic ¹⁾	5,000
Lead ¹⁾	10,000
Cadmium	5,000
Nickel ¹⁾	5,000
Soluble (at 20 °C) salts ²⁾	300,000

1) These limits do not apply to vitrified or semi-vitrified waste
(e.g. hardened rests of paints, varnishes, waste incorporated
in glass, ceramic or concrete products).

2) Determined as filter residue after filtration of extract,
calculated per dry matter.

Appendix 4 to the No.606:1992 (Digest) Regulation of the
government of the Slovak republic

Leachate classes

Table 1: Limit concentrations of substances in
aqueous extracts - Leachate class 1

Parameter	Unit	Limit ¹⁾
pH	-	5.5 - 10
Conductivity	mS/m	100
Odour		None
Biological test		2)
Polycyclic aromatics	mg/l	0.002
Phenols ³⁾	mg/l	0.010
Chemical oxygen demand ⁴⁾	mg/l	20
Total hydrocarbons	mg/l	0.1
Volatile halogenated organics	mg/l	0.03
Anionic surfactants ⁵⁾	mg/l	0.1
Benzene, toluene, xylenes	mg/l	0.03
Calcium	mg/l	6)
Magnesium	mg/l	6)
Aluminium	mg/l	0.2
Antimony	mg/l	0.05
Arsenic	mg/l	0.05
Barium	mg/l	1.0
Beryllium	mg/l	0.005
Borone	mg/l	0.5
Lead	mg/l	0.05
Chromium (total)	mg/l	0.005
Chromium (hexavalent)	mg/l	0.02
Iron	mg/l	1.0
Cobalt	mg/l	0.05
Copper	mg/l	0.1
Manganese	mg/l	0.1
Nickel	mg/l	0.1
Mercury	mg/l	0.001
Selenium	mg/l	0.01
Silver	mg/l	0.1
Thallium	mg/l	0.01
Vanadium	mg/l	0.05
Zinc	mg/l	3.0
Tin	mg/l	0.05
Fluorine	mg/l	1.5
Ammonia	mg/l	0.1
Chlorides	mg/l	200
Cyanides (total)	mg/l	0.05
Cyanides (easily liberated)	mg/l	0.01
Nitrates	mg/l	50
Nitrites	mg/l	0.1

Phosphates	mg/l	1.0
Sulfates	mg/l	250

- 1) Outside of water protection areas
- 2) In special cases only (not yet generally specified)
- 3) Steam-removable phenols (determined as phenol index)
- 4) Oxidable with KMnO₄
- 5) Anionic surfactants, calculated as sodium dodecylsulfonate
- 6) Limited by the conductivity value.

Table 2: Limit concentrations of substances in aqueous extracts - Leachate class 2

Parameter	Unit	Limit ¹⁾
pH	-	5.5 - 13
Conductivity	mS/m	300 ²⁾
Odour		3)
Biological test		4)
Polycyclic aromatics	mg/l	0.003 ²⁾
Phenols ⁵⁾	mg/l	1.0
Chemical oxygen demand ⁴⁾	mg/l	80
Total hydrocarbons	mg/l	5.0
Volatile halogenated organics	mg/l	0.1 ²⁾
Anionic surfactants ⁶⁾	mg/l	2.0 ²⁾
Calcium	mg/l	7)
Magnesium	mg/l	7)
Aluminium	mg/l	10 ²⁾
Antimony	mg/l	0.1 ²⁾
Arsenic	mg/l	0.1 ²⁾
Barium	mg/l	10
Beryllium	mg/l	0.005 ²⁾
Borone	mg/l	3.0
Lead	mg/l	0.5 ²⁾
Cadmium	mg/l	0.05 ²⁾
Chromium (total)	mg/l	1.0 ²⁾
Chromium (hexavalent)	mg/l	0.1 ²⁾
Iron	mg/l	20
Cobalt	mg/l	0.5 ²⁾
Copper	mg/l	1.0 ²⁾
Manganese	mg/l	10
Nickel	mg/l	0.5 ²⁾
Mercury	mg/l	0.005 ²⁾
Selenium	mg/l	0.1
Silver	mg/l	0.1 ²⁾
Thallium	mg/l	0.01 ²⁾

Vanadium	mg/l	0.05 ²⁾
Zinc	mg/l	3.0 ²⁾
Tin	mg/l	0.5 ³⁾
Fluorine	mg/l	5.0 ²⁾
Ammonia	mg/l	5.0 ²⁾
Chlorides	mg/l	7)
Cyanides (total)	mg/l	0.5 ²⁾
Cyanides (easily liberated)	mg/l	0.1 ²⁾
Nitrates	mg/l	7)
Nitrites	mg/l	0.1 ²⁾
Phosphates	mg/l	10.0
Sulfates	mg/l	7)
Sulfides	mg/l	1.0

- 1) Max.3 parameters may be exceeded, except those marked
- 2) Limit values must not be exceeded
- 3) Value included in the test protocol
- 4) In special cases only (not yet generally specified)
- 5) Steam-removable phenols (determined as phenol index)
- 6) Anionic surfactants, calculated as sodium dodecylsulfonate
- 7) Limited by the conductivity value.

Table 3: Limit concentrations of substances in aqueous extracts - Leachate class 3

Parameter	Unit	Limit ¹⁾
pH	-	5.5 - 13 ²⁾
Filter residue of dry matter	mg/l	20,000
Polycyclic aromatics	mg/l	0.005 ²⁾
Phenols ³⁾	mg/l	100
Total hydrocarbons	mg/l	100 ⁴⁾
Volatile halogenated organics	mg/l	5.0
Extractable halogenated organics	mg/l	10.0
Calcium	mg/l	5)
Magnesium	mg/l	5)
Aluminium	mg/l	5)
Antimony	mg/l	5.0
Arsenic	mg/l	5.0
Barium	mg/l	50
Beryllium	mg/l	0.5
Borone	mg/l	100
Lead	mg/l	10.0
Cadmium	mg/l	0.5 ²⁾
Chromium (total)	mg/l	50.0
Iron	mg/l	5)
Cobalt	mg/l	10.0
Copper	mg/l	10.0 ²⁾

Manganese	mg/l	5)
Nickel	mg/l	50.0
Mercury	mg/l	0.05 ²⁾
Selenium	mg/l	5.0
Silver	mg/l	5.0
Thallium	mg/l	2.0 ²⁾
Vanadium	mg/l	20.0
Zinc	mg/l	100
Tin	mg/l	100
Fluorine	mg/l	50.0
Ammonia	mg/l	5)
Chlorides	mg/l	5)
Cyanides (total)	mg/l	20.0 ²⁾
Cyanides (easily liberated)	mg/l	10.0
Nitrates	mg/l	5)
Nitrites	mg/l	5)
Phosphates	mg/l	5)
Sulfates	mg/l	5)

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- 1) Max.3 parameters may be exceeded, except those marked
 - 2) Limit values must not be exceeded
 - 3) Steam-removable phenols (determined as phenol index)
 - 4) Total hydrocarbons (e.g. hexane-extracted)
 - 5) Limited by the soluble part.

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Introduction

The contribution to the this UNIDO workshop for Pulp and Paper Industry consists of three chapters. Chapter 1 gives an overview on the emission legislation in Europe and future trends of regulations. Chapter 2 covers recent developments on Environmental Management Systems and Environmental Auditing. It is based on the British Standard BSI 7750, on the International Standard (currently available as a committee draft) ISO 14.000 and on the Council Regulation #1836/93 of the Council of the European Union. Chapter 3 summarizes the developments in pollution abatement technologies in the fields of waste water treatment, air pollution control and waste management.

- Environmental Management Systems and Environmental Auditing

Until now, a company was looked at from different angles, like the financing side, the marketing point of view and recently also the quality perspective among others. Based on a regulation from the European Union as well as on different standards (ISO 14.000 or BSI 7750) the Environmental perspective is now added to regular company performance evaluation. Therefore, the main questions, which will be answered in this chapter are

What is the meaning of an Environmental Management System?

How is such a system implemented and how does it work?

What are the benefits and what are the disadvantages of such a system?

In order to understand the meaning of the very general term management better, we will look at the finance perspective as an example, by asking „What is the overall goal of the management of a company?“

The answer is „to increase the shareholder's value within the given framework of legal constraints, within a given market, with the given human resources and others other factors of success“. In simple words he has to select the projects and ideas, which promise the highest gains, measured as the highest net present value, and he has continuously to improve operations. For example, he will have to answer a question like "Can the costs of this product be lowered"? He has to follow a specific methodology of analysis and implement the necessary changes. He might have to look at fixed costs, such as rent for space or others. He might look at variable costs, such as the purchasing process or at factors within the production process, such as work pace, rework level, or downtime. After identifying the reasons for the high costs, he has to act and to implement the changes. After a while he has to check on the improvements and to start from the beginning, if the goal was not reached, or if the process of improvement should be continued.

Of course, he has to remain within the framework set by the law for safety, health and others, such as the environment. In European countries, it is no longer enough to be just within the emission limits. Consumers ask for clean production, the market, not the legislation, is beginning to be the driving factor for using environmental technology.

In Europe, there has been a shift from very stringent emission limits and controls to a voluntary implementation of environmental good practices. There are two reasons for this development: Reason number one is that the administration is hardly capable of paying the price of more and more stringent emissions limits. All limits have to be controlled by more difficult and, therefore, expensive measurement processes. Reason number two is that consumers are interested in the environmental performance of companies. Therefore, environmental performance has become a driving factor of the market. To say it in simple words: a product sells better, if it is produced in an environmental safe way and if the consumer is informed about this fact.

The question which has to be answered, is "How is the consumer informed in an objective way and how is he assured that the information is accurate?" The answer is a standardized procedure of evaluation of environmental performance by an independent expert and an environmental statement, which contains relevant facts for the consumer.

Definitions and standards

A first standard was set by the British Standards Institute. This was followed by the regulation 1836 of the Council of the European Union and, right now, there is a worldwide draft of the International Standards Organization in discussion.

In the BSI standard environmental management is defined as those aspects of the overall management function (including planning) that determine and implement the environmental policy. That means, management has to define the environmental policy as a first step. The policy should state the company's commitments, for example like „reduce waste and the consumption of resources (materials, funds and energy)". The new ISO 14.000 draft defines Environmental Management a little further by saying that Environmental Management includes those aspects of the overall management function of an organisation (including planning) that develop, achieve, implement and maintain its environmental policy and objectives. The difference here are words "achieve" and "maintain", which are aimed towards continual improvement, which is also used in the EU regulation.

In the BSI standard the Environmental management system is defined as "The organisational structure, responsibilities, practices, procedures and resources for implementing environmental management". In the EU regulation the Environmental management system is defined very similar by saying "Environmental management system" shall mean that part of the overall management system which includes the organizational structure, responsibilities practices, procedures, processes and resources for determining and implementing the environmental policy. Finally within the upcoming ISO standard the Environmental Management System is defined as "The organisational structure, responsibilities, practices, procedures and resources for implementing and maintaining environmental management".

The steps to implement an Environmental Management System

The implementation of an Environmental Management System is likely to follow five steps after having conducted an initial review:

- setting up the policy
- the planning stage
- implementation and operations
- measure and monitor
- management review.

Then the process starts again by focusing on the potential of continual improvement.

The first step of implementing an Environmental management system is the review of the current situation. The organisation should begin where there is obvious benefit, for example, by focusing on regulatory compliance, by limiting sources of liability or by making more efficient use of materials.

As the organisation grows in experience, and its Environmental Management System starts to take shape, procedures, programs, and technologies can be put in place to further improve environmental performance. Then, as the Environmental Management System matures, environmental considerations can be integrated into all business decisions.

An initial environmental review covers the following areas:

- identification of legislative and regulatory requirements
- identification of environmental aspects, significant environmental impacts and liabilities
- evaluation and documentation of significant environmental issues
- evaluation of performance compared with relevant internal criteria, external standards, regulations, codes of practice and sets of principles and guidelines
- existing environmental management practices and procedures
- identification of the policies and procedures dealing with procurement and contracting activities
- feedback from the investigation of previous incidents of non-compliance
- opportunities for competitive advantage
- the views of interested parties
- functions or activities of other organisational systems that can enable or impede environmental performance

In all cases, considerations should be given to the full range of operating conditions, including possible incidents and emergency situations.

Building on the findings of the initial review an environmental policy has to be determined. An environmental policy establishes an overall sense of direction and sets the parameters of action for an organisation. It sets the overarching goal as to the level of environmental performance required of the organisation, against which all subsequent actions will be judged. The responsibility for setting environmental policy rests with those

with proprietary interests in the organisation, or with their delegates (the board of directors). An environmental policy should consider the following:

- the organisation's mission, vision, core values and beliefs.
- requirements of and communication with interested parties
- continual improvement
- guiding principles
- alignment with other organisational policies
- specific local or regional conditions

As guiding principles, for example, the Council of the European Union has issued an outline of good management practices, which could be used as a base for an environmental policy, in addition to compliance with environmental regulations.

After having defined the policy the planning has to begin. This contains the legal requirements, the establishing of internal performance criterias, the setting of objective and targets and the environmental management plan and program.

Several sources can be used to identify environmental regulations and ongoing changes, including:

- all levels of government
- industry associations or groups
- commercial databases
- professional services.

To facilitate keeping track of legal requirements, an organisation should establish and maintain a list of all laws and regulations pertaining to its activities. This list should contain the name of the regulation, date of issue, and if necessary an overview of the contents.

Internal priorities and criteria should be implemented where external standards do not meet the needs of the organisation.

Objectives are broad overall goals for environmental performance identified in the environmental policy. When establishing its objectives an organisation should also take into account the relevant findings from environmental reviews. These reviews lead to the identifications of specific, measureable environmental performance indicators. These indicators can be used to describe the organisation's performance or become the basis for objectives or targets.

Environmental targets can then be set to achieve these objectives within a specified time frame. The targets should be specific and measurable.

A useful distinction can be made between a longer term environmental management plan and a shorter term program. Long term planning is useful in mapping out the application of the continual improvement of environmental performance, and provides the basis for future details of an environmental management program.

A long term environmental management plan can include:

- a description of the current situation of the organisation's environmental performance at the time the plan is released
- a description of the proposed improvements of the organisation's environmental performance over the planned period
- consideration of technology requirements to implement the proposed improvements
- awareness of internal and external factors influencing the proposed improvements (eg. financial resources, legislative and regulatory developments)

A short term environmental management program can include:

- prioritisation of environmental issues
- development of options for priority issue resolution
- a cost/benefit review of these options and selection of the preferred approach
- identification of responsibility for implementation
- provision for post-implementation review and assessment

Responsibility for the overall effectiveness of the EMS is assigned to a senior person or function with sufficient authority, competence and resources. Operational managers have to define the responsibilities of relevant personnel and are responsible and accountable for effective implementation of the EMS and environmental performance. Employees at all levels are accountable, within the scope of their responsibilities, for environmental performance in support of the overall environmental management system.

Often the key item of EMS documentation is an Environmental Management Manual. The nature of this varies depending on the size and complexity of the organisation. Where elements of the EMS are integrated with an organisation's overall management system the environmental documentation is favorably integrated into existing documentation.

Measuring, monitoring, and evaluating are key activities of an environmental management system which ensure that the organisation is performing in accordance with the stated environmental management program.

There should be a system in place for measuring and monitoring actual performance against the organisation's environmental objectives and targets in the areas of management systems and environmental effectiveness of the operational processes. The results should be analysed and used to determine areas of success and to identify activities requiring corrective action and improvement.

Audits of the EMS can be carried out by organisation personnel, and / or by external parties selected by the organisation. In any case, the person conducting the audit has to be in a position to do so objectively and impartially and has to be properly trained.

The organisation's management has to conduct a review of the Environmental Management System to ensure its continuing suitability and effectiveness. This review includes:

- review of environmental objectives, targets and environmental performance
- findings of the EMS audits
- an evaluation of its effectiveness
- an evaluation of the suitability of the environmental policy and the need for changes in the light of
 - changing legislation
 - changing market preferences and changing expectations of interested parties
 - advances in science and technology.

After the management review the loop within the Environmental management system starts over again, by searching for fields of improvement. This process should focus to

- identify areas of opportunity for improvement of the EMS
- determine the root cause of nonconformances or deficiencies
- develop and implement a plan of corrective and preventive action to address root causes
- verify the effectiveness of the corrective and preventive actions
- document any changes in procedures resulting from process improvement
- make comparisons with objectives and targets.

In addition to the ISO 14.000 standard, the EU regulation encourages companies to produce and disseminate periodic environmental statements containing information for the public on the factual environmental situation for the specific industrial site. These statements and of course the environmental management system shall be examined to verify that they meet the relevant requirements of the EU regulation. The EU member countries have to provide the necessary national legislation in order to establish an independent and neutral accreditation organisation for the accrediting environmental verifiers. The deadline for the establishment of this organisation is April 1995. The accreditation system establishes, revises and updates a list of accredited environmental verifiers in each member state and shall communicate this list every six months to the Commission. The Commission shall publish an overall Community list in the Official Journal of the European Communities.

The verification of a site will involve examination of documentation, a visit to the site including interviews with personnel, preparation of a report to the company management. The independent verifier has to check

- whether the environmental policy has been established
- whether an environmental management system is in place and operational
- whether the environmental review and audit are carried out regularly
- whether the data and information in the environmental statement are reliable.

Then the verifier will validate the environmental statement and the company can apply to register at the accreditation organisation. The accrediting organisation will establish a register of sites meeting the EU regulation and the company will receive a statement of participation

Environmental auditing

An important part of the Environmental management system is the audit. The origin of the auditing profession appears to be the Roman Empire. There, announcements from the Authorities were communicated through official messengers. To ensure that the announcements were made correctly, auditors, who knew the announcement equally well as the messengers, accompanied the messenger to listen to the communication of the announcement and to evaluate the correctness: the auditing. Since then auditing of course has been and continues to be a trend used for many years in the financial accounting profession and literature on financial auditing is abundant. More scarce is the volume of literature to be found on auditing on a more generic level.

A definition of an Audit could be: To investigate and review the actions (or inaction), decisions, achievements, statements or reports of specified persons with defined responsibilities, to compare these actions with some norm, and to form and express an opinion on the result of that investigation, review and comparison.

There is a distinction of three audit types: the environmental management system audit examines the procedures and processes within a company. The environmental statement audit validates the statement prepared by the company concerning the environmental situation. The compliance audit examines whether the operations conform to the legal regulations.

An Audit consists of three main phases, the pre-audit planning, the audit and the report of the audit findings. Within the pre-audit planning several questions have to be answered. Which environmental sector should be examined? Which part of the organisation should be examined? Who belongs to the audit team? What is the time schedule and what tasks have to be performed within the given timeframe.

The audit itself consists of five steps. In a first step the audit team has to develop an understanding of the management system and of the company that is being audited. In a second step the strengths and weaknesses are being assessed and the exact time plan for the visit of the site is being prepared. In a third step the visit of the site is being conducted and the audit evidence is collected. The findings are evaluated in a fourth step and finally the findings are reported to the management. Having the response and feedback of the management the audit report is prepared.

The contents of the audit report can be structured as following:

- description of organization audited, client
- audit team members
- scope, objectives and audit plan
- list of reference documents against which the audit is conducted
- distribution list for the audit report
- statement of confidentiality
- summary of the audit process including the obstacles encountered
- audit conclusions

The benefits from being audited are broad. The main item is to get a clear overview on the company's environmental performance. This is connected with limited liability, less insurance fees, and maybe with factors such as conservation of input materials and energy. Also soft factors will be a result of an environmental audit, such as enhanced image and easier access to obtaining permits and authorisations

The validated environmental statements are going to be collected and analysed. That will lead to the development of environmental indicators within industry branches. The companies might even be rated according to their environmental performance.

Take over Audits or Environmental Site Assessments are studies performed in a transaction situation, where either the management of the company which is the subject of the transaction, or an external party involved in the transaction, wants to investigate whether environmental aspects involved in the company's past or present activities should be represented on the company's balance sheet. This will frequently involve site contamination aspects.

Before a site is being used as a place to locate a company, a study should be performed to consider the environmental feasibility of that site for the planned company activities. This type of study has been identified around 1970 and has been named an **Environmental Impact Assessment**. It is a study which produces new information about the expected environmental impacts in normal and extreme situations, and therefore doesn't qualify as an audit.

Chapter 3 - Pollution abatement technologies

This chapter gives an overview on the current situation of pollution abatement technologies and describes some recent developments in air pollution control, wastewater treatment and waste management. The basic materials to elaborate this chapter were found in studies by EKONO/duoplan (Environmental performance, regulations and technologies in the pulp and paper industry, Dec. 1994) and by Jaakko Pöyry (Techno-Economic study on the reduction measures, based on best available techniques of emissions from paper and board manufacturing industry for the Commission of the European Community, Jan. 1994).

Environmental Auditing

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- What is an Audit?
- How is an Audit performed?
- What are the benefits from being audited?



What is an Audit?

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Definition

Systematic and documented verification process to objectively obtain and evaluate evidence to determine whether an organisation's environmental management system conforms to the audit criteria.

Types of Audit

- Environmental Management System Audit
- Environmental statement Audit
- Compliance Audit



How is an Audit performed?

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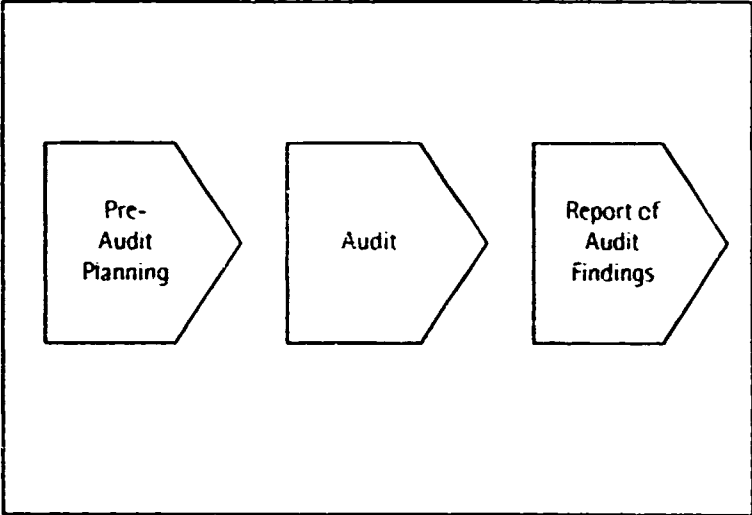


Figure 10.1

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The Steps of an Environmental Audit

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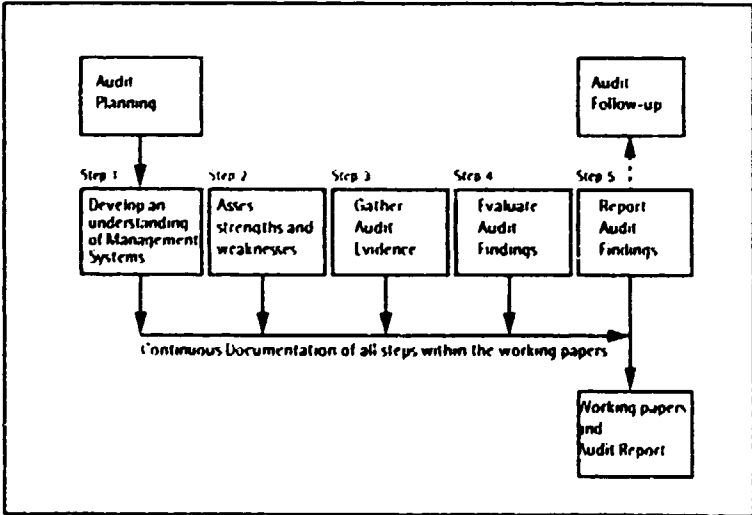


Figure 10.2

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The contents of an Audit report

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- organization audited, client
- audit team members
- scope, objectives and audit plan
- list of reference documents against which the audit is conducted
- distribution list for the audit report
- statement of confidentiality
- summary of the audit process including the obstacles encountered
- audit conclusions

1. 2. 3. 4.

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What are the benefits from being audited?

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- clear overview on the environmental performance
- enhanced image and market share
- meeting certification criteria
- improving cost control
- liability limitation
- demonstration of reasonable care
- conservation of input materials and energy
- facilitate obtaining permits and authorisations


1. 2. 3. 4.

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Future Trends

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Comparison of environmental performance within industry branches



kg SO ₂ per ton of product	2,0	0,2	0,1
kg NO _x per ton of product	2,2	1,4	2,2
kg AOX per ton of product	1,6	0,3	0,5


Figure 10

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Related Environmental Investigations

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Take over Audits or Environmental Site Assessments



Assesment of environmental related costs during a transaction situation or during the formation of a JV

Environmental Impact Assessment

Study being performed in order to assess the environmental impact of future activities




Figure 11

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Contents

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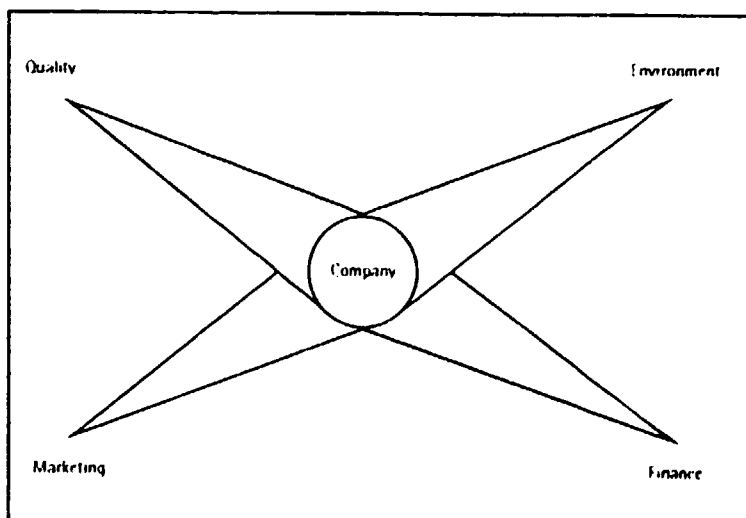
Environmental Management and Environmental Audits
Introduction to Environmental Management The Concept of Environmental Management Specifications for Environmental Management Systems Environmental Audit Related Environmental Investigations
Recent Developments in Pollution Abatement <small>(based on the EKONOMIKUPPLAN study "Environmental compliance, regulations and technologies in the Pulp and Paper Industry", December 1994)</small>
Recent Development in Air Pollution Abatement Recent Developments in Waste Water Treatment Solid Waste Treatment/Disposal

5-11-1995

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Introduction to Environmental Management

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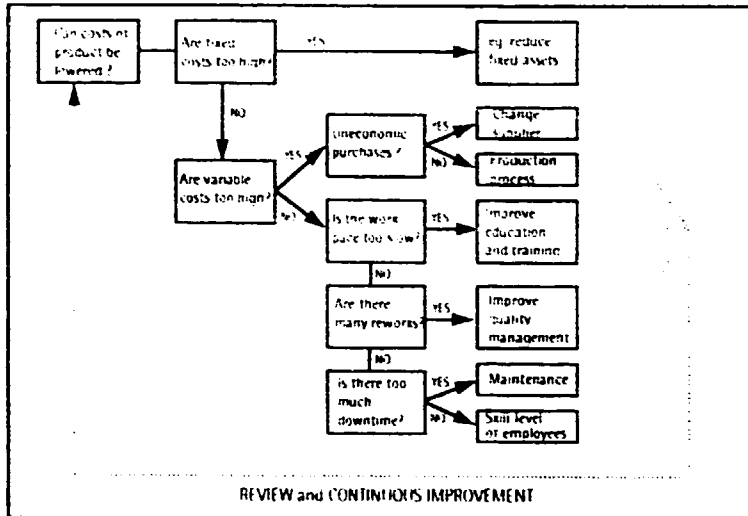


5-11-1995

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Example - Management Cycle

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Standards for Environmental Management Systems

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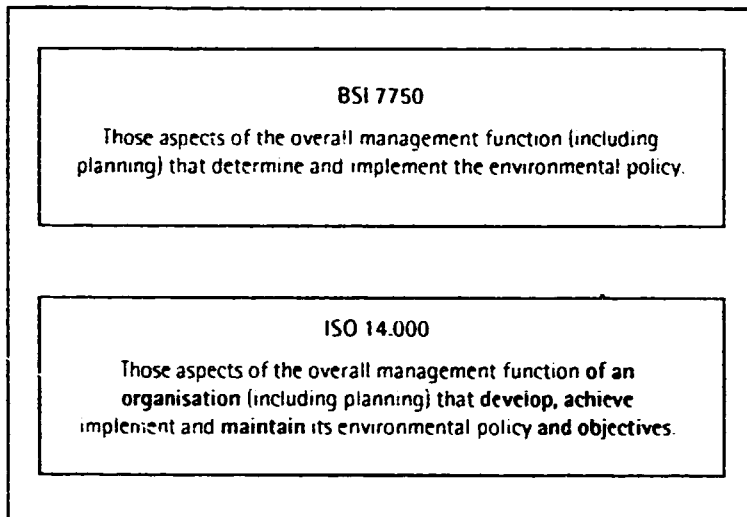
United Kingdom	European Union	Worldwide
BSI 7750	# 1.836/93	ISO 14.000
"Specification for Environmental Management Systems"	EU Council regulation allowing voluntary participation by companies in the industrial sector in a Community eco-management and audit scheme	"Environmental Management Systems" Draft
British Standards Institutions	Council of the European Union	International Standards Organisation

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What is Environmental Management?

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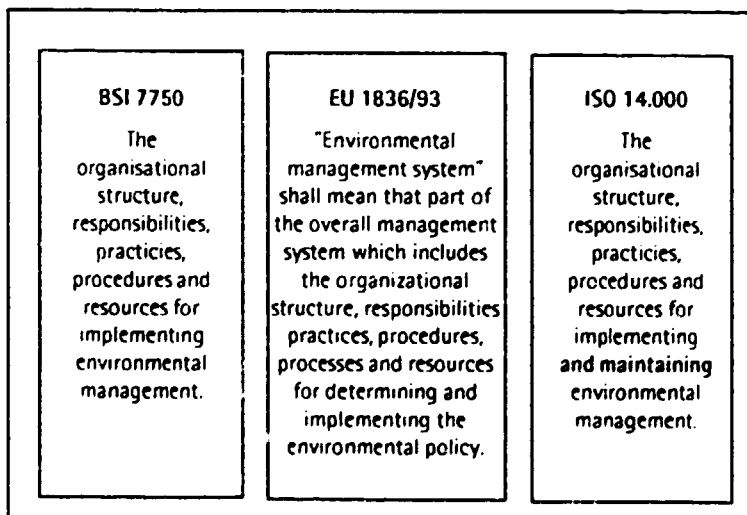


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What is an Environmental Management System?

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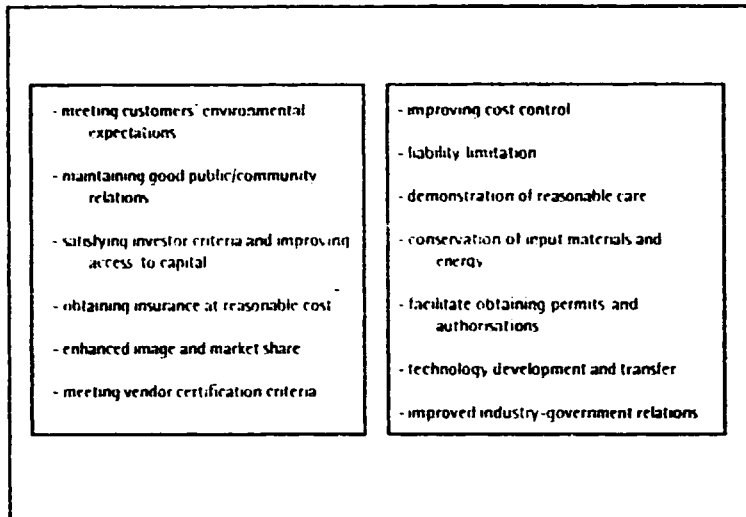


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Benefits of an Environmental Management System

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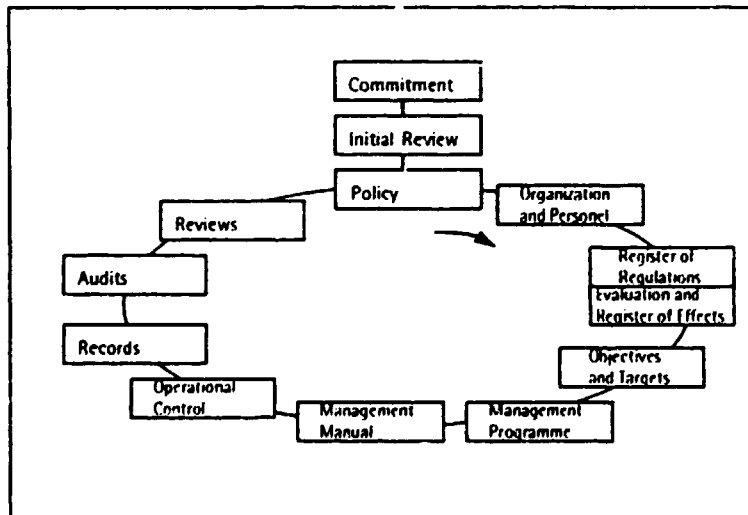


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Stages in the implementation of an EMS according to BSI 7750

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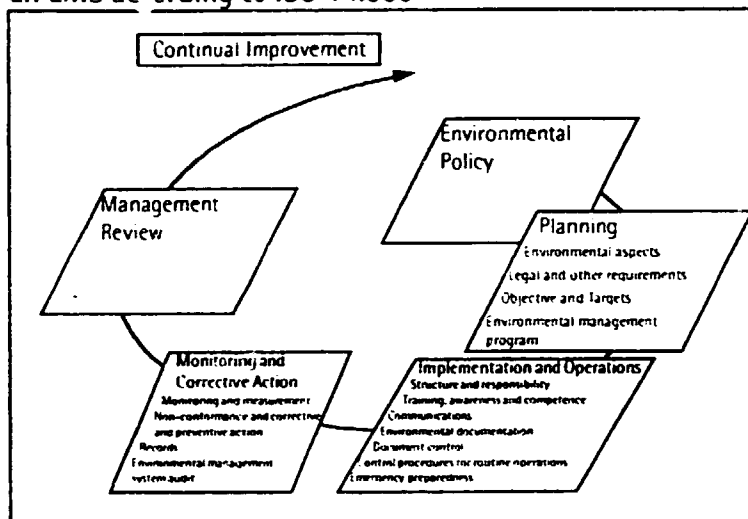


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Stages in the implementation of an EMS according to ISO 14.000

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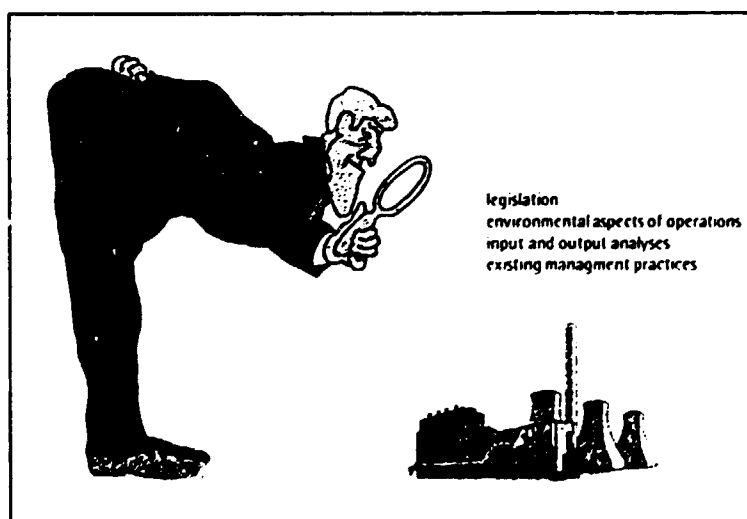


14000

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Initial Review

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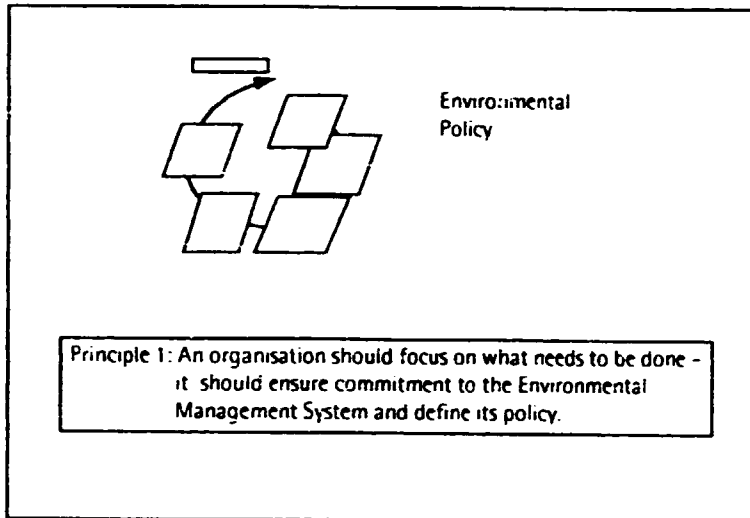


14000

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Step 1: Setting up the Environmental Policy

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Good Management Practices

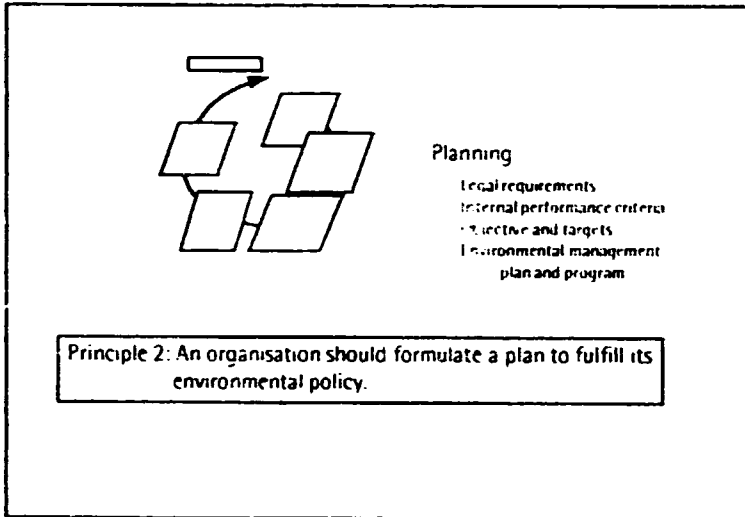
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1. A sense of responsibility for the environment amongst employees at all levels shall be fostered.
2. The environmental impact of all new activities, products and processes shall be assessed in advance.
3. The impact of current activities on the local environment shall be assessed and monitored, and any significant impact of these activities on the environment in general, shall be examined.
4. Measures necessary to prevent or eliminate pollution, and where this is not feasible, to reduce pollutant emissions and waste generation to the minimum and to conserve resources shall be taken, taking account of possible clean technologies.
5. Measures necessary to prevent accidental emissions of materials or energy shall be taken.
6. Monitoring procedures shall be established and applied, to check compliance with the environmental policy and, where these procedures require measurement and testing, to establish and update records of the results.
7. Procedures and action to be pursued in the event of detection of non-compliance with its environmental policy, objectives or targets, shall be established and updated.
8. Cooperation with public authorities shall be ensured to establish and update contingency procedures to minimise the impact of any accidental discharge to the environment that nevertheless occur.
9. Information necessary to understand the environmental impact of the company's activities shall be provided to the public, and an open dialogue with the public should be pursued.
10. Appropriate advice shall be provided to customers on the relevant environmental aspects of the handling, use and disposal of the products made by the company.
11. Provisions shall be taken to ensure that contractors working at the site on the company's behalf apply environmental standards enunciated to the company's own.

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Step 2: Planning

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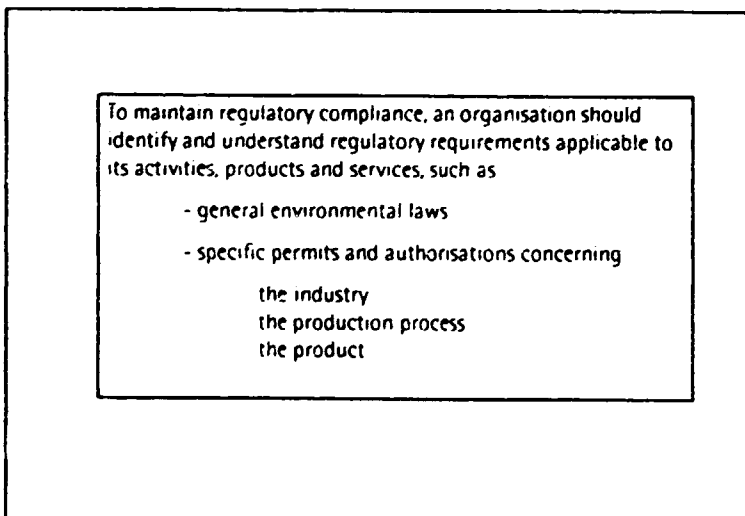


12.01.01

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Legal Requirements

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12.01.01

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Internal Performance Criteria

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<ul style="list-style-type: none">- management systems- employee responsibilities- acquisition, property management and investiture- suppliers- contractors- product Stewardship- environmental communications- regulatory relationships- environmental incident response and preparedness- environmental awareness and training	<ul style="list-style-type: none">- environmental measurement and improvement- process risk reduction- pollution prevention and resource conservation- capital projects- process change- hazardous material management- waste management- water management- air quality management- energy management- transportation
---	---

1995-1996

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Objectives and Targets

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Objective: reduce energy required in manufacturing operations.
Indicator: quantity of fuels and electricity per unit production.
Target: achieve 10 percent reduction during 1995.

1995-1996

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Environmental Management Plan and Program

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Policy:	to conserve natural resources.
Objective:	to minimise the use of water wherever technologically and commercially viable.
Target:	to reduce water consumption by 15 percent of present levels within one year.
Action plan:	install equipment to recycle rinse water for process A for reuse in process B, which does not require water of the same high quality.
Person responsible:	John Waters
Resources:	existing operations staff, new equipment, budget (\$\$\$) allocated from capital budget.
Completion date:	31.12.1995

Figure 10

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Step 3: Implementation and Operations

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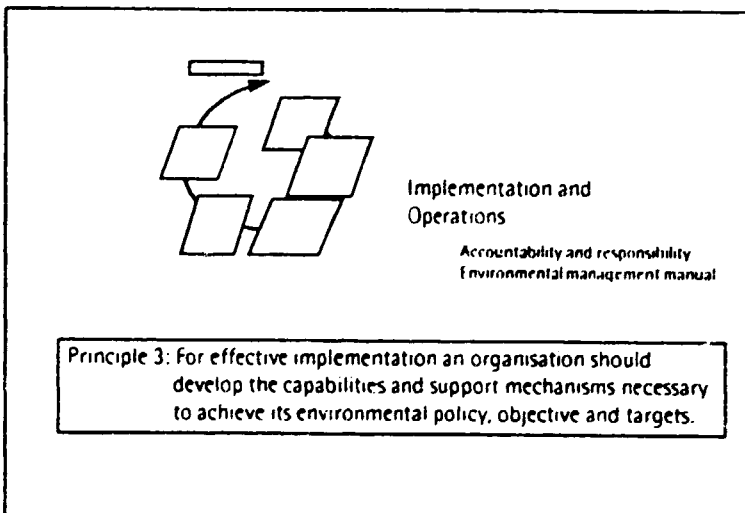


Figure 11

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Accountability and Responsibility

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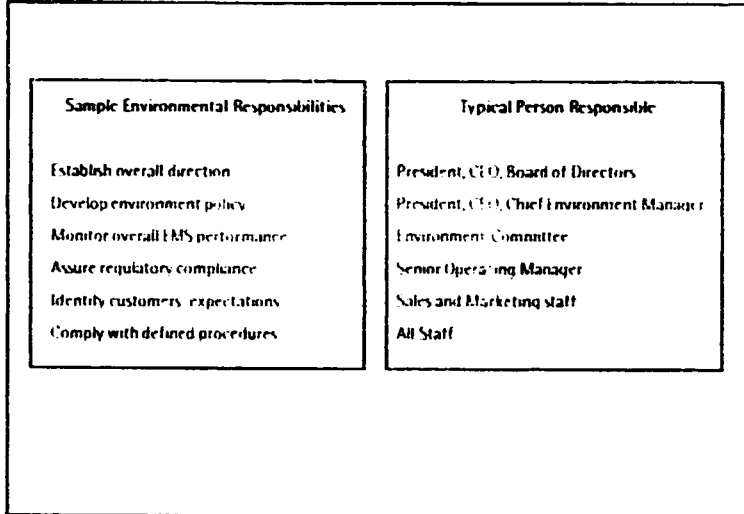


Figure 10-1

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Environmental Management Manual

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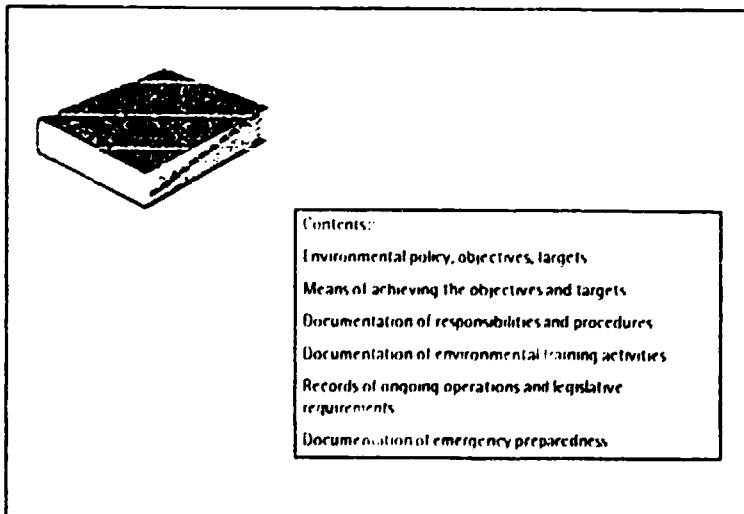
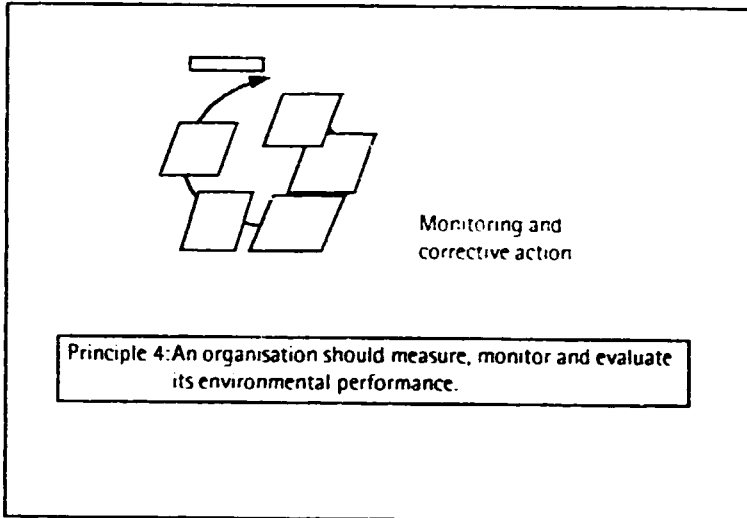


Figure 10-2

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Step 4: Monitoring and Corrective Action

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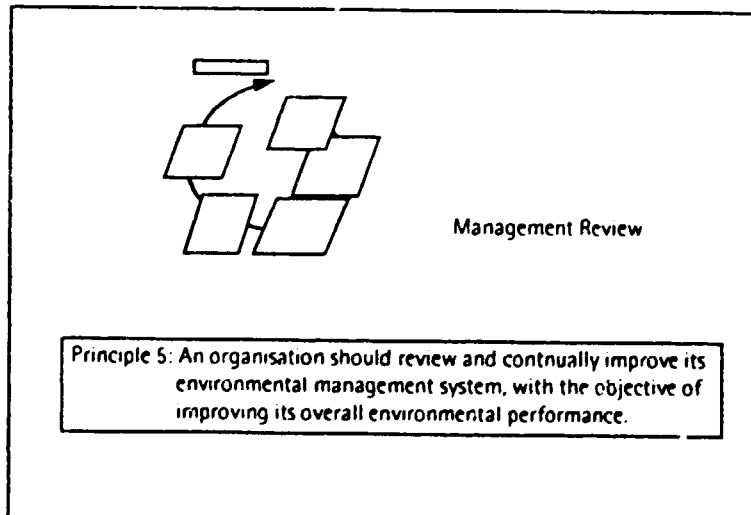


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Step 5: Management Review

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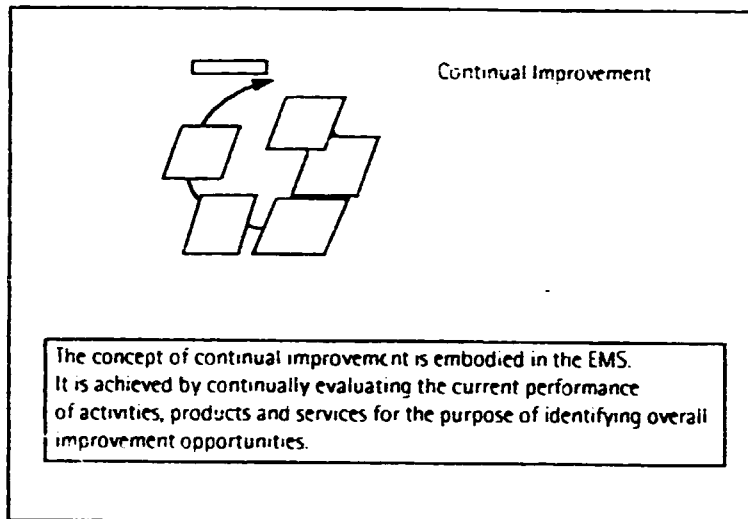


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Continual Improvement

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The Environmental Statement

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- a description of the company's activities at the site considered;
- an assessment of all the significant environmental issues of relevance to the activities concerned;
- a summary of the figures on pollutant emissions, waste generation, consumption of raw material, energy and water, noise and other significant environmental aspects, as appropriate;
- other factors regarding environmental performance
- a presentation of the company's environmental policy, programme and management system implemented at the site considered;
- the deadline set for submission of the next statement;
- the name of the accredited environmental verifier

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The Registration of sites

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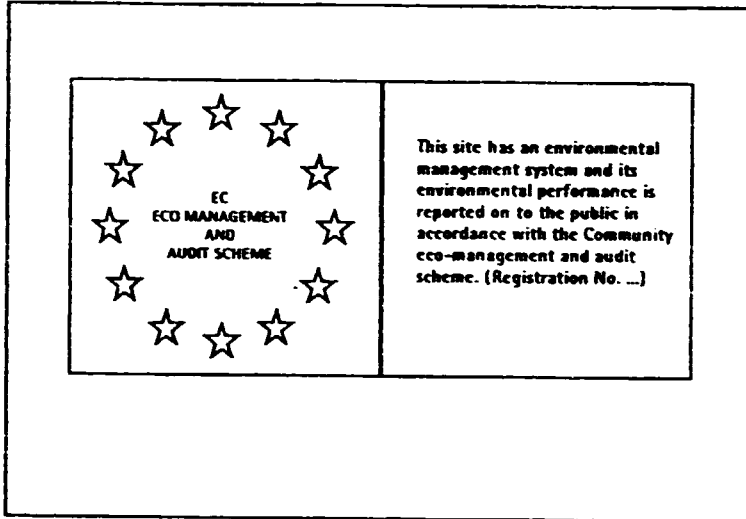


Figure 21

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Raimo Malinen. Vice President Pulping

The Finish Pulp and Paper Research Institute. KCL

PULPING, BLEACHING, CHEMICAL RECOVERY, CLOSED CYCLE MILL

1. INTRODUCTION

Paper industry has been regarded as a very conservative and stable industry utilizing basically the same processes as 100 years ago. However, during the last ten to fifteen years the development has speeded up in most branches of the industry. The main driving forces behind the development of pulping have been:

- Environmental concerns
- Utilization of fibre raw material - forests
- Product quality - pulp and paper
- Energy economy
- Manufacturing costs - capital, chemical, wood costs

The rapid development of kraft pulping has resulted in numerous achievements such as:

- Kraft pulping has become the dominating chemical pulping process
 - Oxygen delignification is applied in most mills in Europe
 - Chlorine and hypochlorite have almost disappeared as bleaching chemicals in Europe
 - TCF bleaching has been developed
 - The capacity of mills has still been growing
 - The kappa number of cooking has decreased (extended delignification)
 - Energy economy has improved
 - Biological effluent treatment has become common
- Discharges of pulp mills have reduced substantially to the present, fairly low level.

The long - term goal for the industry must be sustainable development - the industry must take care of the fact that the nature and forests have to be preserved close to the natural state, energy use must be in balance and pollution limited to no visible effect on the environment. Paper industry have good chances to become a frontrunner in this development.

The goal towards sustainable development emphasizes the importance of environmental concerns also in future as the main driving force for the development. For the pulp industry this mean wider application of recent developments in delignification, bleaching, recovery and effluent treatment but above all this emphasizes the development towards a closed - cycle pulp and paper mill.

The main drawback of the present pulping industry is its capital costs. The possibilities to cut markedly the capital costs of kraft pulping are limited. The research shall try to find new costs - effective pulping methods.

The quality is another leading driving force for the development. The quality of kraft pulp has been so far unmatched being one of the main reasons that kraft process has replaced other chemical methods. Kraft pulp will be developing from a commodity product to more tailor-made grades. The quality of kraft will be the target for the newcoming processes.

Energy consumption is a big concern in paper industry. However, chemical pulping especially kraft can generate energy from waste liquor and waste wood at the best much more than the process needs. The energy excess can be sold as a surplus steam and/or power. Kraft pulp industry has a lot of potential even to increase its energy surplus making thus the process still stronger.

A new criteria has become important for the fibres of paper industry, i.e. recyclability. The proportion of recycled fibre is globally some 40% of the fibres used and still growing. Kraft pulp fibres are strong and their recyclability is good.

The present alternatives for kraft pulping are as follows:

A Sulphite pulping

The latest sulphite pulp mills were built in the early 1980's. The advantage of the sulphite process over the kraft is less odour and easy TCF bleaching, serious drawbacks are poor product quality for many paper and board grades, special requirements for wood raw material and higher SO₂ emissions. The sulphite process will gradually disappear although present mills may be running for years.

B Organocell process

The Organocell process is a combined solvent and alkaline (soda-AQ) pulping process applied in a Kelheim pulp mill in Germany, now shut down.

Organocell is a complicated process with a double recovery (methanol and soda) - to be competitive the value of by-products must be high. Pulp quality is almost comparable to kraft pulp, but the process does not look economically competitive (Kelheim was an economic disaster).

C Others

The ASAM process is also a combined process (solvent and AS-AQ), with the expected same problems as in Organocell. The development is still in a pilot phase. No bright future is expected.

The MILOX process development at the KCL, Finland is an organosolv process based on multistage peroxyformic acid delignification. The process is in a pilot development stage. The process fits well to hardwoods, more poorly for

softwoods. The process is still far from industrial application, best for dissolving pulp.

ALCELL is a solvent process based on catalysed ethanoi delignification. This process has also been tested in a large pilot plant with promising results. The process fits to hardwoods with acceptable pulp quality. The large-scale process is under serious consideration. This process may lead to lower capital costs in chemical pulping.

There are several other solvent pulping methods tested, but still in a laboratory stage.

To summarize, kraft pulping has almost totally replaced sulphite and the newcomers are not yet ready for the industrial applications. Kraft pulping will necessarily be the dominating chemical pulping process for years to come for many reasons:

- Wide raw material base
- High quality pulp
- Energy efficiency
- Techno-economic aspects.

In this paper the discussion is mainly limited to the kraft process for the reasons presented above. This paper is a summarizing presentation. More details are included in the specific publications attached to this paper.

2 PULPING TECHNOLOGY

2.1 Wood raw material

Wood species and the quality of wood raw material in general are essential to the quality of the pulp produced and manufacturing costs. Kraft pulping can tolerate low wood quality, but wood quality is anyhow directly reflected in

- Pulp quality (strength, brightness, etc.)
- Mill capacity
- Costs (wood, chemicals etc.)
- Discharges (depending on cooking, bleaching)

High wood quality is especially important for TCF pulping - high quality wood (light-coloured, decay-free, no bark etc.) is easier to delignify and bleach.

2.2 Woodhandling

Debarking

Debarking is the first stage in all pulping operations. Unbarked wood has been used for kraft pulping but not very successfully for various reasons (quality, process disturbances, capacity etc.). Quality aspects and TCF bleaching emphasizes the importance of efficient debarking.

In most cases debarking is carried out in barking drums, which can be either wet or dry. The wet debarking drum is more efficient than the dry one, and high debarking efficiency can be achieved easily. The main problem in wet debarking is water pollution; organic material including carbohydrates, tannins, extractives, proteins, etc. is dissolved, resulting in high BOD, effluent colour, and toxicity. Phosphorus and nitrogen compounds, rich in bark, are also dissolved. The amount of suspended solids is high in these effluents, and a separate clarification of filtrates is justified.

In dry debarking, water is not used in the drum except in wintertime for melting. However, debarked logs must be washed and thus some effluents still exist.

The debarking drums are getting more efficient for dry debarking, which nowadays replaces wet drums. Environmental problems can thus be minimized. Separate internal treatment of debarking filtrates may open possibilities for complete water circulation in this area, now under research.

Chipping and chip screening

Chip quality (dimensions, size distribution, fines, oversize) is very important for efficient

chemical pulping:

- Overthick chips (> 7 mm) are difficult to impregnate resulting in uneven cook, lower yield, lower quality etc.
- Fines make especially continuous cooking more difficult (circulations); fines also decrease fibre length and pulp strength.

Chip quality has improved due to the new design of chippers. Notwithstanding better chippers, more and more mills have installed effective chip thickness screening with slicers and fines removal to control chip dimensions. This is important for even cooking, especially if targeted to low kappa levels. Very thin chips (shavings) would allow direct cooking to kappa 10 or below, but the manufacture of shavings effectively and the digester operations with shavings are unsolved.

2.3 Kraft Cooking

2.3.1 General

The ultimate goal in developing kraft pulping is basically to eliminate its environmental problems. Progress has been so rapid that this goal no longer appears utopia, but may be just around the corner. In striving for this goal, all unit operations of kraft pulping have to be considered, including cooking, washing, oxygen delignification and bleaching. The final objective is to optimize each unit operation to achieve the long-term goal: the practically closed-cycle kraft pulp mill. In future this may be the only sustainable option.

Cooking and bleaching are integral parts of the kraft pulping process - cooking directly affects bleaching requirements. Most (90-95%) of the lignin in wood is removed in the cooking stage. Residual lignin is removed during bleaching, where the main objective is to achieve the pulp brightness required. Thus, cooking conditions play a major role in helping to achieve a specific bleaching result. The overall target in kraft cooking is to achieve the minimum kappa number prior to bleaching, with acceptable yield and product quality. The conventional kappa level of 30-32, which still dominates today, has already fallen in many countries and will still drop even further in the future.

One of the main objectives in delignification is as high selectivity as possible. Selectivity may refer to yield or quality or both resulting from different chemical reactions. To maintain the selectivity in final delignification is essential.

2.3.2 Impregnation and Chemistry

The active agents in kraft cooking are the hydroxide (OH^-) and hydrogen sulphide (HS^-) ions. Increasing the OH^- ion concentration increases the delignification rate, but also the dissolution of polysaccharides resulting in lower yield. Increasing the HS^- ion concentration (sulfidity) accelerates delignification especially in the early part of the cook, but the HS^- ion does not affect on polysaccharides. Thus the ratio of HS^- to OH^- should be

high for selectivity - for delignification rate the concentration of both ions should be high.

The profiles of OH^- and HS^- ions should be carefully controlled during cooking. The targets for effective and selective delignification are:

- Even OH^- ion profile throughout the cook for selectivity; the OH^- ion concentration may never be too low to prevent condensation reactions, too high OH^- concentration cuts the yield
- As high HS^- ion concentration as possible, especially in the early part of the cook
- Low concentration of lignin and Na^+ ions towards the end of the cook
- Low cooking temperature

In general, careful impregnation of chips with the cooking liquor with high HS^- ion and sufficient OH^- ion concentration is essential. In practice the optimum impregnation liquor would be black liquor fortified with white and/or green liquor.

In actual cooking compromises are necessary. No industrial cooking system can achieve all objectives presented above.

In mill operation pulp quality, especially strength is always lower than in lab scale (strength delivery < 100%). The main reasons for that are uneven cooking as well as blowing of the cook, which tends to deteriorate pulp fibres. The mills are very specific in this respect.

2.3.3 Technical Solutions

Continuous cooking

Modified Continuous Cooking (MCC) was first applied in the early 1980's. This includes split alkali charge and a counter - current phase of cooking - no changes in impregnation or white liquor. MCC improves delignification allowing lower kappa number and/or improves quality and bleachability.

The next phase in the development was *EMCC (extended MCC)* including the conversion of the Hi-Heat wash zone to final cooking zone (higher temperature and alkali charge). This evens further chemical charge and extends cooking zone for lower kappa levels.

ITC (Isothermal cooking) is another modification of MCC. The wash zone has been totally converted to a cooking zone. Because of longer cooking time temperature can be decreased. Quality may improve and lower kappa numbers are possible.

Black liquor impregnation has been tested also in the Kamyr digester with good results. Because of rather high impregnation temperature the control of the OH^- ion concentration must be good. This is now becoming an industrial process.

Lo-Solids cooking is a modification of MCC, where the dissolved organics are removed from the digester during the bulk delignification stage. This approach also includes levelled OH^- ion concentration and lower temperature. The results are promising.

Tens of different modified continuous cooking systems are now in operation.

Batch cooking

Batch cooking has suffered from the poor heat economy of the system until the new generation of batch cooking systems was born during the 1980's. The poor heat economy really initiated the development, but several surprising, positive side-effects were found, first without understanding all phenomena. Several commercial systems were developed which are technically very similar. All of those have now good heat economy and improved efficiency for low kappa cooking and higher strength. The actual commercial processes are RDH (Rapid Displacement Heating), Super Batch and Enerbatch. *Super Batch* and *RDH* are actually the same processes. The essential feature is displacement impregnation and heating with warm and hot black liquor. Black liquor impregnation means careful HS^- ion impregnation. However, HS^- ion concentration is rather low and OH^- ion concentration easily even too low depending on residuals and temperature. White liquor is charged totally at one time.

Super Batch and RDH cooking allow low Kappa cooking when necessary. Pulp quality is good, the yield - kappa relationship is the same as in normal cooking.

Numerous Super Batch and RDH digester facilities are now in operation or under construction.

In Enerbatch cooking impregnation is carried out with fairly cool (75°C) white liquor. Low temperature and high alkalinity guarantee good impregnation and even cooking. Displacement heating results in the same heat economy as in Super Batch or RDH. Only one industrial application is in operation.

Isoalkaline cooking has been developed at the KCL, Finland and tested on mill scale. This includes impregnation with black liquor fortified with white and/or green liquor as well as split alkali charge. This approach guarantees high HS^- ion concentration in the beginning and even OH^- ion profile throughout the cook. Low kappa cooking is easy and pulp strength good, but the yield is no better than in other methods. This is coming to industrial use in Finland.

2.4 Sulphite pulping

Sulphite pulping has been known as a big polluter. Its bad reputation comes from the days when sulphite mills had no recovery and all spent liquors were sewerred. Unfortunately, such mills are still in operation, but not in Europe.

Decisive for a sulphite pulp mill from the environmental point of view is which base is used, whether there is any recovery, and which recovery rate the mill uses. The best sulphite pulp mills match well with modern kraft pulp mills.

Some specific features of sulphite pulp mills are listed below:

- Debarking efficiency must be good. Dry debarking probably cannot be applied.
- Fairly low kappa number can be achieved in cooking.
- Pitch is a special problem in sulphite pulping. The brown stock area cannot be totally closed.
- Bleaching of sulphite pulp is fairly easy, and chlorine chemical requirements are low. Chlorine chemicals can be replaced, to a large extent or totally, by oxygen and peroxide, resulting in fairly low pollution.

To summarize, sulphite pulping (historically highly polluting) can match kraft pulping well from the environmental point of view. Sulphite pulp production will, however, disappear since old and small mills cannot be modernized economically and new sulphite pulp mills are not competitive for other reasons.

2.5 Washing and screening

Efficient washing of pulp is important to clean pulp sufficiently prior to the following delignification or bleaching stage, and to recover spent cooking liquor with dissolved organics. Washing is required between cooking and oxygen delignification and after oxygen delignification. Washing is to a maximum extent counter-current and thus washing liquor of the stage comes from the next stage. It is very important to be able to wash with minimum dilution to minimize evaporation costs, without increasing other costs (capital, energy).

Washing equipment has gone through rapid development during the last ten years. Vacuum filters, hi-heat washing, diffusers and presses were common in the 1970's and 1980's. In the most recent installations multistage Drum Displacer (DD) washers and displacement presses have become common at least in Scandinavia due to high efficiency and higher operation consistency (less water). Efficiency and low water volumes are getting even more important in a closed-cycle concept.

Pulp screening has developed rather slowly during the last ten years. However, screen design has been improved and especially slotted screens have become more efficient. In the 1980s double screening with holes and slots was very common, today slot screens alone may be as efficient. Another trend has been towards higher consistency.

One of the latest developments is fractionation of pulp with slotted screens. Fractionation opens new possibilities for quality and grade development of chemical pulp towards more tailor-made products.

2.6 Oxygen delignification

Oxygen delignification of pulp in one or two stages has spread rapidly over the last few years. In the beginning the technology was applied to cut AOX and COD discharges, but more recently to prepare the way for more cost-effective TCF bleaching.

Although oxygen delignification as an industrial process is 25 years old, it is still developing fast. Multistage oxygen delignification has become common during the last ten years. The main merit of the two-stage system is a higher delignification rate, up to 70%, with acceptable selectivity. Four two-stage oxygen delignification systems are now in operation in Finland, and a few more are under construction or on order. Many two-stage systems have been in operation in Japan for years, too. As a result, the kappa number of pulp coming to the bleach plant is decreasing rapidly.

The kappa number after oxygen delignification can be adjusted over a fairly wide range, assuming modified cooking and two-stage oxygen delignification can be used. In general, it is hardly worthwhile lowering the kappa too much for ECF bleaching because of the reduced selectivity. For TCF bleaching on the other hand, a low kappa is required to reach the required brightness and acceptable economics. Oxygen delignification is more selective than extended cooking. Two-stage oxygen delignification may be an alternative for extended, low-kappa cooking.

The introduction of two-stage oxygen delignification raises a huge number of questions, i.e. what kind of reaction conditions should be used in the two stages, the need for intermediate washing and the effects of possible activators. A lot of research is still required.

3 BLEACHING TECHNOLOGY

3.1 ECF bleaching

The complete changeover to ECF bleaching in Scandinavia occurred within a few years. The driving forces behind this were pulp market requirements, and to a lesser extent AOX reduction. The use of elemental chlorine practically ceased during the course of 1993. All mills are now capable of producing 100% ECF pulp, with somewhat varying technologies.

As a result, the total amount of chlorinated compounds in the effluent, measured using the AOX (Adsorbable Organic Halides) method, has fallen sharply in Scandinavia during the last ten years, and is now as low as 0.3-0.4 kg/t of bleached pulp.

The move to ECF bleaching has required mill-specific measures, such as lower digester kappa number, oxygen delignification, increased chlorine dioxide capacity, oxygen and peroxide in extraction stages and enzyme treatment. The consumption of chlorine dioxide varies over a wide range.

An optimization study of ECF bleaching was recently conducted by KCL. The results showed that kappa number adjustment, optimization of peroxide and oxygen charges (EOP) and enzyme treatment together resulted together in a 20% reduction in chlorine dioxide consumption.

3.2 TCF Bleaching

3.2.1 General

Today the ultimate goal in bleaching research is totally chlorine-free (TCF) bleaching. Although there is no evidence that the use of reasonable amounts of chlorine dioxide in bleaching is harmful to the environment, pulp and paper markets seem to be pushing forward towards TCF. TCF bleaching probably makes it easier to achieve the closed-cycle process, which is the final goal in eliminating environmental problems. Therefore, TCF bleaching has to be regarded as the main bleaching process in the long term, although ECF bleaching will predominate for some time to come.

The main agents used in TCF bleaching are oxygen, peroxide and ozone. The characteristic features of these chemicals in bleaching are summarized in Table 1:

- From the point of view of catalytic degradation, peroxide and ozone are much more problematic than oxygen. The key question behind successful peroxide and ozone bleaching in terms of chemical consumption and pulp quality is to control degradation of the bleaching chemical.

- Ozone reacts with all aromatic structures, whereas oxygen reacts mainly with free phenolic structures and peroxide with carbonyls. Oxygen should be used effectively after cooking, followed by peroxide and then finally ozone. Ozone also generates carbonyl structures, which must later be eliminated by peroxide.
- Oxygen delignification stabilizes the end-groups of polysaccharides, which helps to maintain the yield.
- All oxygen chemicals introduce carbonyl structures into the polysaccharide chain, resulting in a viscosity drop under alkaline conditions.
- The oxidation potential of ozone is high but not higher than with oxygen.
- In TCF bleaching, oxygen and ozone remove lignin more effectively than peroxide. Ozone and peroxide are more effective brightening agents. The viscosity drop is marked with all oxygen chemicals, but biggest with ozone.

Considering the points listed above, it can be concluded that the efficiency of oxygen delignification should always first be maximized, irrespective of the brown stock kappa number. Peroxide should be used as the main brightening agent, and always as the final bleaching stage. Ozone should be used for delignification after oxygen (and peroxide) to achieve the delignification rate required for bleached pulp.

Table 1. Oxygen chemicals in TCF-bleaching.

	O ₂	H ₂ O ₂	O ₃
Degradation of chemical ^{a)}			
- Catalytic degradation by heavy metals	+	+++	++
- Formation of free radicals	+	+	+++
Reactive units of lignin	Free phenolic structures	Carbonyls, free phenolics structures	All aromatic structures
Reactions of polysaccharides ^{a)}			
Stabilization of end-groups	++	+	?
- Carbonyl formation and chain cleavage	+	(+)	++
Oxidation potential, OXE/kg	125	59	(12)-125
Efficiency in TCF bleaching ^{b)}			
- Kappa number drop per kg chem.	0.6-1	0.1-0.5	1-1.4
- Brightness unit gain per kg chem.	≤ 1	1-5	0.7-5
- Viscosity unit drop per kg chem.	5-15	0-20	20-40

Notes a) The number of pluses reflects the relative strength of effect.

b) Results achieved at KCL; the range of tens of different bleaching tests.

3.2.2 TCFZ bleaching with ozone

At the moment there are at least eight mills producing ozone-bleached pulp on full scale. More mills are coming; SCA Graphic Papers, Östrand, Wisafors of Kymmene Corp. and a new Finnish pulp mill Metsä-Rauma.

In TCFZ bleaching full brightness can be achieved with both hardwoods and softwoods. The number of stages depends on the kappa number after the O stage – with softwood pulp kraft two ozone stages are required unless the kappa number is very low prior to the Z and P stages. With birch pulp kraft one ozone stage is adequate in most cases. This statement is mainly based on laboratory tests conducted at KCL during the last three years. Lately, these findings have been confirmed at several Finnish and Swedish mills, in some cases with even more encouraging results. The bleaching sequences may be (examples):

O-O-Z-Q-P
 O-O-Q-P-Z-P
 O-O-Z-Q-P-Z-P

There have been some indications on both the laboratory and mill scales that ozone might adversely affect pulp strength properties. TCFZ pulps tend to have lower tear strength than ECF pulps. TCF pulp may also be inferior in terms of bulk and light scattering coefficient, and may require more beating, resulting in slow drainage.

The papermaking properties of TCF pulps depend on the different bleaching stages employed, the goal being optimization of the whole bleaching sequence. The intensive research going on in this field will help to achieve this goal.

The commercial systems are based on either medium consistency (Ah'ström, Kvaerner) or high consistency (Sunds Defibrator, Andritz). It is too early to state which one will be the market leader in future.

3.2.3 TCFP bleaching with peroxide

TCF bleaching can also be carried out with peroxide only (TCFP). Usually the brightness levels achieved are around 85% ISO with softwoods and 87% ISO with hardwoods. Full brightness has also been achieved in TCFP bleaching using activators such as peroxy acids. A prerequisite for a successful peroxide bleaching is careful metal control, usually meaning a chelation stage (Q) before the peroxide stage.

As peroxide mainly acts as a brightening agent and not as a very efficient delignification agent, the yellowing of pulp may be severe. Research efforts are being directed at TCFP bleaching to eliminate this problem, including improving the peroxide stage, and the use of various activators and enzymes.

Peroxide stage can be carried out as atmospheric (80-95°C) or pressurized (100-120°C); either at MC or HC consistency. Recently pressurized MC systems have become most popular. The HC system is most effective, but expensive.

3.2.4 TCF bleaching using activators

As a result of the tremendous amount of research put into TCF bleaching, new chemicals are entering the markets. Also, the development of new enzymes resistant to alkaline pH and high temperatures requires a re-examination of the effects, especially on pulp.

One promising group of bleaching chemicals is the peroxy acids. Full-scale operation in Finland using peroxy monosulphuric acid (Caro's acid) have been successfully conducted. Peroxyacetic acid has been used for commercial-scale bleaching trials in Sweden. Peroxyacetic acid may provide a low-investment alternative to ozone bleaching and has

attracted considerable interest from several mills, not only in Scandinavia.

In Canada and the USA a new bleaching agent, dimethyldioxirane (DMD), a reaction product of sulphuric acid, hydrogen peroxide and acetone, is under development. DMD is reported not to be an effective brightening agent itself, as it introduces chromophores into the residual lignin. However it has a positive effect on pulp brightening in the succeeding peroxide stage.

Polyoxometalates are a class of metal ion oxide clusters. The delignification effects of these chemicals were discovered in the USA in 1990. Kemira Chemicals Oy has started marketing the Greenox bleaching method, in which peroxide bleaching is activated by polyoxometalates. The investment cost for this process is low as only equipment for charging the chemicals is needed. Greenox has been tested in mill-scale operation in Finland.

3.3 Environmental performance of ECF and TCF bleaching

TCF was introduced into pulp and paper markets to satisfy demands from environmental pressure groups and the public, and to a lesser extent from the authorities. They strongly believed that the chlorinated organics from ECF bleaching would be more harmful to the environment than TCF effluents. Very soon the debate turned emotional and the facts were used less and less.

During the last few years numerous studies, publications and surveys have been made to evaluate the environmental impact of ECF and TCF bleaching. All the results are similar. Assuming that the delignification technology is roughly the same, the discharges are fairly similar in ECF and TCF. One visible difference is the very low effluent colour in TCF, which is important at some mill sites. ECF and TCF look environmentally almost comparable in most mill environments, reduced colour and zero AOX being today the main merits of TCF.

Toxicity measurements and biotests also indicate no marked differences between ECF and TCF mill effluents demonstrated in the study which included all pulp mills in Finland.

4 RECOVERY TECHNOLOGY

4.1 General

The recovery cycle of the kraft process is efficient but also expensive. The basic chemistry is very old. Rapid technical advances during the past two decades have concentrated on improving efficiency in terms of energy, pollution abatement, reliability and economy. Efficient sodium and sulphur recovery and energy generation are vital parts of kraft mills, and make kraft pulping less likely to be superseded.

Numerous new alternatives or modifications for the unit operations of basic kraft pulp mill recovery have been presented. Very few of those have yet commercial interest.

The chemical recovery cycle includes four major process stages which are closely related together:

- black liquor evaporation
- black liquor combustion
- recausticing
- lime reburning

The targets set to these unit operations can be summarized as follows:

- recovery of sulfur compounds as sodium sulfide
- recovery of the rest of sodium compounds as sodium hydroxide
- recovery of energy as steam and electricity by combusting the organics dissolved during pulping
- environmental protection by minimizing the losses to waste waters and to the atmosphere.

When the unit operations and the equipment are properly designed and linked together, the kraft mill stands even the hardest requirements set to an efficient and environmentally acceptable production plant.

4.2 Evaporation

In black liquor evaporation the dry solids content is raised from 18-20% to 70-80%. The latest development is higher and higher dry solids content utilizing new superconcentrators. The typical dry solid level was 60-65% in the 1970's, 68-73% in the 1980's, but most recently above 80%. A special heat treatment may be required to decrease viscosity of black liquor prior to burning. The new evaporation plants are now often falling-film evaporators and have totally seven effects.

4.3 Recovery boiler

During the last 10-15 years the kraft recovery boiler has become:

- safe and well-controlled
- low-odour, low emissions
- highly efficient for chemical and energy recovery
- bigger and bigger.

Some ten years ago it was believed that the limit of the boiler size has been reached at around 2500 ton dry solids per day. Now over 3000 t/d boilers are in operation and even bigger under construction. There are no limits which is important for the capacity of closed cycle mills. The detailed design of the boiler has developed. The recent developments are high dry solids firing (up to 80-85%) resulting in higher steam generation, less flue gases as well as low SO₂ and TRS emissions. In average temperature and pressure have increased.

New Combustion Developments

There have been several new combustion alternatives under development, but so far no serious alternative to the recovery boiler are available. The most interesting alternative is gasification, which is still being studied in many laboratories and even in demonstration plants. Successful gasification combined with gas turbine cogeneration would increase substantially power generation of the pulp mill.

Direct alkali recovery process (DARS), suitable for sulphurfree pulping, has already been tested in mill-scale. In this system sodium carbonate is bound to ferrioxide and sodium hydroxide is released from the sodium ferrite formed. The system looks interesting, but so far the experiences are discouraging.

4.4 Lime Kiln and Recausitizing

Lime kiln and recaustitizing areas in the kraft recovery cycle have developed rather slowly compared to other areas in the kraft pulp mill. Some developments can be mentioned:

- Bigger and bigger equipment matching well the capacity needs
- Higher energy efficiency; high dry solids of lime used, energy-efficient lime kiln without chains
- Less emissions from the lime kiln (TRS, SO₂, dust)
- Higher quality of white liquor - improved clarification/filtering (pressure filters)

4.5 Chemical balance in the kraft process

In modern kraft pulp mills a balance between sodium and sulphur has been difficult to achieve because of low emissions but rather high amounts of the byproduct Na_2SO_4 from ClO_2 generation into the recovery cycle. In future, achieving a sodium-sulphur balance will be easier thanks to less chlorine dioxide in bleaching. Sulphidity can be controlled independently with make-up chemicals. The major chemical balance problem will be caustic availability. The demand for caustic soda will increase and at the same time the demand for chlorine will drop to zero. New sources of caustic soda will be needed. In the long term the kraft pulp mill may be forced to produce caustic soda itself. In closed-cycle mill that would be necessity.

4.6 Energy balance

The modern kraft pulp mill produces surplus energy in terms of both heat and power, depending on the rate of back-pressure or condensing power production. The surplus power in the best Finnish kraft pulp mills is now about 300 kWh/ADt. This may well double in the near future. It has been estimated that the process heat requirement could be further reduced by 20% and the power requirement by some 10%. The modern kraft pulp mill needs an intergrated paper and/or paperboard mill for effective utilization of its cheap energy sources, waste liquor and waste wood.

5 THE CLOSED-CYCLE KRAFT PULP MILL

The ultimate goal in the development of kraft pulping is practically closed-cycle pulp mill with water consumption only a fraction of that of today's best mills. To reach that goal requires a lot of measures almost in all departments of the pulp mill, but above all, recirculation of bleach plant filtrates. A lot of research is now under progress both for ECF and TCF bleaching. It looks very obvious that the complete counter-current circulation in the fibre line is impossible; an internal purification of bleach plant filtrates is required. Evaporation seems to be almost a necessity to be able to produce water which replaces fresh water and to maintain the water balance. Other unsolved problems are incineration of organics and removal of non-process elements from the cycle. Several process alternatives have been yet developed.

It looks fairly evident that the reuse of bleach plant filtrates can be developed. However, this does not mean that the closed-cycle concept is ready. Several additional problems have to be solved, such as:

- Purification of evaporation condensates for the substitute of fresh water
- Recycling and purification of debarking effluents/filtrates
- Internal chemical purification for the bleach plant
- The control of water balance in the closed-cycle concept; buffers, disturbances
- Solid waste management; the amount of solid waste will grow substantially.

The water consumption of the best new pulp mills will be very low, 10 to 15 m³/ADt compared to today's best mills with 30 to 50 m³/ADt. However, to reach the level below 5 m³/ADt requires a lot of effort and costs and the complete TEF may prove a dream for years to come although technical problems in unit operations can be solved fairly soon.

6 CONCLUDING REMARKS

Until late 1980's the kraft pulp industry was considered by most engineers, scientists and even public as a mature industry, where the breakthrough of major new innovations is no longer likely. Yet, during the last five years kraft pulping has undergone the most significant changes in its entire history. Pollution has decreased substantially measured in any terms, that is the case especially in the technology-leading area, Scandinavia. Toxicity of effluents has been totally removed, no dioxin is formed, AOX discharges are minimal etc. The practically effluent-free pulp mill is no more technically a dream although; very expensive to realize especially in existing mills. The new mills will have a very low water consumption and low discharges in general, new mills have a lot of surplus energy and quality is developed towards more tailor-made for end-uses. What almost remains unchanged is the recovery cycle. New unit operations are needed in closed-cycle mills. As a whole, although the kraft pulp mill is developing, it is not becoming any cheaper in terms of capital and manufacturing costs. Totally new innovations are needed to solve these problems - but their commercialization are not expected under our generation.

PULPING ALTERNATIVES

- Mechanical pulping
 - GWD, PGW, TMP, CTMP etc.
 - For newsprint, magazine papers, cartonboards, tissue etc.
 - Characteristics:
 - high yield
 - high energy consumption
 - quality:
 - printing properties (opacity, surface)
 - low strength
- Chemical pulping
 - Kraft
 - Sulphite
 - Others
- Semichemical pulping

LONG-TERM GOAL - SUSTAINABLE DEVELOPMENT

- No environmental impact which nature cannot eliminate fairly rapidly
- Sustainable forestry; species, forest areas, volumes, biodiversity
- Energy selfsufficiency
- Less capital and chemicals

DRIVING FORCES BEHIND THE DEVELOPMENT OF PULPING

- Environmental concerns
- Product quality
- Energy
- Fibre raw materials
- Capital costs
- Operation costs

MAJOR ACHIEVEMENTS AND RESULTS OF PULPING DEVELOPMENT

- Kraft pulping dominating for primary fibre
- Kraft cooking has developed rapidly
- Oxygen delignification
- Chlorine gas almost disappeared as a bleaching chemical
- TCF bleaching - oxygen chemicals bleaching (OCB)
- Mill size/capacity has grown
- Capital costs have grown
- Energy economy has improved essentially
- Environmental impact has diminished substantially
- Pulp quality has improved - more tailor-made

ORGANOCELL

- Soda-AQ and methanol
- Critical aspects
 - more complicated
 - higher costs
 - quality
- Advantages?
 - by-products

SODA

- Anthraquinone accelerates cooking
 - wood species possible; otherwise suitable for annual plant fibres
- Critical aspects
 - quality
 - costs
- Advantages
 - low sulphur emissions - low odour

CONCLUSIONS

- **RECYCLED FIBRE WILL BE THE FIBRE OF THE 21ST CENTURY**
- **KRAFT PULP WILL BE THE PRIMARY FIBRE OF THE 21ST CENTURY**
- **KRAFT PULPING WILL BE THE 21ST CENTURY PULPING PROCESS**
 - * superior quality
 - * superior energy economy
 - * wide raw material base
 - * high overall efficiency
 - * acceptable and controlled emissions in any terms

CHEMICAL PULPING

- Kraft
- Sulphite) Mill
- Soda
- Organocell

- Asam
- Milox) Pilot
- Alcell

- Acetocell
- Formacell) Lab
- Phenol
- Others

CHIPPING

- New chipper design improves chip quality

	Conventional	New
Overthick, %	12	5
Accepted, %	82	89
Fines, %	6	6

- New chipper design may make chip screening unnecessary

THICKNESS SCREENING

- Thickness is the most important dimension of the chip for proper impregnation
- Thin chips (< 7 mm) improve impregnation resulting in more even cooking
- Thickness screening with a slicer has become very popular
 - high yield
 - better quality
 - higher capacity

DEBARKING

- Dry debarking drums - less discharges
- Efficiency of debarking is very important for all processes
- Water is needed in dry debarking for washing, melting; in wet drums water use is high
- Internal water circulation and purification cuts water use essentially

WOOD RAW MATERIAL

- Wood species
- Wood quality; age, distribution, storage, decay, other defects
- Effects on
 - pulp quality
 - yield - mill capacity
 - costs
 - discharges
- High wood quality is especially important for TCF bleaching

SELECTIVITY

- Yield

$$\sim k \times \frac{[\text{HS}^-]}{[\text{OH}^-]}$$

- Quality (Viscosity)

$$\sim k \times \frac{1}{[\text{OH}^-]}$$

- For selectivity high $[\text{HS}^-]$ and low $[\text{OH}^-]$
beneficial: $[\text{HS}^-] / [\text{OH}^-] > 8 - 10$
- Practical arrangements:
 - black liquor impregnation
 - green liquor impregnation

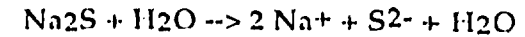
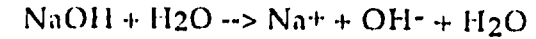
OPTIMIZATION OF PULP KAPPA NUMBER

1. DEFIBERABILITY OF PULP; THE AMOUNT OF REJECTS MUST BE REASONABLE WITHOUT REFINING (KAPPA < 35 - 40 WITH SW, < 25 WITH HW)
2. CAPACITY OF PULP MILL DEPARTMENTS; LOWER KAPPA INCREASES LOADING OF THE RECOVERY CYCLE
3. COSTS; YIELD VS. CHEMICALS
4. QUALITY; DEPENDENT ON PAPER GRADE
5. OTHER PROCESSES, SUCH AS OXYGEN DELIGNIFICATION, ALLOW HIGHER KAPPA AFTER COOKING
6. ENVIRONMENTAL POLLUTION - LOWER KAPPA - LESS POLLUTION; ALMOST LINEAR CORRELATION

KRAFT COOKING IS OH- & SH- DELIGNIFICATION

- Soda process
- One-charge kraft processes
- Split charge kraft processes
- Split SH- and OH- charges kraft processes

KRAFT PULPING



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COMMERCIAL TECHNOLOGIES FOR LOW-KAPPA COOKING

- Kamyr-EMCC
- Kamyr-ITC
- RDH
- Super Batch
- ENERBATCH
- Other modifications

KRAFT PULPING KINETICS

- Rate of lignin removal
 $\sim k \times [\text{OH}^-] [\text{HS}^-]$
- Rate of cleaving cellulose chains,
Rate of carbohydrate dissolution
 $\sim k \times [\text{OH}^-]$

**SUMMARY OF APPLIED MODIFICATION RULES
IN CURRENTLY DELIVERED COOKING SYSTEMS**

	Rule 1	Rule 2	Rule 3	Rule 4		Time at Cooking
	Entire Cook	Front End	Back End	Front End	Back End	Temp. h
MCC	+	-	+	-	+	1+1
EMCC ITC	+	-	++	-	+	1+1+3
SUPER BATCH	+	++	-	+	-	1
RDH	+	+	-	+	-	1

**THE RULES OF MODIFIED KRAFT
COOKING**

- Rule 1** Concentration of hydroxide ion, OH⁻
 - low at the beginning of the cook
 - even throughout the cook
- Rule 2** Concentration of hydro-sulfide ion, SH⁻
 - as high as possible at the beginning of the cook
- Rule 3** Concentration of dissolved lignin and sodium
 - as low as possible, especially at the end of the cook
- Rule 4** Temperature
 - low, especially toward the beginning and end of bulk delignification

OBJECTIVES IN WASHING

- Minimum amount of wash liquor
- High consistency
- High temperature
- Low discharges and emissions

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ITC (ISOTHERMAL) COOKING

- Cooking at lower temperature utilizing the volume of the Kamyr digester totally for cooking
- Counter-current stage with a fresh liquor
- Advantages:
 - Lower kappa possible
 - High viscosity



"ISOALKALINE" KRAFT COOKING

- Impregnation with black liquor fortified with white and/or green liquor
- Split alkali charge

CRITICAL STEPS IN KRAFT COOKING

- Impregnation - even and deep
- Cooking chemical charge
 - split charge - right order (OH^- , SH^-)
 - avoid SH^- and OH^- shortage
 - avoid high initial CH^- concentration
- Fast and uniform heat transfer
- Optimum time and temperature - isothermal/low temperature cooking
- Residual alkali high enough

WASHING EQUIPMENT

- Pressure washers
 - DD filter
 - Pressure diffuser
- Displacement press
Wash press
Twin-wire press
- Atmospheric
 - Diffuser
 - Vacuum filters

OBJECTIVES IN WASHING

- Minimum amount of wash liquor
- High consistency
- High temperature
- Low discharges and emissions

PULP WASHING

- Recovery of dissolved organics and chemicals
- After cooking
- Post-oxygen washing
- Bleaching plant

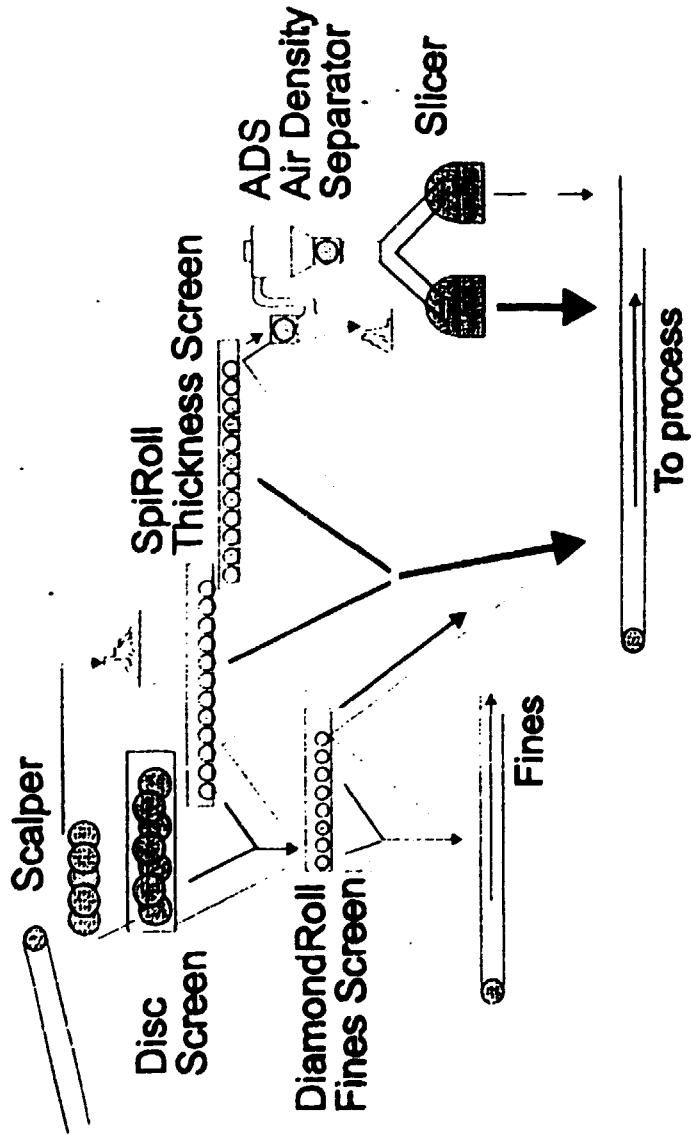
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EFFECT OF CARRY-OVER ON BLEACH PLANT DISCHARGES

(Carry-over 10 kg COD_{Cr}/t)

	Act.Cl consumption kg/t	AOX kg/t	COD _{Cr} kg/t	BOD ₇ kg/t
<ul style="list-style-type: none"> • Closed circulations - no discharges • Higher consistency (up to 3%) • New designs especially for slotted screens • Double screening (holes and slots) -> one-stage with slots • Fractionation technology with slot screens 				
Softwood, no oxygen delignification	5	0.5	7	1.0
Softwood, oxygen delignification	5	0.7	8	1.0
Hardwood	3.5	0.3	6	1.5

THICKNESS SCREENING

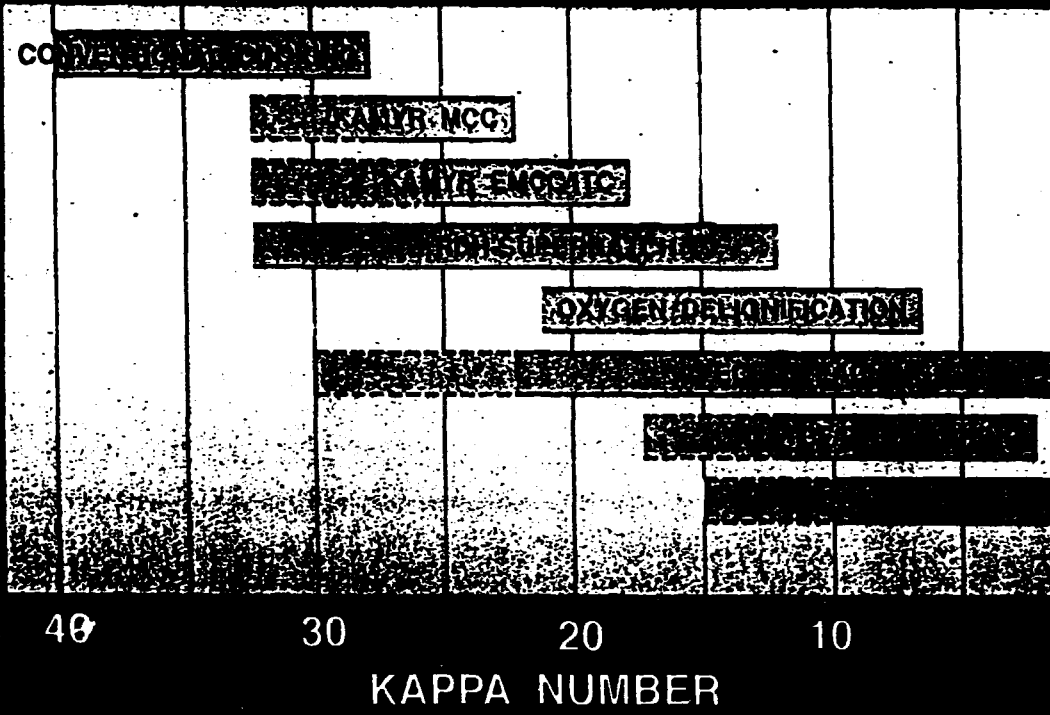


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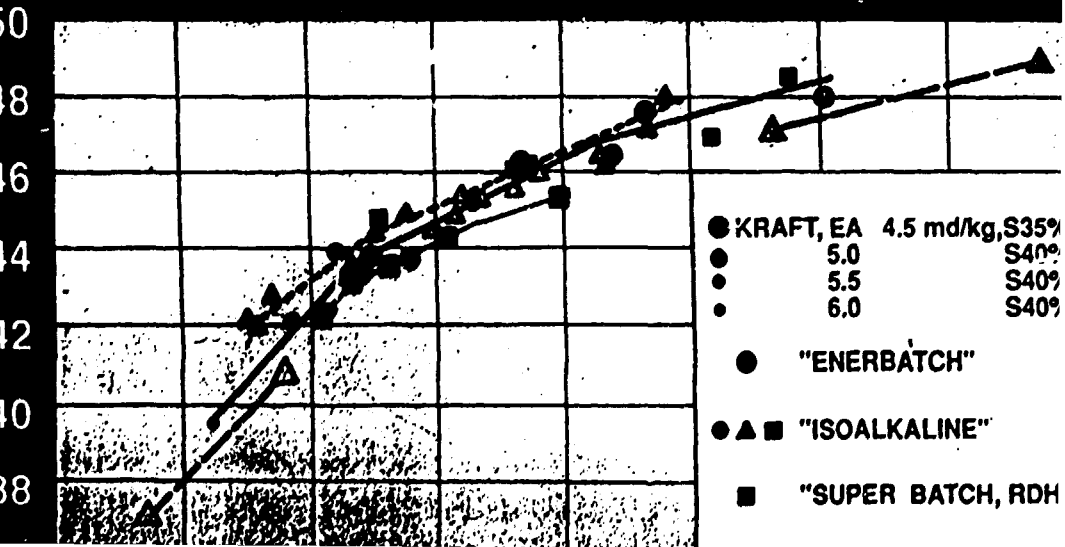


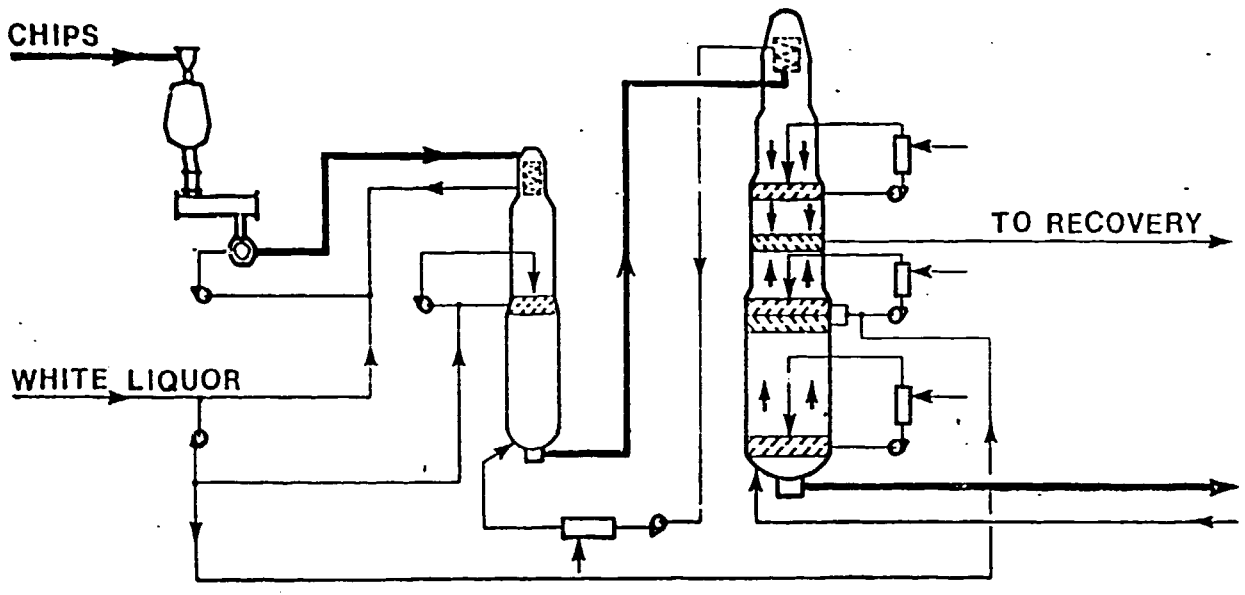
DELIGNIFICATION OF SOFTWOOD BY KRAFT COOKING MODIFICATIONS AND BLEACHING



YIELD-KAPPA NUMBER RELATIONSHIPS IN CONVENTIONAL AND MODIFIED KRAFT COOKING OF SOFTWOOD

TOTAL UNBLEACHED YIELD, %





Extended Modified Continuous Cooking



Concentration vs. Time

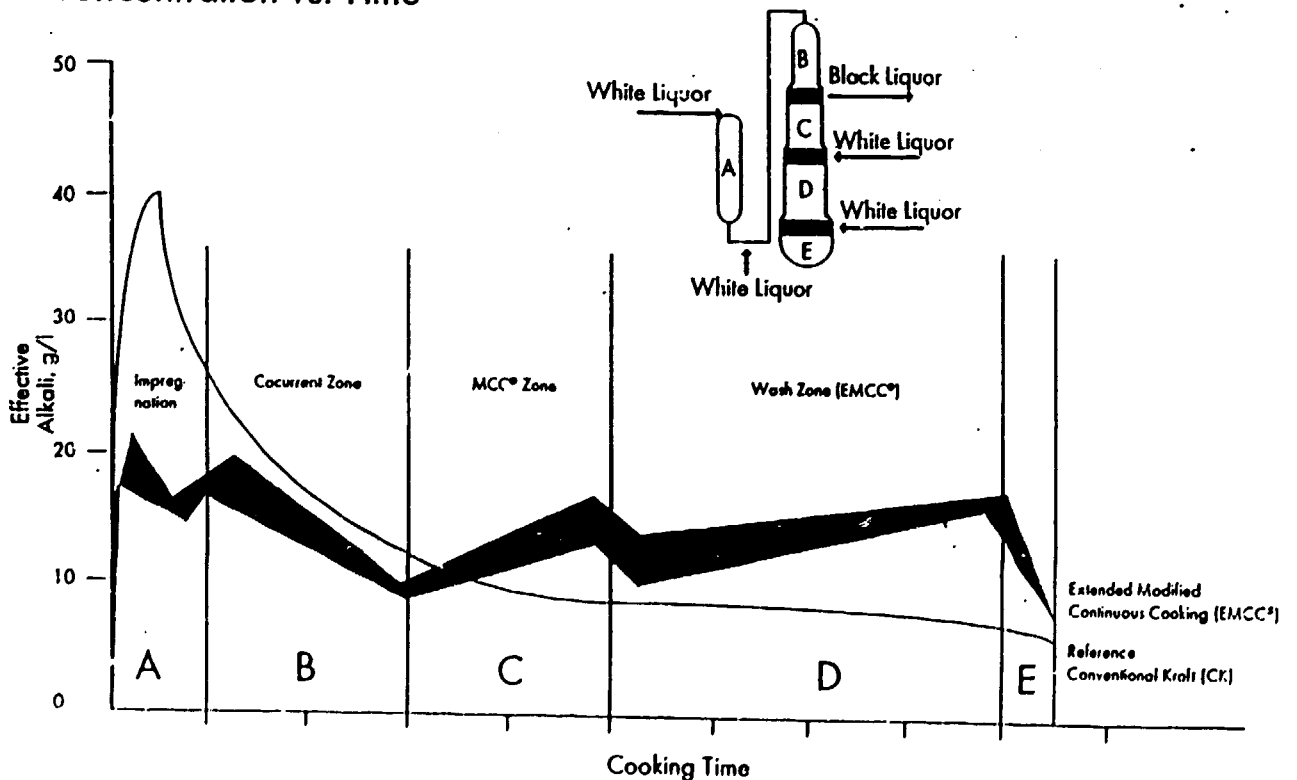
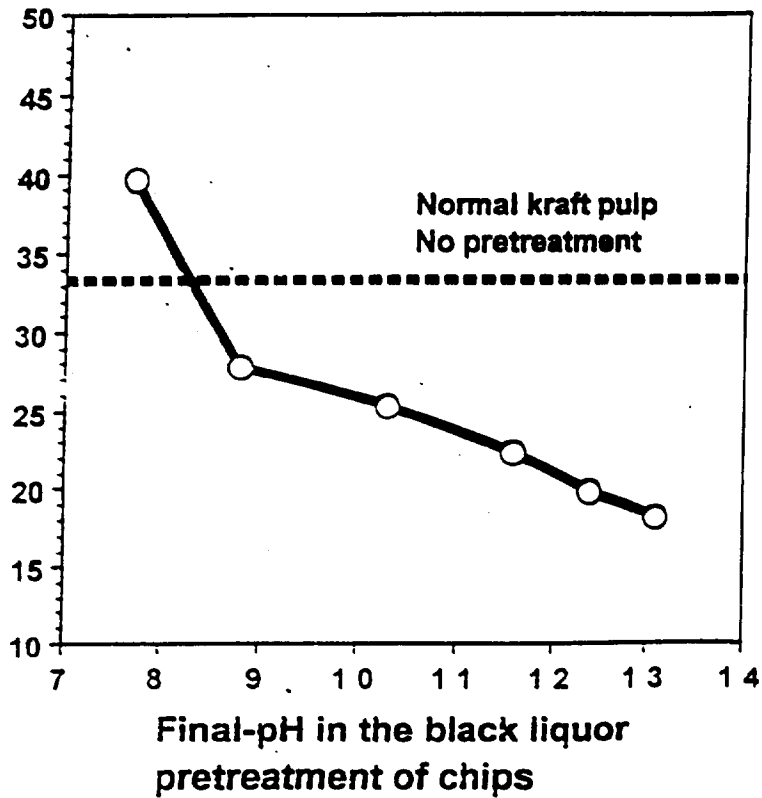
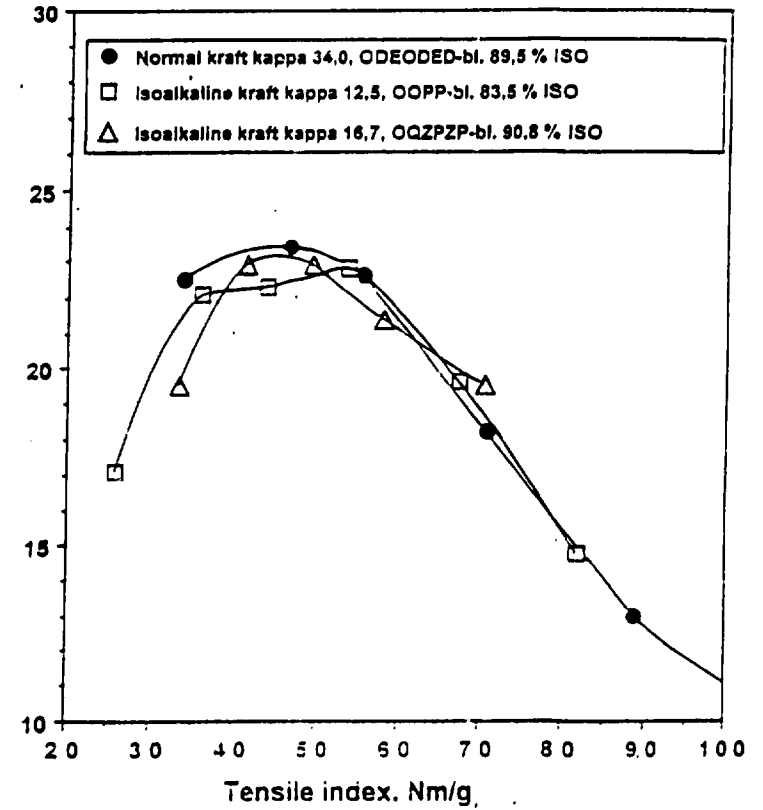


Fig. 2. Approximate Concentration of effective alkali in liquor (Dependent on alkali splits)

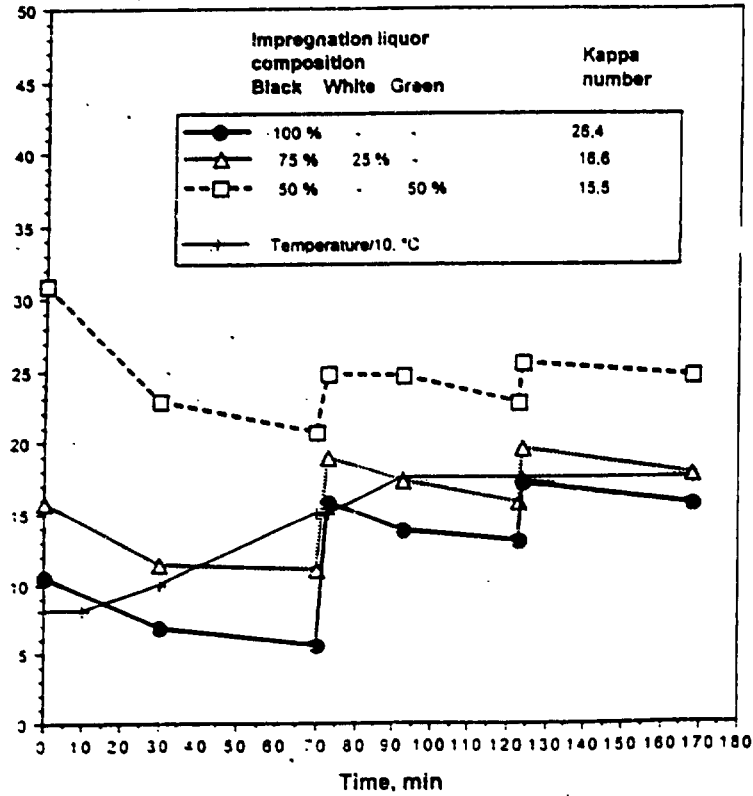
Kappa number after kraft cooking



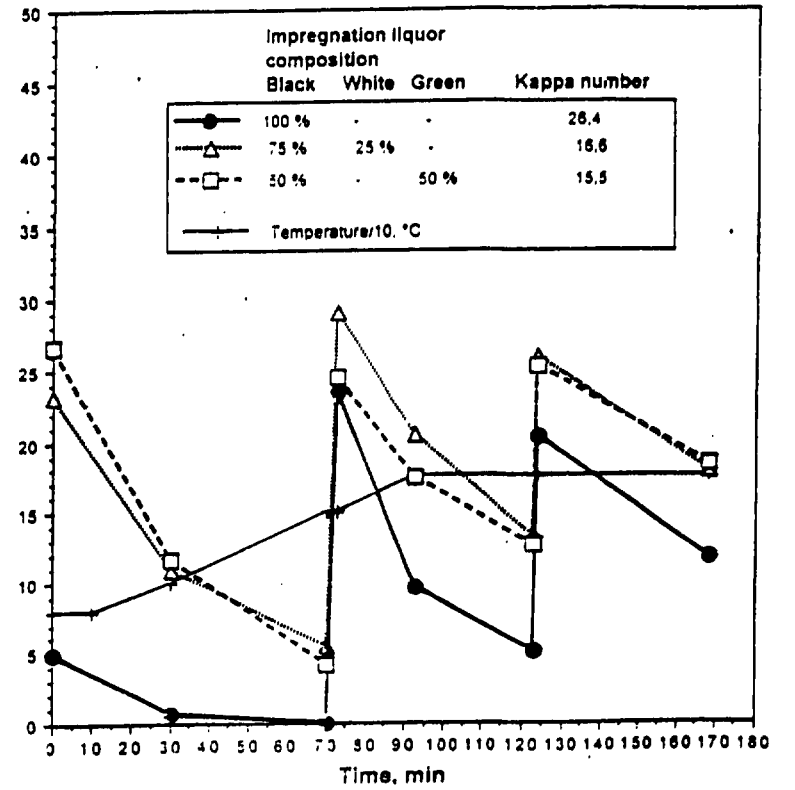
Tear index, mNm²/g



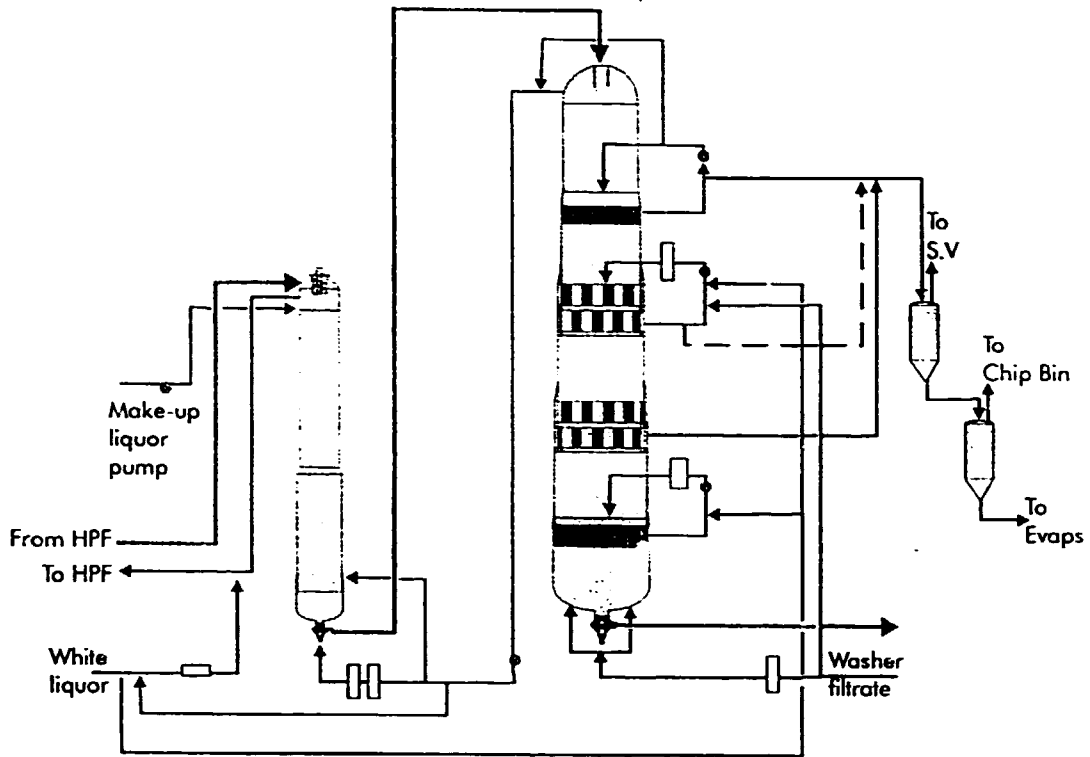
Na₂S, g/l
Temperature/10, °C



Effective alkali, g/l
Temperature/10, °C



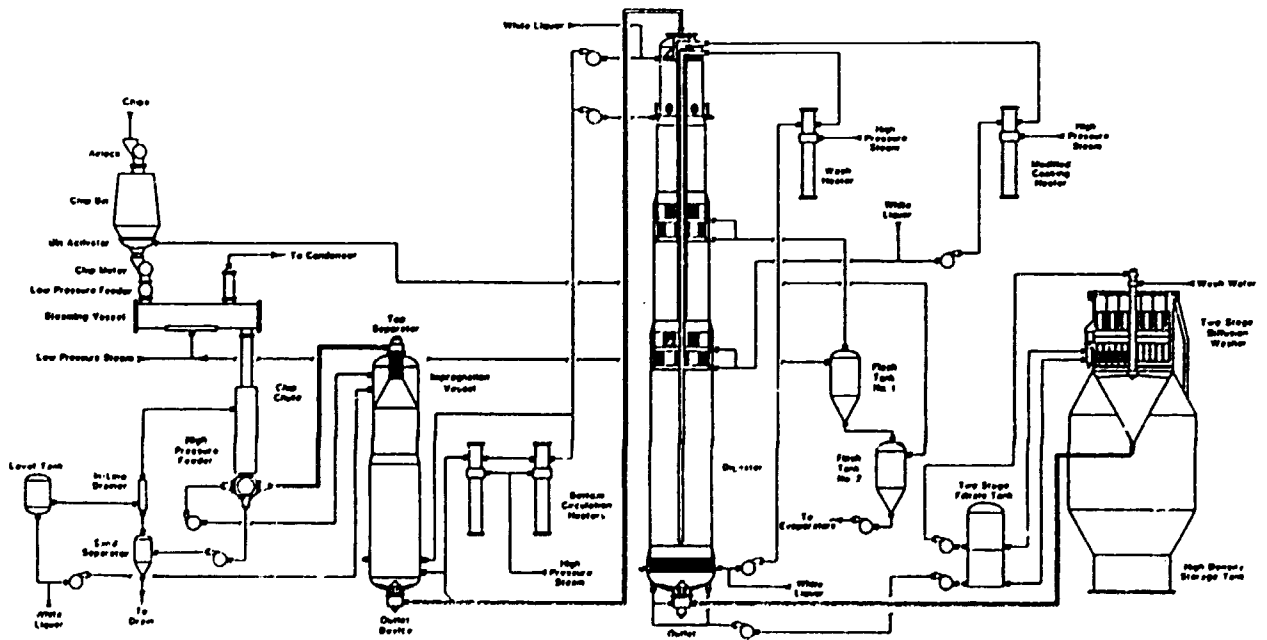
Two Vessel Hydraulic Digester with Standard Impregnation and Lo-solids™ Cooking



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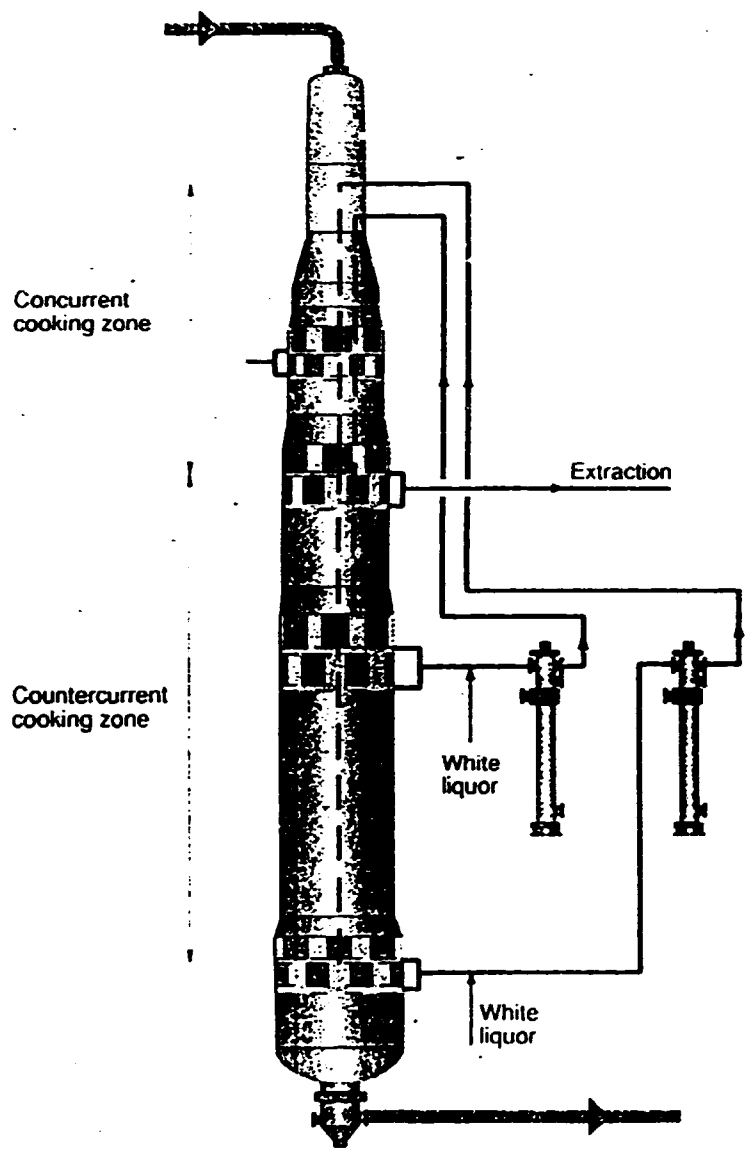
Two Vessel Hydraulic Digester

With EMCC® And Two Stage Diffuser

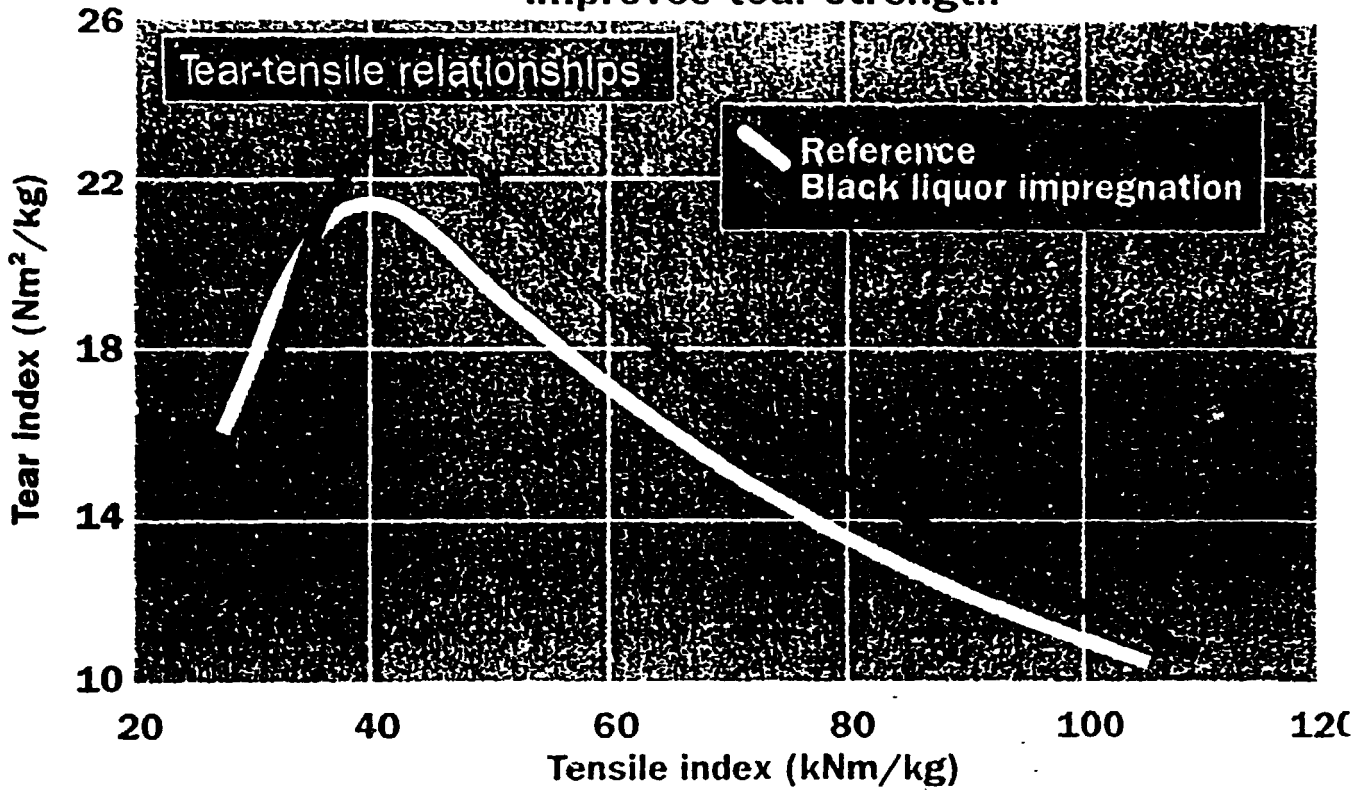


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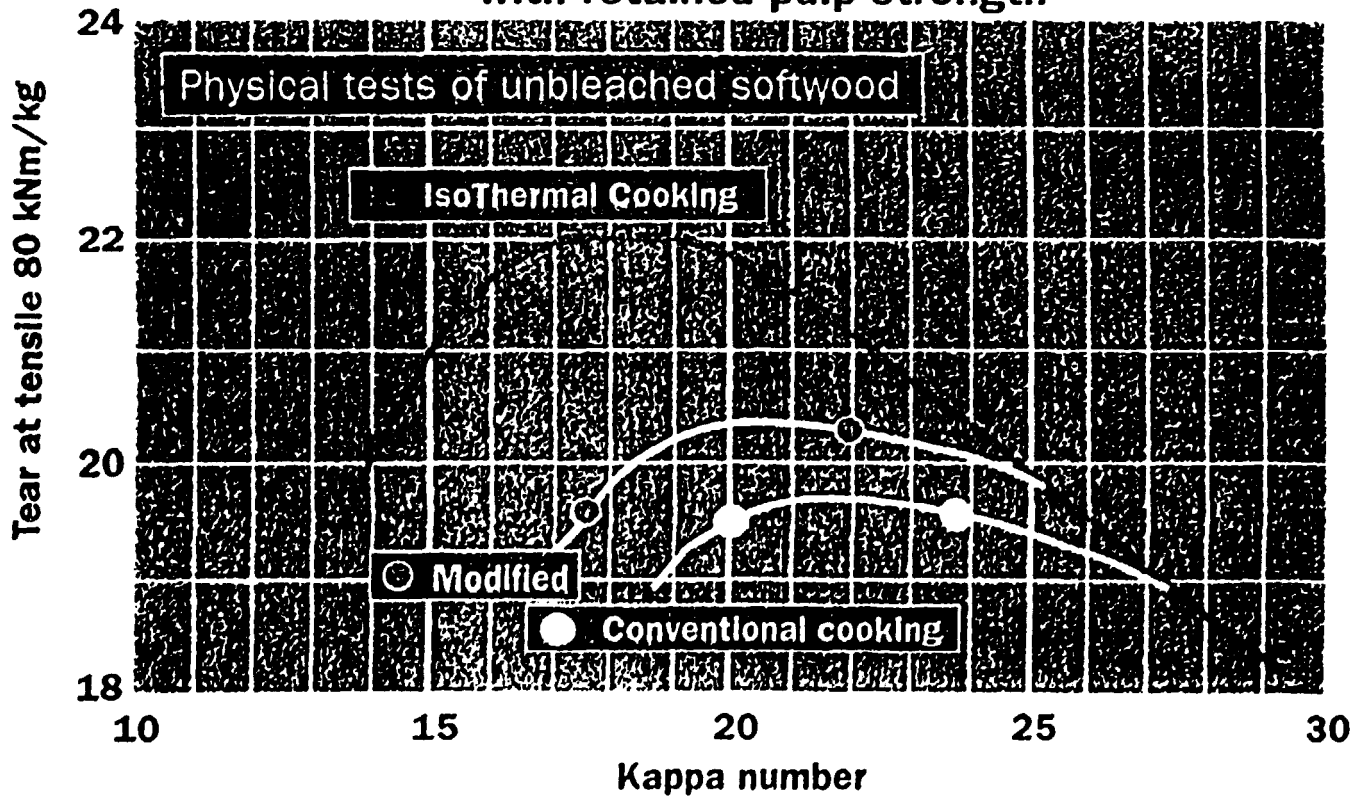
IsoThermal Cooking (ITC™)



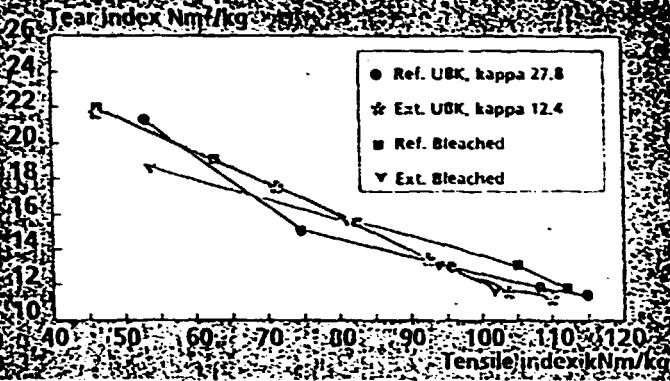
Kværner black liquor impregnation improves tear strength



ITC™ (IsoThermal Cooking) enables low Kappa pulping with retained pulp strength

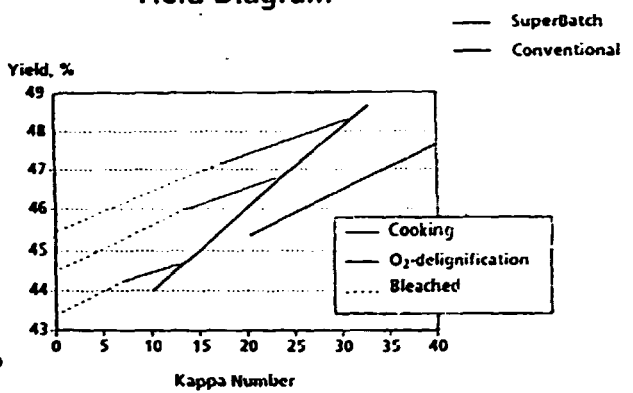


Strength of SuperBatch™ Softwood Pulp Unbleached and Bleached Pulp

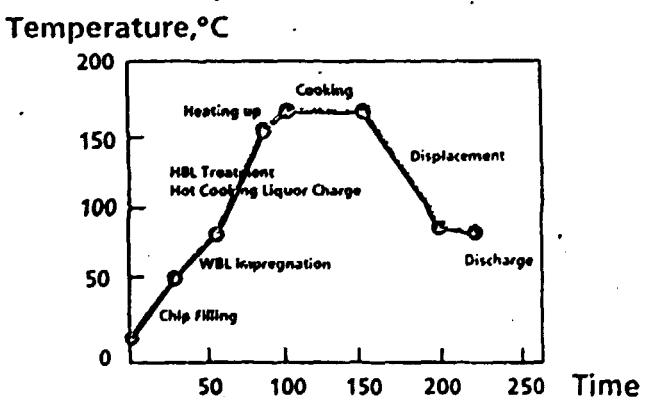


SuperBatch Cooking of Softwood

Yield Diagram



SuperBatch™ Cooking Temperature Profile



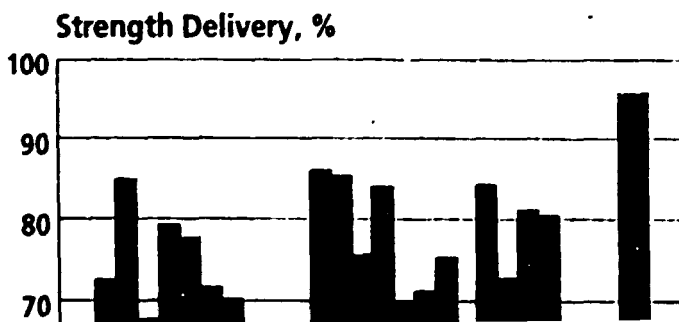
Strenght Delivery

$$SD = \frac{T_B}{T_L} \times 100 \%$$

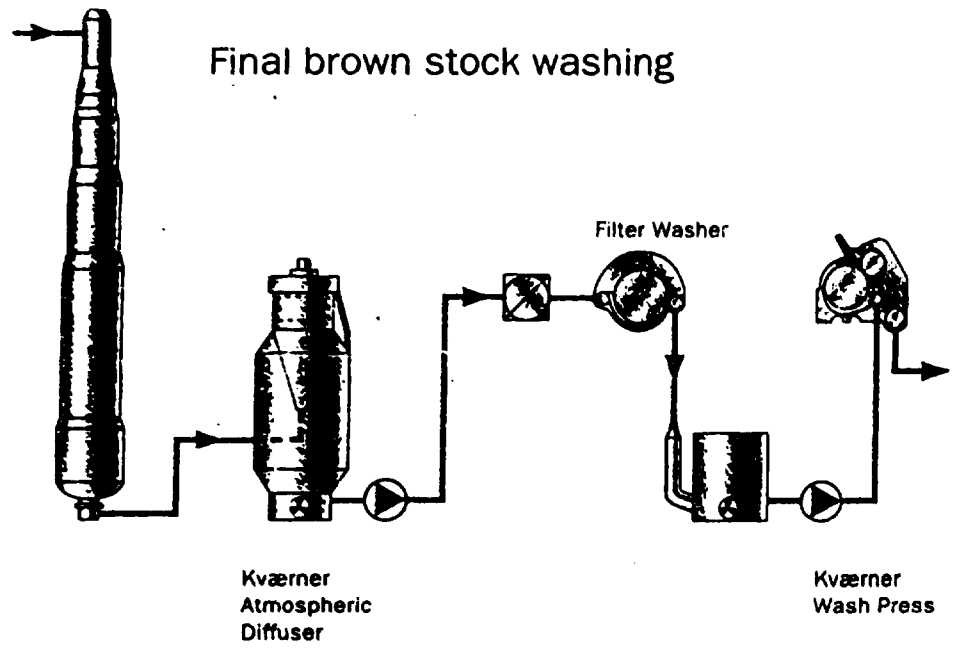
T_B = Blown Pulp Tear (mNm^2/g)
at Tensile 70 (Nm/g)

T_L = Lab Pulp Tear (mNm^2/g)
at Tensile 70 (Nm/g)

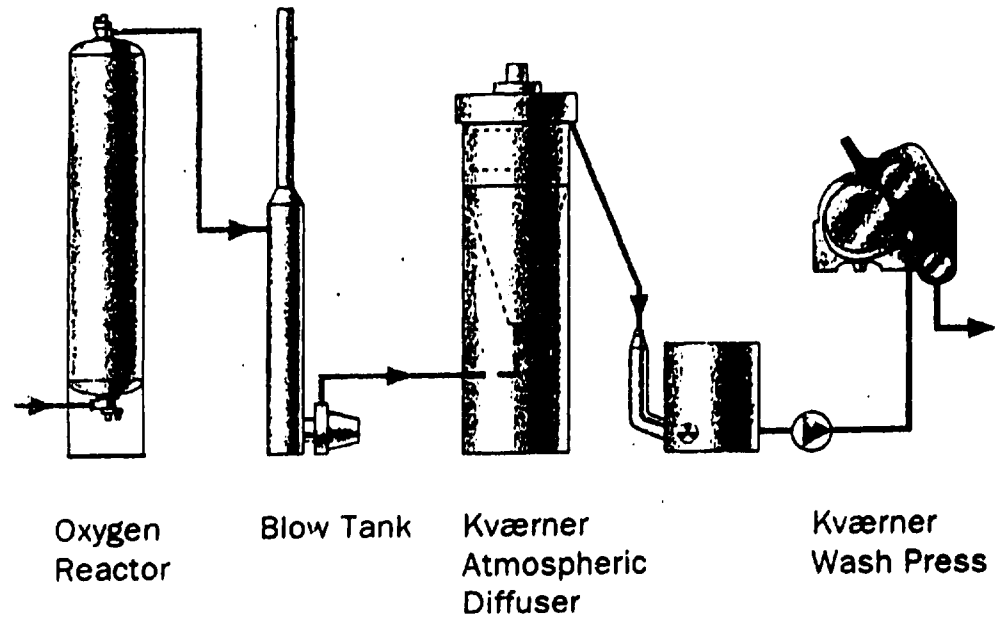
Strenght Delivery



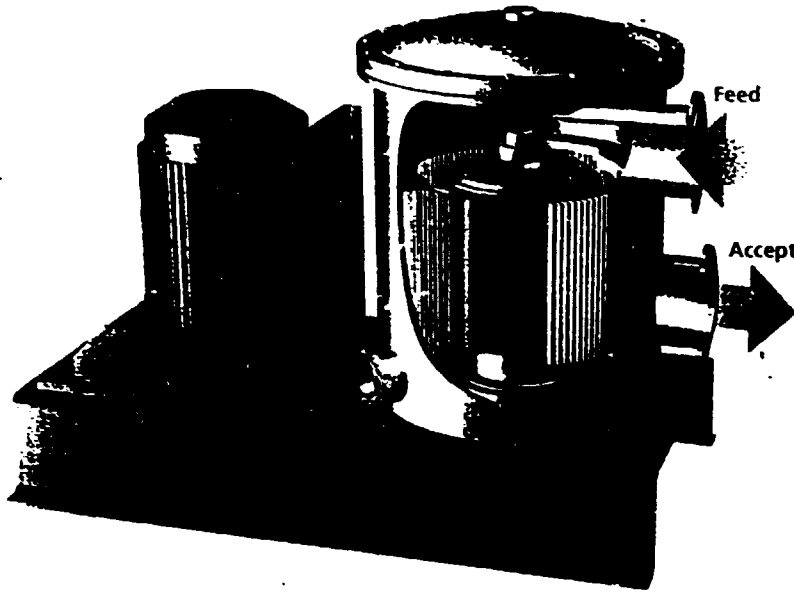
Final brown stock washing



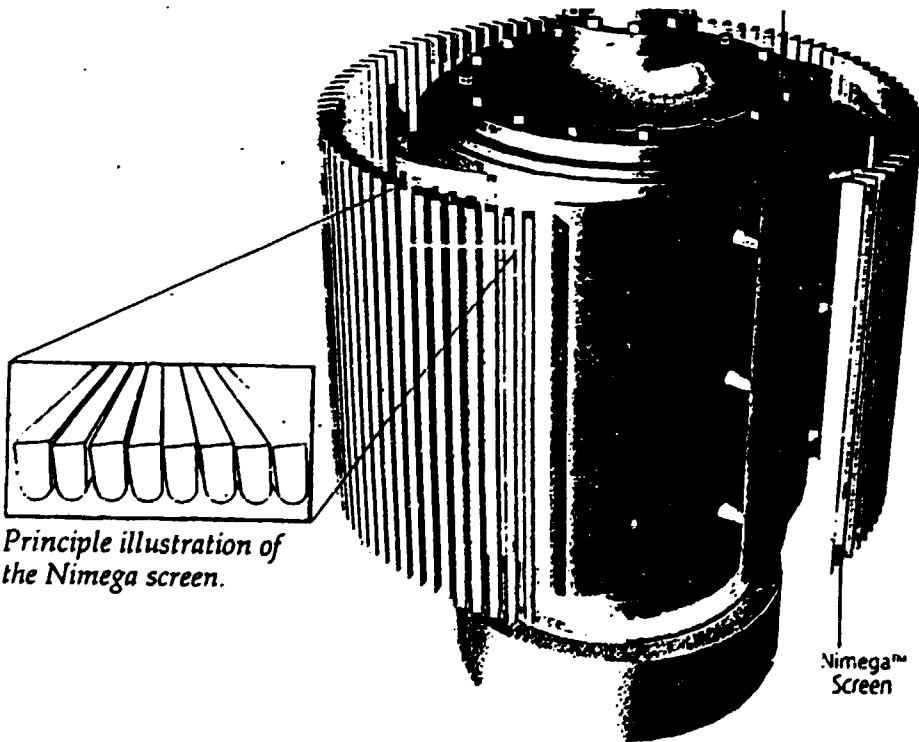
Post oxygen washing



DeltaScreen™ for High Consistency Screening



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Principle illustration of the Nimega screen.

ENVIRONMENTAL ASPECTS OF PULP BLEACHING

- BLEACHING IS THE BIGGEST POLLUTER OF WATER AT A MODERN PULP MILL

	Proportion of bleaching, %
BOD	30-60
COD	50-80
AOX	100
DIOXIN	100
COLOUR	50-80

- THE AMOUNT OF DISCHARGES VERY WELL CORRELATES WITH THE INCOMING KAPPA NUMBER OF THE PULP
- TO MINIMIZE POLLUTION, THE KAPPA NUMBER SHOULD BE MINIMIZED PRIOR TO CHLORINE CHEMICAL BLEACHING

CHLORINE AS A BLEACHING CHEMICAL

ADVANTAGES:

- VERY SELECTIVE FOR DELIGNIFICATION
- LOW PRICE
- DEVELOPED TECHNOLOGY

DISADVANTAGES:

- CHLORINATED ORGANICS FORMED IN LARGE VOLUMES
- CLOSING OF WATER CIRCULATION IMPOSSIBLE DUE TO CHLORIDE CORROSION
- LOW BRIGHTENING EFFECT

CHLORINE DIOXIDE AS A BLEACHING CHEMICAL

ADVANTAGES:

- VERY SELECTIVE FOR COMPLETE DELIGNIFICATION
- REASONABLE PRICE
- CONSIDERABLY LESS CHLORINATED ORGANICS FORMED THAN WITH CHLORINE
- HIGH PULP BRIGHTNESS - DELIGNIFICATION AND BRIGHTENING

DISADVANTAGES:

- CHLORINATED ORGANICS FORMED, THOUGH TO A LIMITED EXTENT
- HIGHER PRICE THAN THAT OF CHLORINE
- AVAILABILITY MAY BE LIMITED DUE TO CAPACITY REQUIREMENTS (ON-SITE MANUFACTURE)

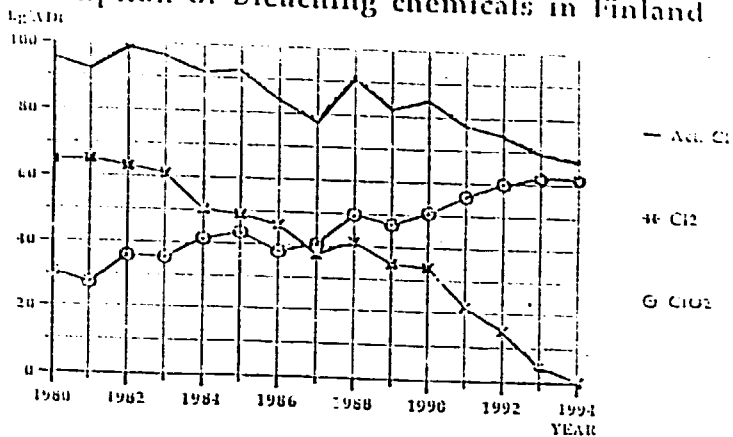
HIGH-SUBSTITUTION CHLORINATION

- CHLORINE IS SUBSTITUTED WITH CHLORINE DIOXIDE
- SUBSTITUTION LEVELS ABOVE 50% HAVE MARKED ENVIRONMENTAL EFFECTS:
 - LOWER AOX/TOCL
 - LOWER DIOXINS
 - LOWER COLOR
 - SLIGHTLY LOWER BOD, COD
- OTHER EFFECTS OF HIGH SUBSTITUTION:
 - LOWER CAUSTIC CONSUMPTION
 - LESS PITCH
 - LESS SHIVES
- ALTHOUGH VERY ATTRACTIVE, HIGH SUBSTITUTION INCREASES BLEACHING COSTS IN MOST CASES
- FOR THE CONTROL OF DIOXIN AND AOX, HIGH-SUBSTITUTION CHLORINATION IS EMERGING AS STANDARD TECHNOLOGY IN NORTH AMERICA: NUMEROUS NEW CHLORINE DIOXIDE PLANTS ARE NOW UNDER CONSTRUCTION OR ORDERED

LOW-MULTIPLE CHLORINATION

- LOW-MULTIPLE CHLORINATION (CHLORINE CHARGE $< 0.15 \times$ KAPPA NUMBER) IS A POWERFUL TOOL FOR DIOXIN CONTROL
- LOW-MULTIPLE CHLORINATION REQUIRES EFFICIENT EXTRACTION STAGE (E/O, E/O,P) TO ACHIEVE HIGH BRIGHTNESS
- CHLORINE DIOXIDE REQUIREMENTS WILL INCREASE
- A MODIFICATION OF LOW-MULTIPLE CHLORINATION: TWO-STAGE CHLORINATION FOR DIOXIN CONTROL

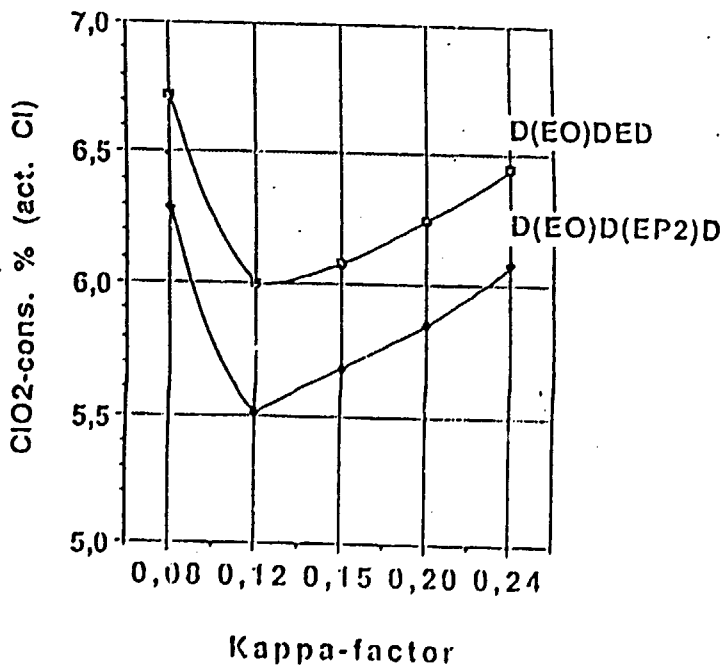
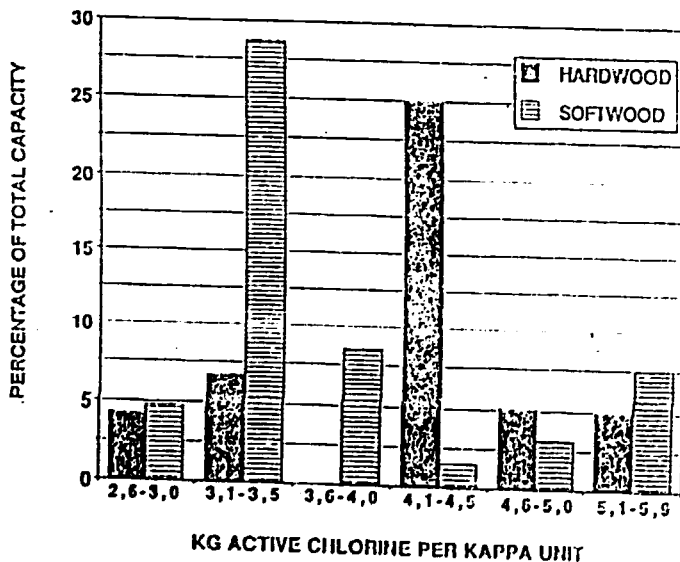
Consumption of bleaching chemicals in Finland



Kuva 7. Kloorikemikaalien käyttö valkaisuissa Suomessa.



TOTAL CHLORINE DIOXIDE CONSUMPTION IN THE FINNISH KRAFT PULP MILLS (KG ACTIVE CHLORINE PER KAPPA UNIT, NOV 1993)



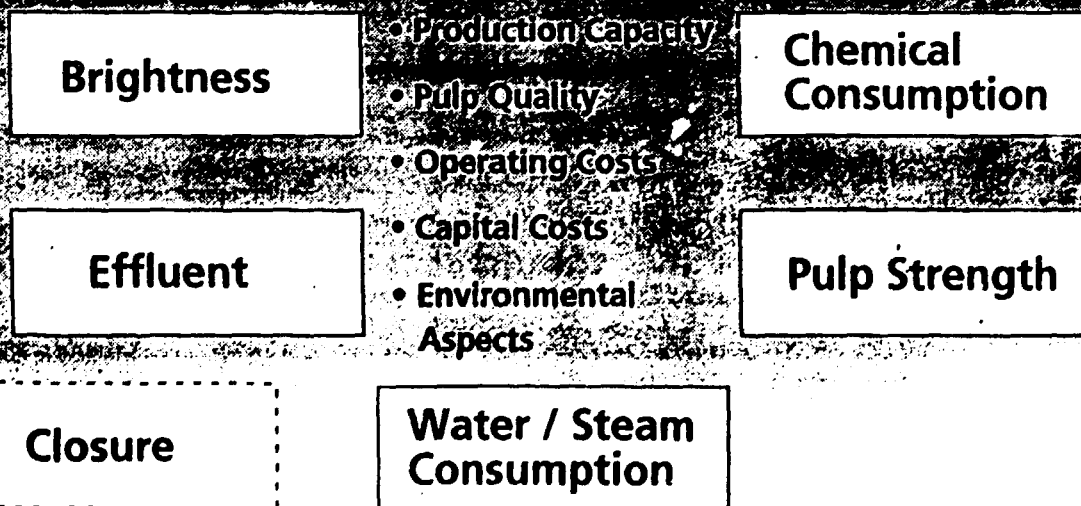
OXYGEN CHEMICALS IN TCF-BLEACHING

	O ₂	H ₂ O ₂	O ₃
Degradation of Chemical ^a			
- Catalytic degradation by heavy metals	+	+++	++
- Formation of free radicals	+	+	+++
Reactive units of lignin			
	Free phenolic structures	Carbonyls, free phenolics structures	All aromatic structures
Reactions of polysaccharides ^a			
- Stabilization of end-groups	++	+	?
- Carbonyl formation and chain cleavage	+	(+)	++

Notes a: The number of pluses reflects the relative strength of effect.



ECF-Bleaching Line - Key Design Factors



TCF BLEACHING - OZONE

- Ozone is utilized to remove residual lignin for high-bleached pulps
- Ozone removes lignin effectively but selectivity is poor

TCF BLEACHING CHEMICALS

- Oxygen
- Hydrogen peroxide
- Ozone
- Caustic soda
- Peroxyacids
- Enzymes

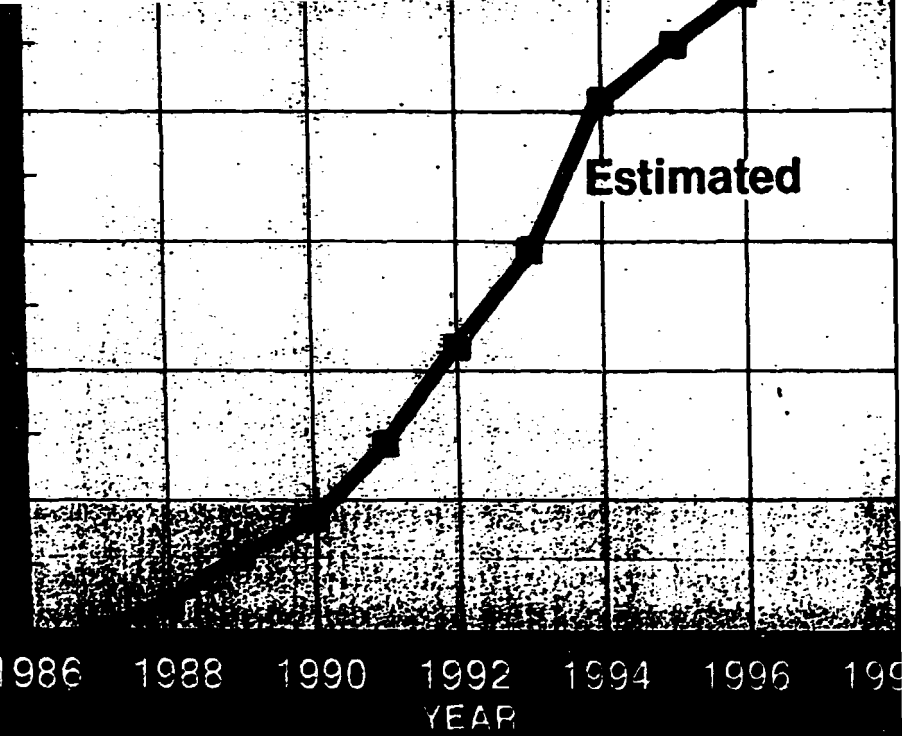
REACTION MECHANISMS OF
CHLORINE AND NON-CHLORINE
BLEACHING AGENTS

I	II	III
Cl_2 (C)	ClO_2 (D)	NaOCl (H)
O_3 (Z)	O_2 (O)	HOOH (P)

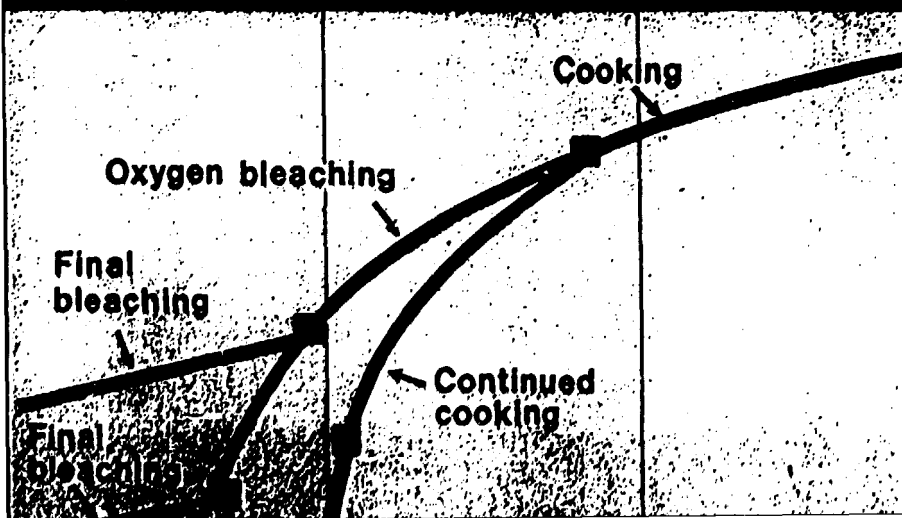
- I** : reaction with any phenolic group + double bond
II : reaction with free phenolic groups (+ double bond)
III : reaction with carbonyl groups

TCF BLEACHING - OXYGEN

- Oxygen should be utilized to a maximum degree
 - efficiency
 - selectivity
 - price
- Two-stage oxygen delignification
 - delignification rate > 50%



BLEACHING OR CONTINUED COOKING



- Peroxide is an effective brightening agent in TCF bleaching
- The P stage shall be a final stage in the sequence
- The optimization of the P stage important
 - removal of transition metals
 - costs
 - delignification vs brightening

Benefits of oxygen delignification

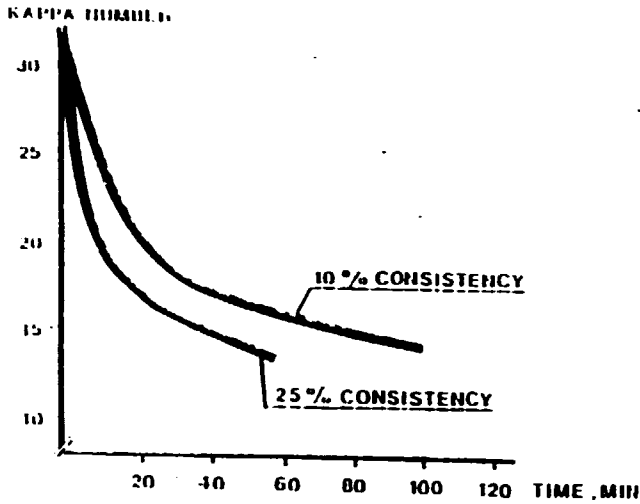
- * removes residual lignin - less lignin entering the bleaching plant
- * saves yield compared to extended cooking
- * improves bleaching efficiency
- * effluent is returned into the recovery system
- * decreases consumption of bleaching chemicals
- * a pre-requisite for short TCF-bleaching sequences
- * fits the modern mill concepts



TWO-STAGE OXYGEN DELIGNIFICATION

- * high delignification rate (> 50 %)
- * an alternative to extended cooking
- * for lowering the kappa number before TCF bleaching
- * for reduction of AOX discharges from ECF-bleaching plants

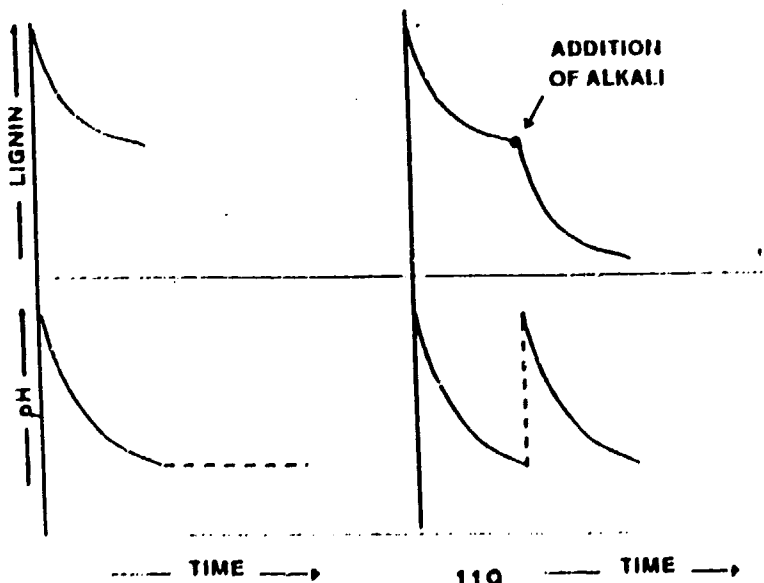




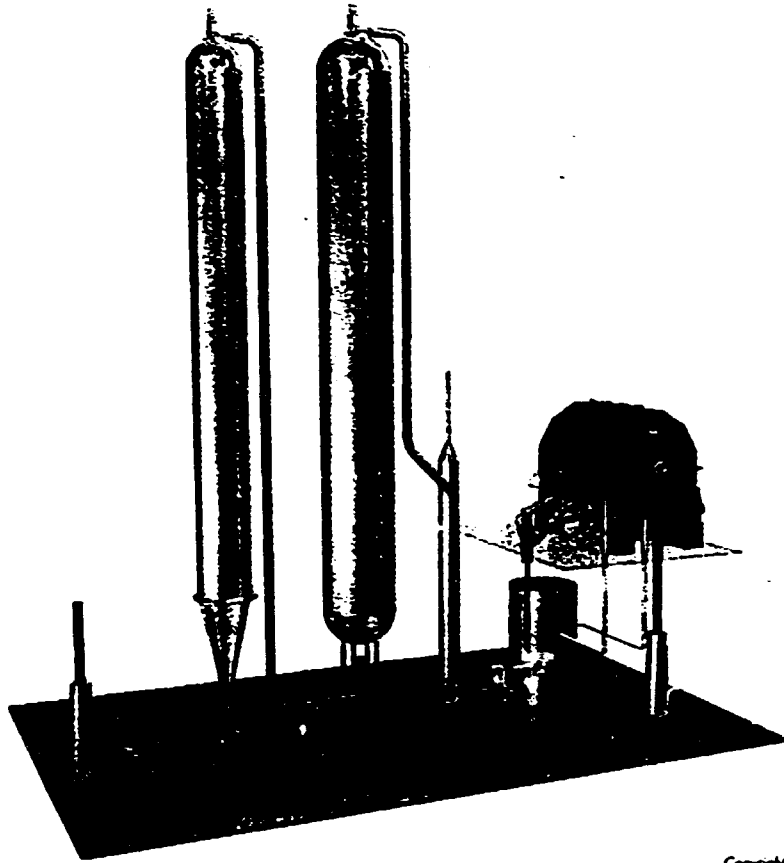
The delignification rate at HC and MC oxygen delignification

(Nj Kline, INSKO 1989)

LIGNIN REMOVAL--pH CHANGE

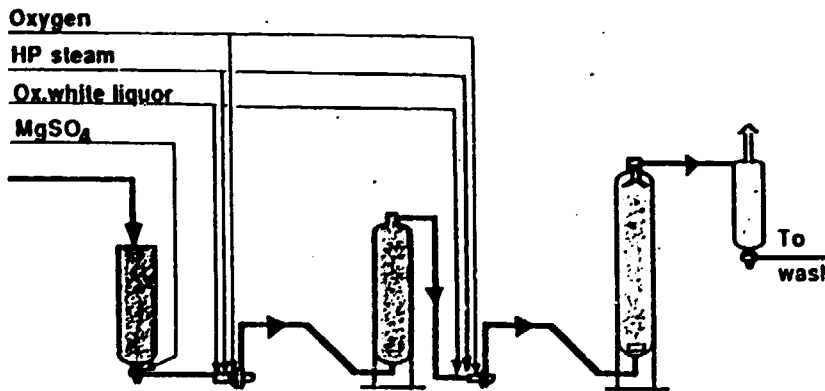


Oxygen Delignification

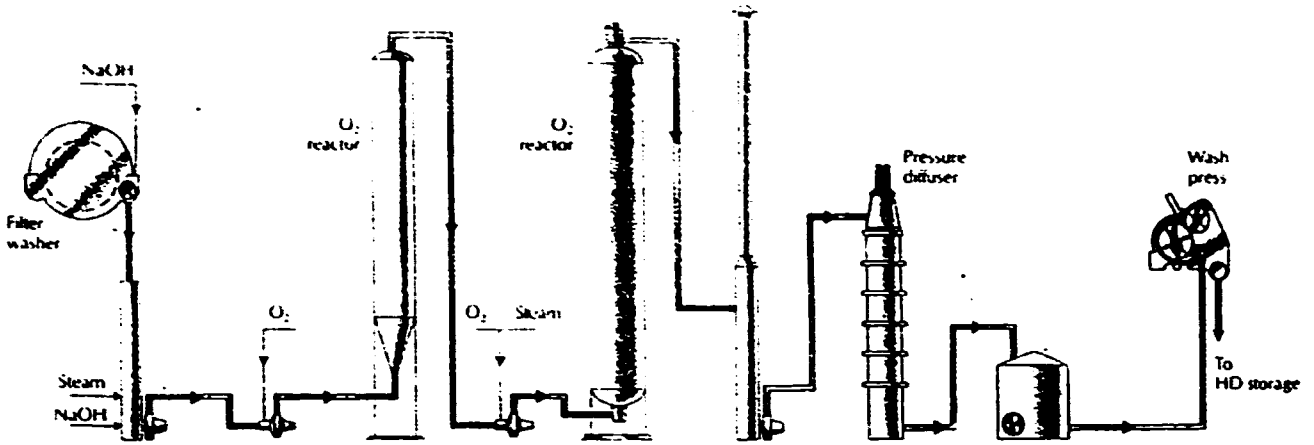


Periplex 9387702

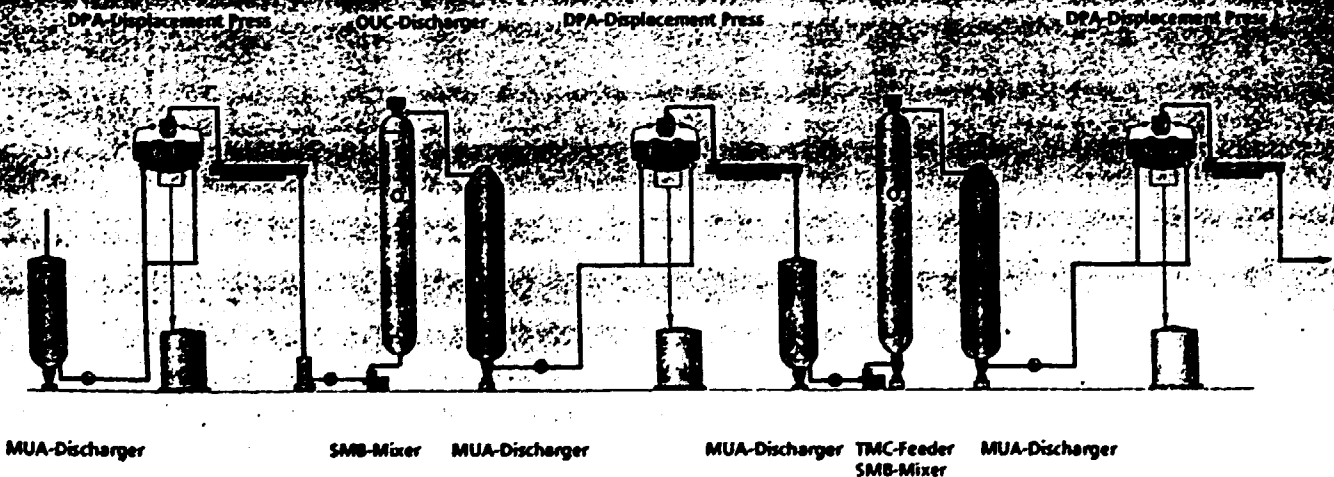
Copyright © 1993 by A Ahlstrom Corporation



Two-stage oxygen delignification



Sunds Modified Oxygen Delignification



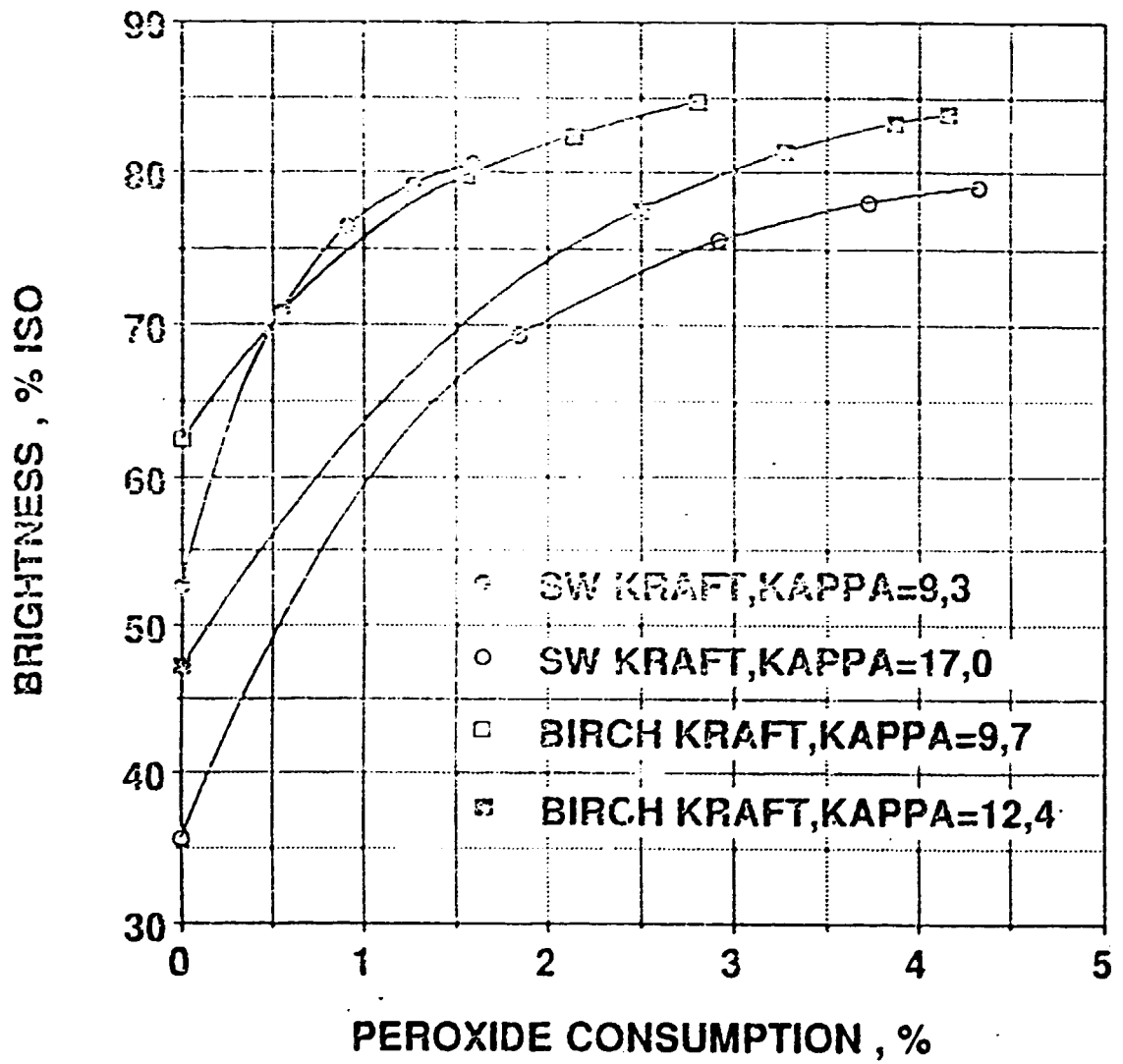
DEVELOPMENT POTENTIAL OF TCF₂ BLEACHING

- HC bleaching (consistency > 30%)
- High-temperature pressurized P stage (100 - 110°C)
- Activation by peroxyacids (peracetic acid, caro's acid)

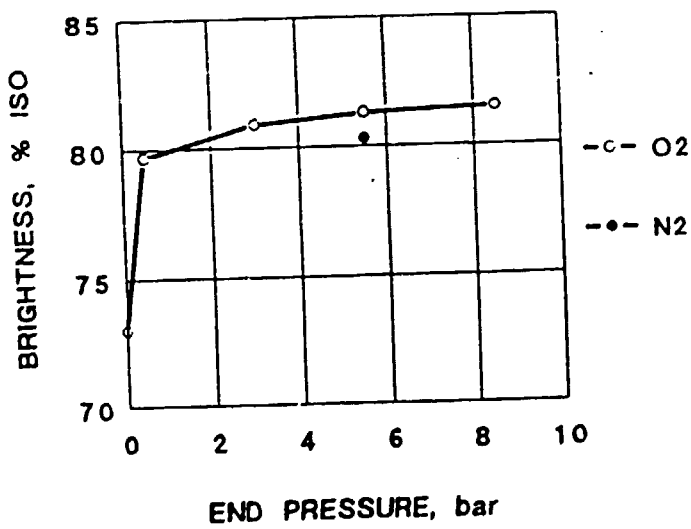
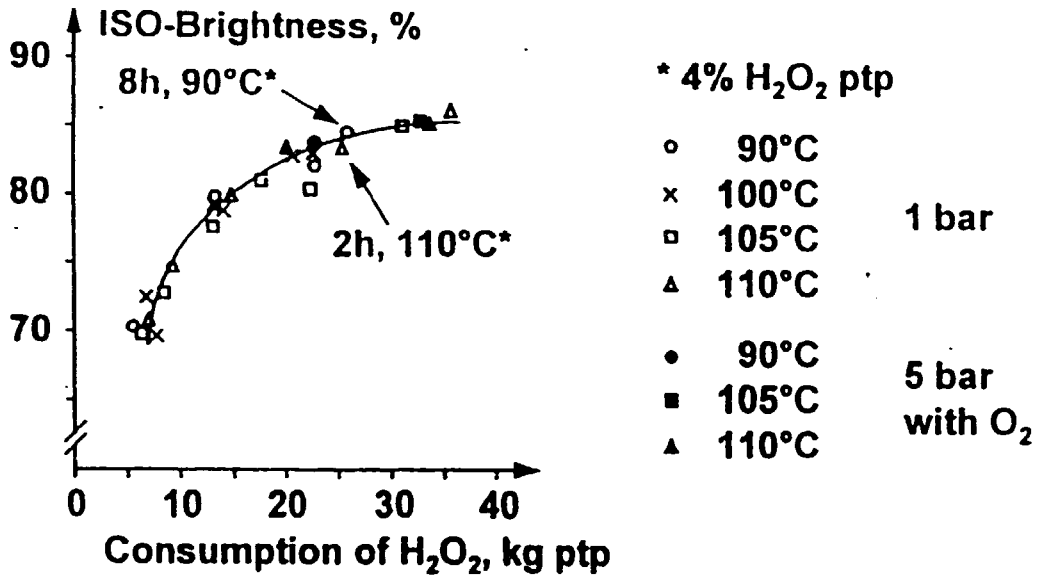
6

PRESSURIZED PEROXIDE BLEACHING

- Conditions
 - 100 - 120 °C
 - N₂/O₂ pressure up to 6 bar
 - Retention time < 2 hrs
 - Consistency; MC (or HC)
- Advantages:
 - Faster reactions - shorter retentions
 - Higher efficiency due to pressure (contradictory results)
- Disadvantages:
 - Higher steam consumption



SW O₂ Kraft pulp Kappa No 10.5



Pressurized (PO)-bleaching of softwood pulp
Effect of pressure and retention time

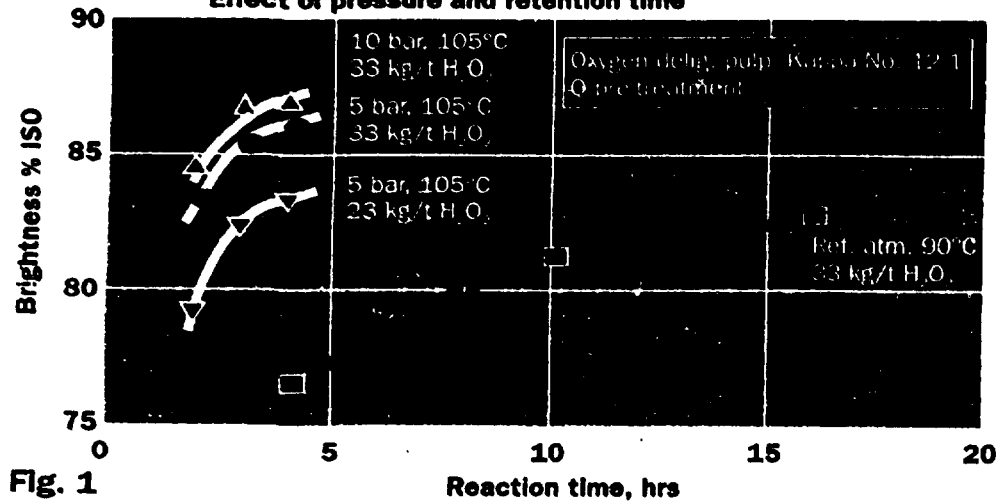


Fig. 1

Pressurized (PO)-bleaching of softwood pulp
Brightness development at different pressures

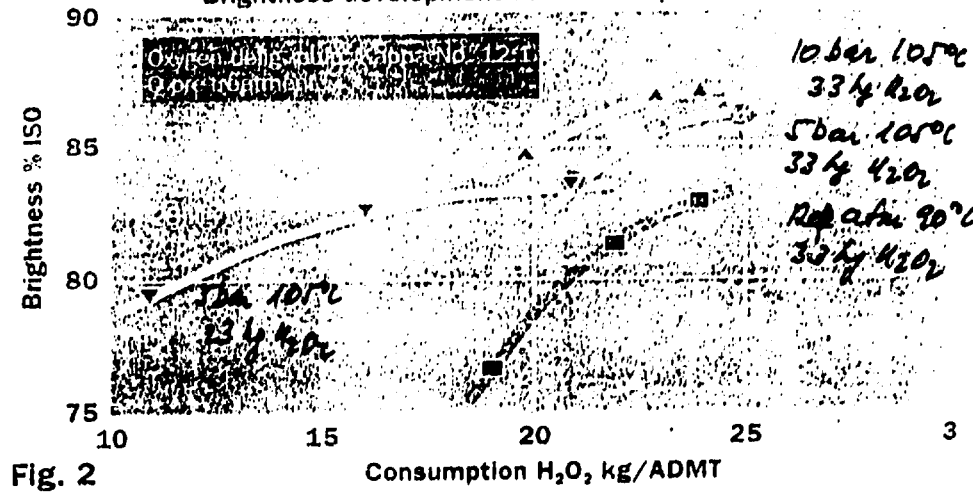
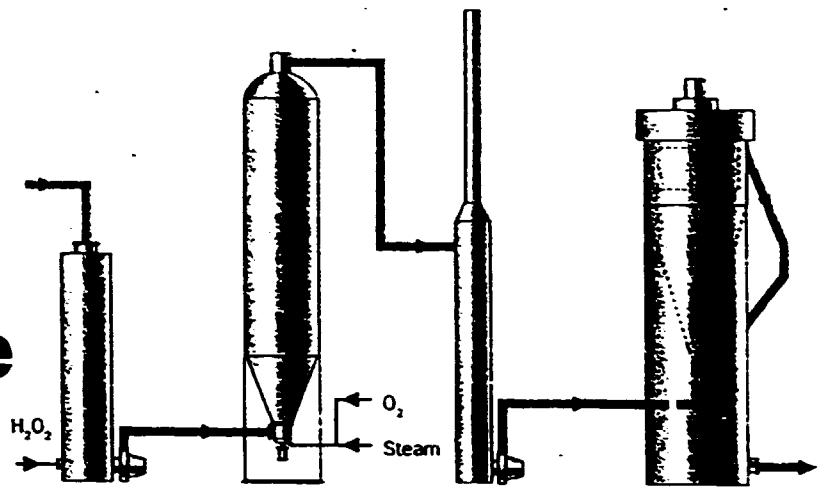
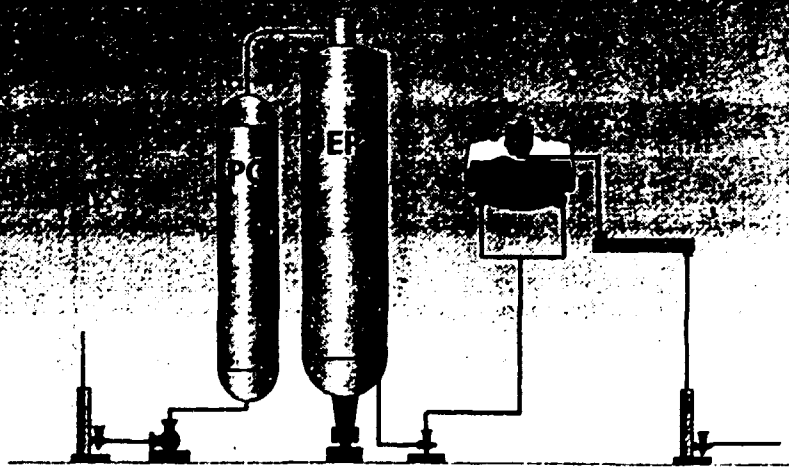


Fig. 2

The Kværner Pressurized Peroxide Stage



Bleaching - PO(EP)



OZONE BLEACHING TECHNOLOGY

HC SYSTEM (30 - 40% consistency)

conventional technology, will be applied at Union Camp

a fairly complicated and expensive system (vs. HC oxygen system)

MC SYSTEM (10 - 15% consistency)

pilot developments in progress

very fast reactions - no special reactors required

may prove a very competitive system

LC SYSTEM (1 - 3% consistency)

impractical

OZONE

- WELL-KNOWN BLEACHING AGENT SINCE A LONG TIME
- MAIN PROBLEMS IN OZONE BLEACHING:
 - UNSELECTIVE; VISCOSITY DROP
 - TECHNOLOGY; MIXING - TRANSFER OF OZONE INTO FIBRES
 - OZONE GENERATION - GENERATOR EFFICIENCY, CAPACITY, PRICE

OZONATION CONDITIONS

Temperature

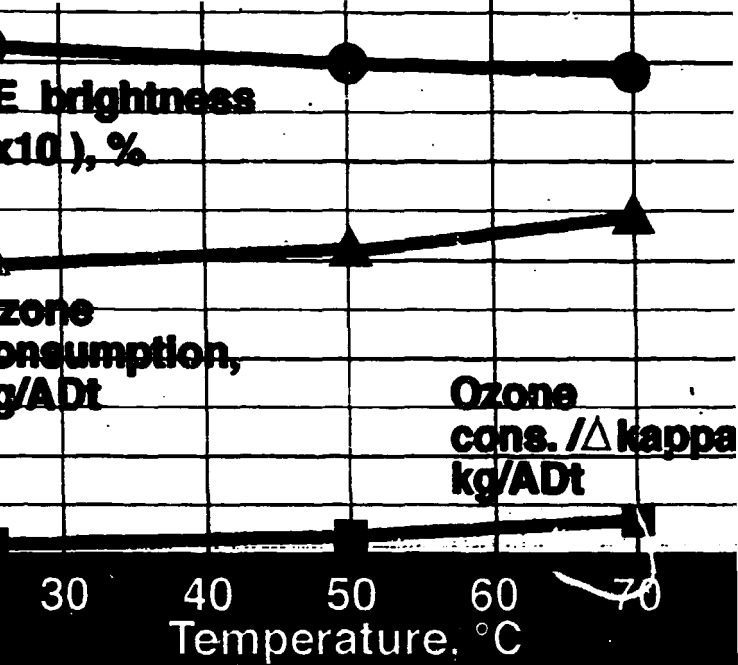
- **Ozone works over a wide temperature range (25 to 70°C)**
- **High temperature**
 - **Lowers selectivity slightly**
 - **Increases ozone consumption**
 - **Does not affect papermaking properties**
- **Temperature of 40 to 70°C can be used in mill practice**

*High temp. is preferred
but is not suitable in practice*

OZONATION CONDITIONS

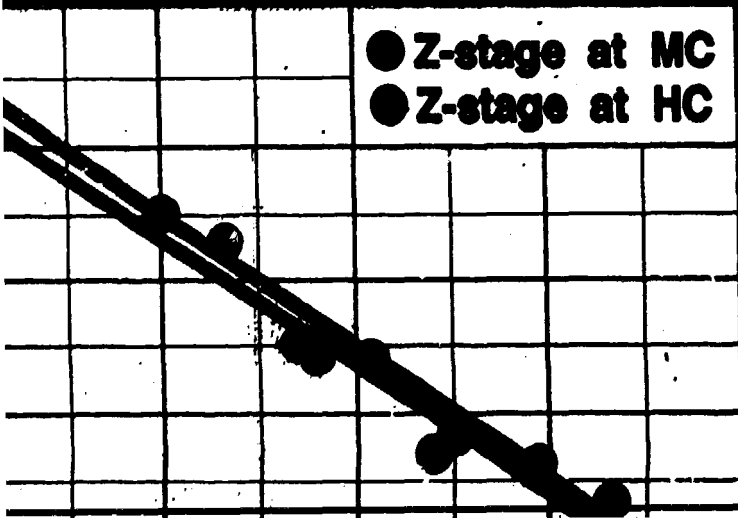
pH

- **Optimum pH 2 to 3**
- **Ozone works over a wide pH range (2 to 10) but delignification efficiency and rate as well as yield suffer at higher pH**



KAPPA NUMBER VS. OZON CONSUMPTION

Kappa Number





TCF_Z SEQUENCE - WHICH STAGE FIRST ?

- Total oxidation power critical
- Number of stages depends on nature of pulp (kappa, wood species, cooking method)
- P is always the final stage, Z or P starts the sequence

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FEATURES OF TCF_Z BLEACHING

- Viscosity low (600-750 dm³/kg)
- Bleaching yield lower, total yield depends on the brown stock and oxygen stage kappa number
- Washing between Z and P stages must be done carefully

OZONATION CONDITIONS

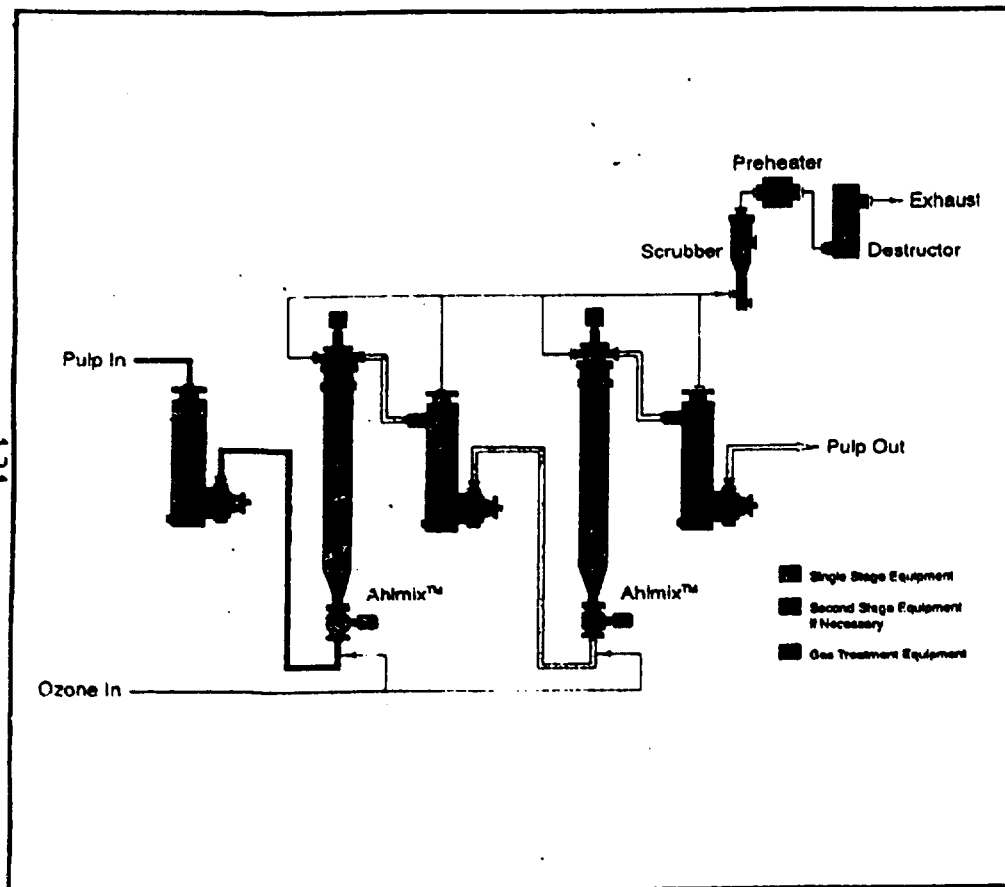
Consistency

- MC (10-12%) and HC (~40%) technical options
- KCL uses the same flow-through reactor at both MC and HC
- MC and HC ozonation almost equally good; HC looks slightly more effective, but viscosity drop tends to be higher

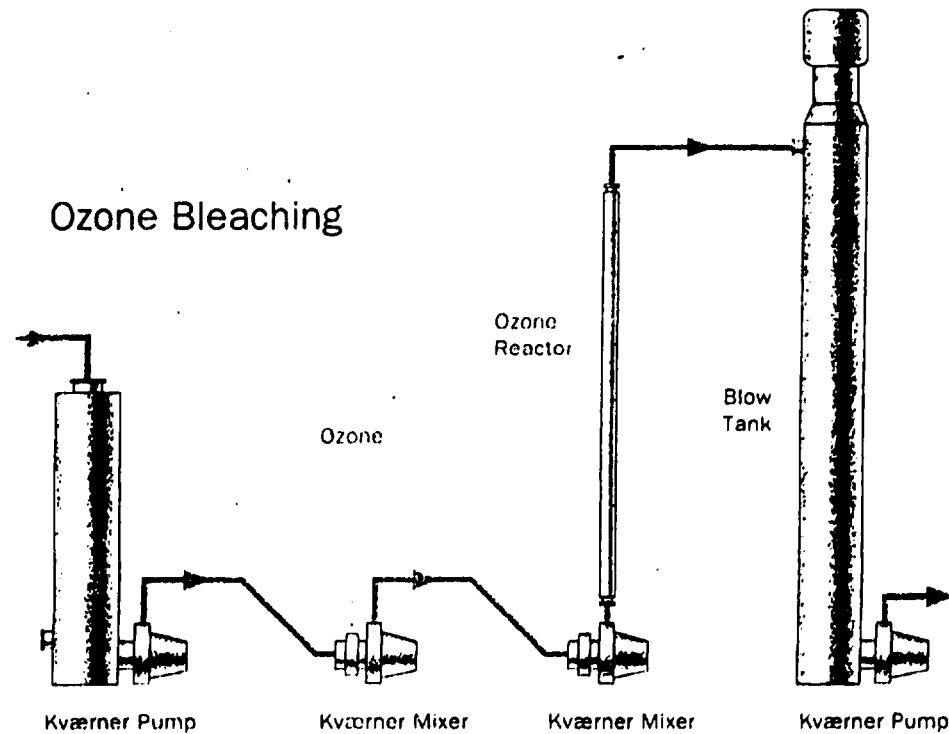
EFFECT OF INITIAL KAPPA NUMBER

- OXE consumption linearly related to kappa number
- Low kappa number preferred in terms of bleaching stages and chemical costs
- Kappa number after the O stage determines the number of stages

(7)



MC® Ozone Bleaching System



Kvæerner Pump

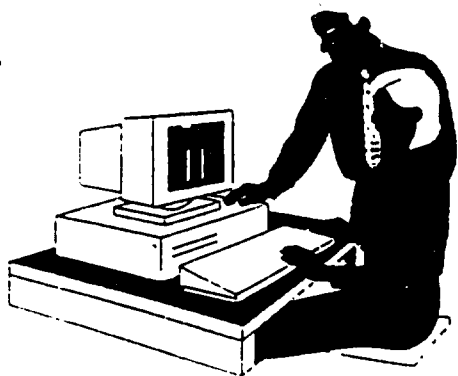
Kvæerner Mixer

Kvæerner Mixer

Kvæerner Pump

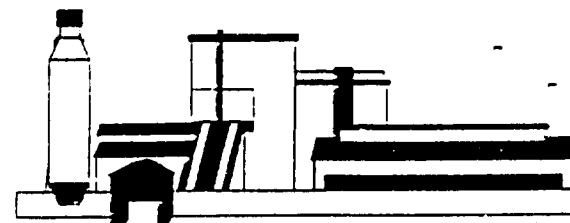
COMPARISON OF PULP PROPERTIES WISABETULA / PFI-BEATING

	<u>ECF</u>	<u>TCF</u>
BRIGHTNESS (ISO),%	89	89
PC-NUMBER	0.5	0.6
DIRT COUNT, mm ² /KG	4	3
KAPPA NUMBER	1.5	2.5
VISCOSITY, dm ³ /kg	950	750
FIBRE LENGHT, mm	0.85	0.85
PFI-BEATING		
TENSILE INDEX	70	70
REVOLUTIONS	650	900
SR	26	25
SHEET DENS. kg/m ³	785	780
TEAR INDEX, mNm ² /g	7.8	7.8



COMPARISON OF PULP PROPERTIES WISAPINE / PFI-BEATING

	<u>ECF</u>	<u>TCF</u>
BRIGHTNESS (ISO),%	89	89 (85)
PC-NUMBER	0.5	0.2 (0.4)
DIRT COUNT, mm ² /KG	6	4 (5)
KAPPA NUMBER	1	1.5 (2.5)
VISCOSITY, dm ³ /kg	950	650 (700)
FIBRE LENGHT, mm	2.3	2.2 (2.3)
PFI-BEATING		
TENSILE INDEX	70	70
REVOLUTIONS	1450	1350 (1200)
SR	16	17.5 (17)
SHEET DENS. kg/m ³	700	690 (680)
TEAR INDEX, mNm ² /g	14.5	12.5 (14)



CONCLUSIONS

- TCF_P bleaching to full brightness not yet possible; activators and P stage development will raise the brightness ceiling to 89-90% ISO
- TCF_Z bleaching to full brightness (90+% ISO) possible with two to four oxidizing stages, depending on the kappa number
- Quality of TCF pulps tends to be slightly below that of ECF but is approaching that of ECF

PAPERMAKING PROPERTIES OF TCF BLEACHED PULP

- Beatability tends to be slower, depends on the cooking method
- Strength of softwood pulp slightly lower, no difference for hardwood pulps
- Opacity lower
- Bulk lower

TCF_P vs TCF_Z

- TCF pulps are still developing rapidly - quality problems will be solved
- The future of TCF bleaching depends on the environmental performance required by markets and authorities, and the cost-competitiveness of the pulps
- TCF bleaching may prove a decisive step towards the *non-polluting kraft pulp mill*

	TCF _P	ECF	TCF _Z
Capital expenditure	(-)	±	--
Operating costs	--	±	(+)
Brightness	-	±	±
Brightness stability	--	±	±
Quality	-	±	(-)
Development potential	++	±	+

BIOBLEACHING

* TREATMENT OF PULP WITH ENZYMES BEFORE BLEACHING AND/OR WITHIN THE BLEACHING SEQUENCE

* AT PRESENT, XYLANASES ARE THE MOST EFFECTIVE ENZYMES FOR TREATING BOTH SOFTWOOD AND HARDWOOD PULP

* ENZYME TREATMENT CONDITIONS: CONSISTENCY TYPICALLY 10 - 12%, TEMPERATURE 45° C (< 60° C), RETENTION TIME 120 MIN, pH 5.5 - 7.0 (-> 9).

* THE EFFECTS OF ENZYME TREATMENT:

- KAPPA REDUCTION MARGINAL (1 - 2 UNITS)
- SAVINGS OF CHLORINE CHEMICALS 15 - 25% IN CHLORINATION OR IN FINAL BLEACHING
- YIELD LOSS 1 - 2% WITH SOFTWOOD, 2 - 3% WITH FIRCH
- PULP QUALITY PRACTICALLY UNCHANGED

PAA STAGE

- Selective delignification
- Activation prior to peroxide
- pH and temperature profiles favourable
- Filtrate circulation
- Disadvantage: costs

PERACID STAGE

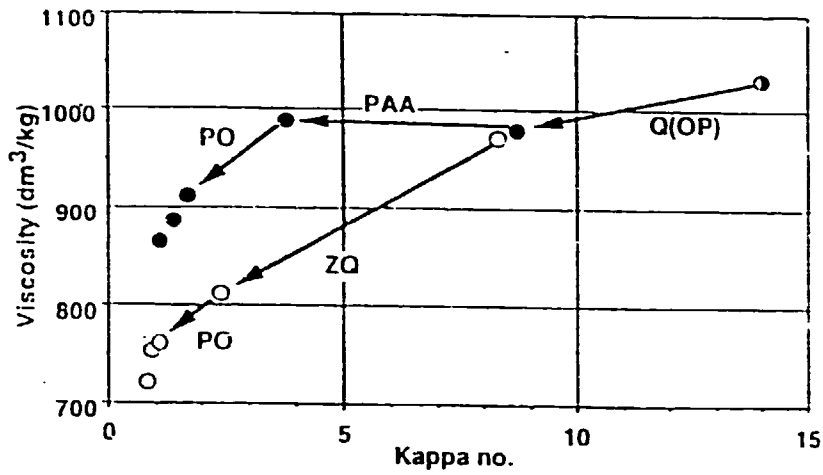
- Retention 2 - 5 hrs
- Temperature 70 - 120 °C (90 °C)
- Consistency MC (10 - 15%)
- Final pH Paa ~ 5
Caa ~ 4-5

CAA STAGE - MILL TRIALS

- Retention time 3 hrs
- Temperature 80 °C
- H₂SO₅ charge 40 kg/ADt
- Kappa reduction 63%

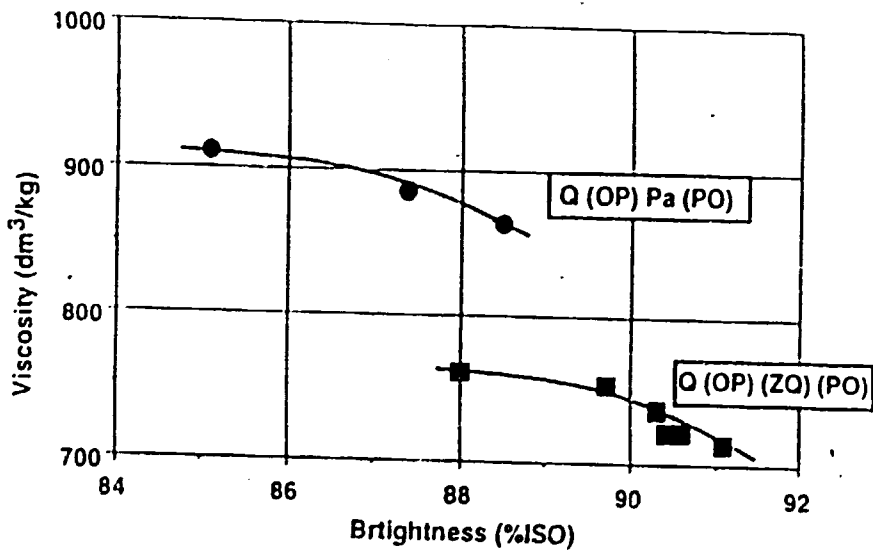
TCF bleaching of a mill oxygen delignified pulp

Kappa no 14.0
 Viscosity 1032 dm³/kg



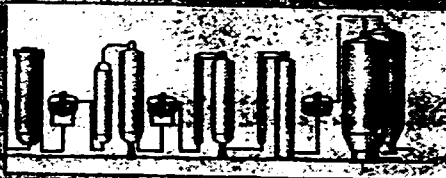
TCF bleaching of a mill oxygen delignified pulp

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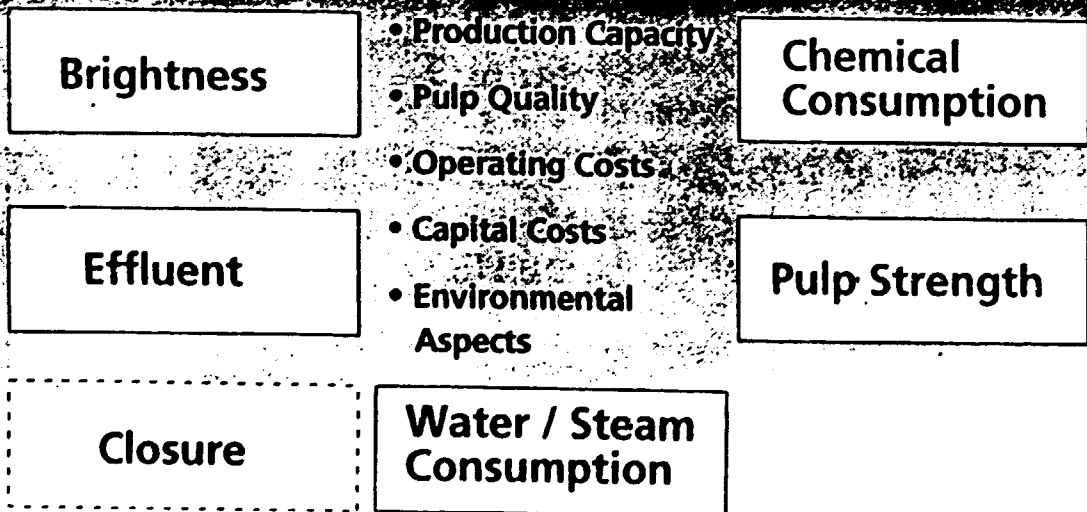


MODIFIED PEROXIDE BLEACHING (GREENOX)

- Activation with polyoxometallates
- Greenox (Kemira Chemicals):
activation with peroxomolybdate
 - Mo + H₂O₂
 - Mo + Si, P + H₂O₂
 - Mo + Si, P + H₂O₂ + CH₃COOOH + CH₃COOH
- Conditions in mP stage:
 - pH ~ 4.5
 - Charge to be optimized
 - Temperature (70 -> 100 °C)
 - Retention time
 - Consistency
 - Metal content
- TCF Sequence:
 - O-O-Q-EOP-mP-Q-PO

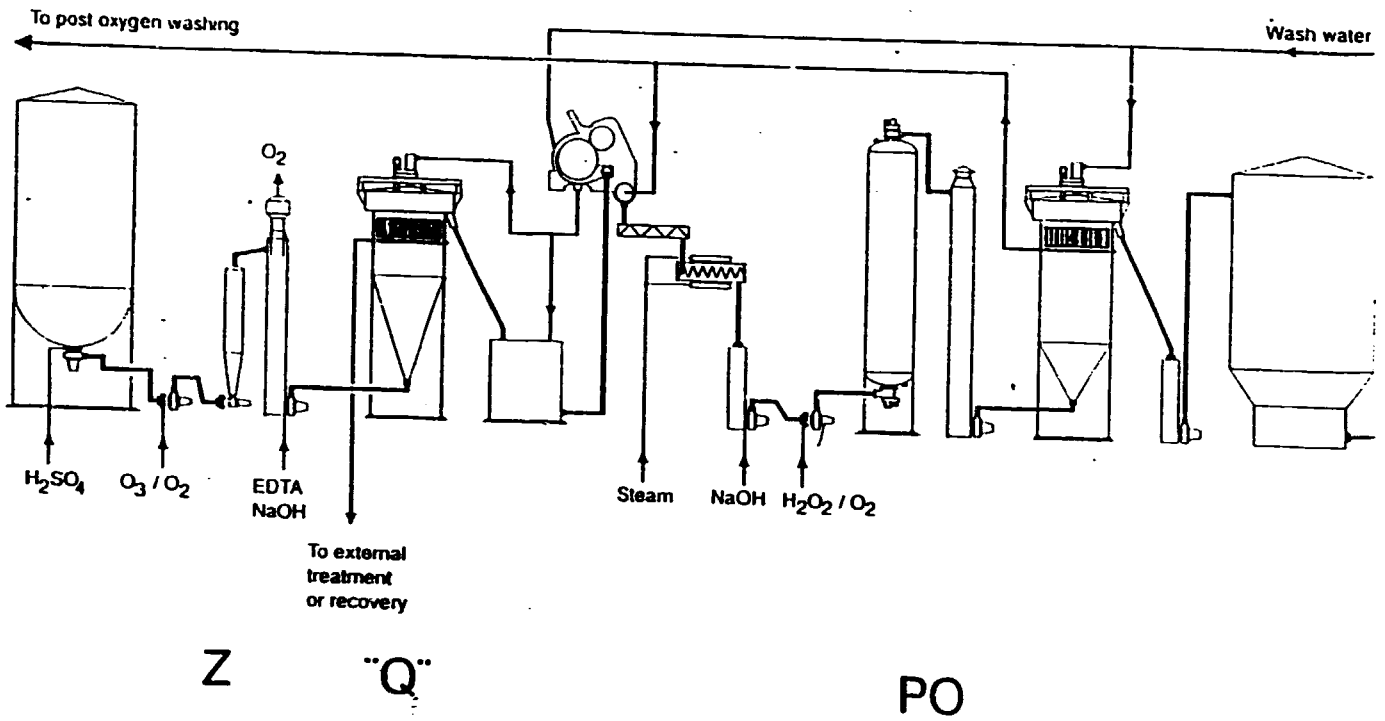


TCF Bleaching Line - Key Design Factors

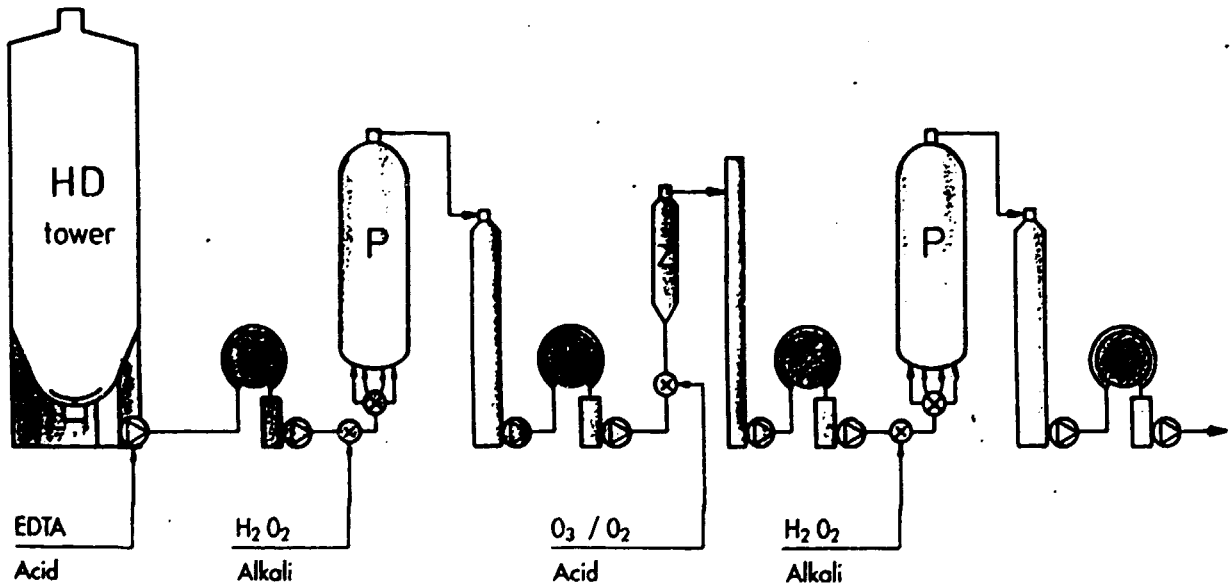


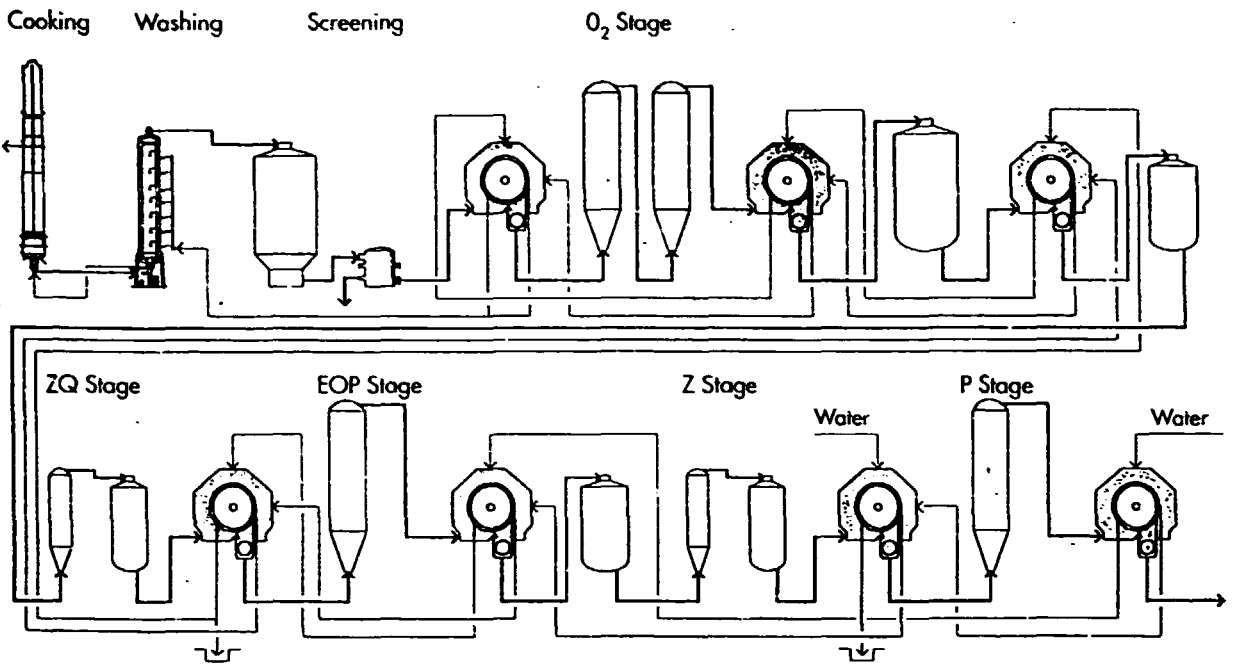


Principal flow sheet for a (ZQ)(PO) bleach plant.



TCF Bleaching

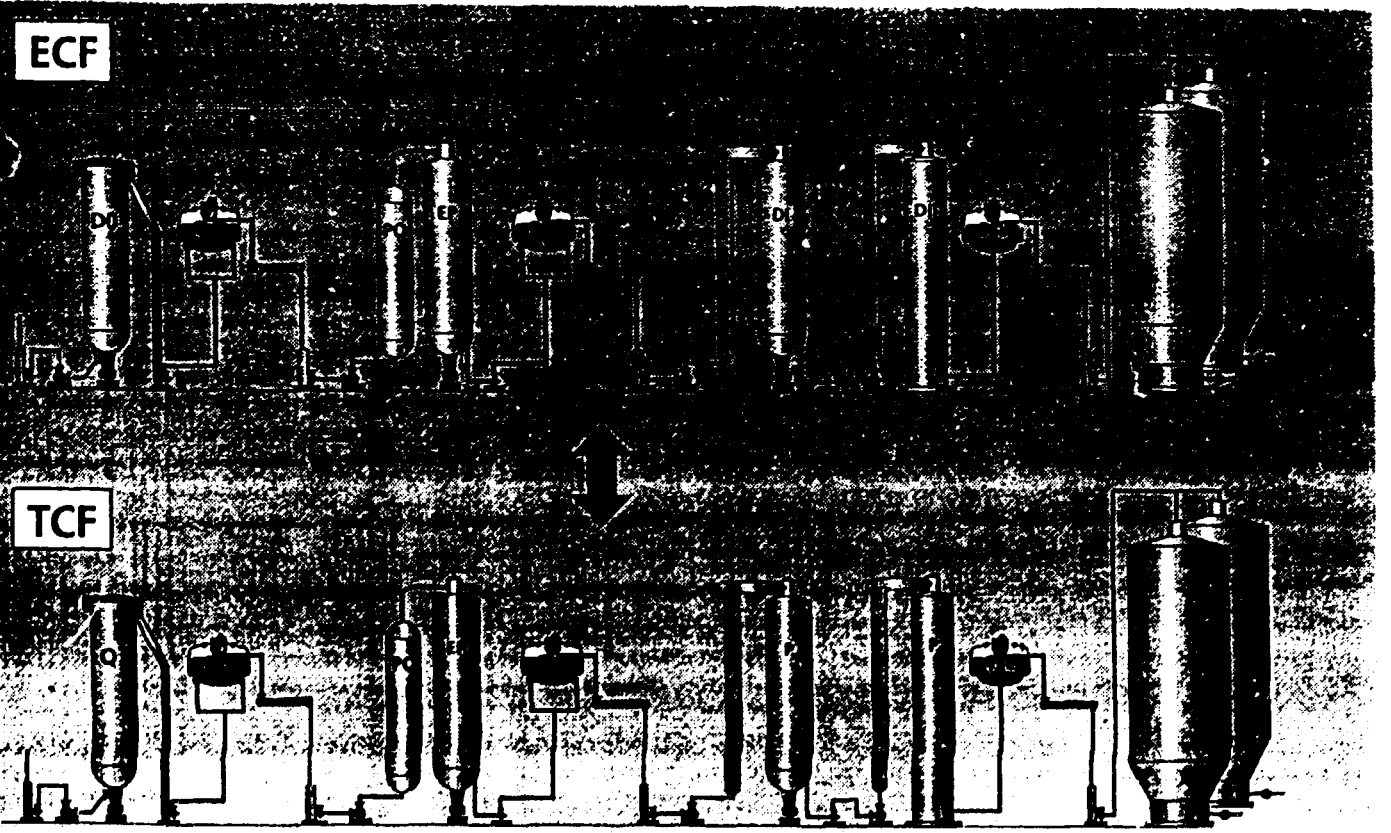




NO1/17/TCF9 94

ECF

TCF

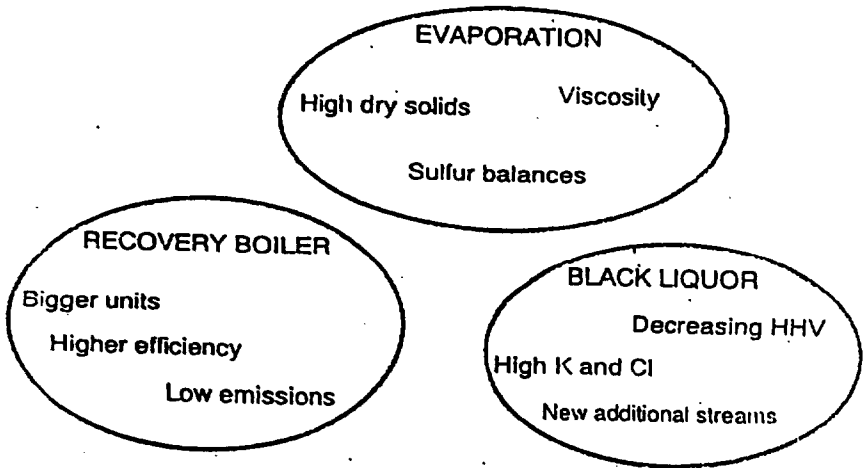


Flexibility

LS314



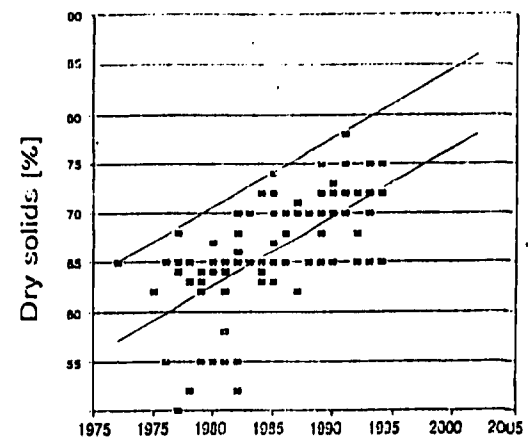
RECOVERY PROCESS TRENDS



A. Ahlström Oyj, 1999

ENR/ENR 10/11
March 1, 1999

BLACK LIQUOR DRY SOLIDS IS INCREASING



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March 1, 1999

BLACK LIQUOR PROPERTIES CHANGE

	1982	1992	2002
Dry solids, t/ADt	1.70	1.70	1.80
Sulfidity, %	42	45	48
HHV, MJ/kgas	15	13.9	13
Dry solids, %	64	72	80

140

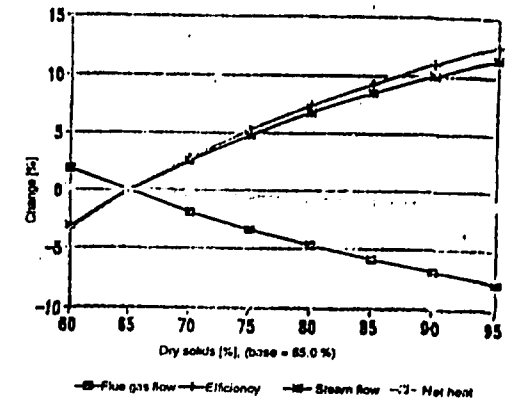
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RECOVERY BOILER TECHNOLOGY



EFFECT OF DRY SOLIDS INCREASE



—■— Flue gas flow —▲— Efficiency —■— Steam flow —□— Net heat

RECOVERY BOILER

- Capacity increasing to 3000 - 4000 t dry solids per day
- High dry solids firing
- Lower emissions
- Better control
- High efficiency for chemical and energy recovery
- New technology: Gasifiers
 - capacity booster
 - power generation by gas turbine

EVAPORATION

- Multistage evaporation to 65 - 82% dry solids
- Several alternatives:
 - evaporator type
 - number of stages
 - pre-evaporation
 - (super) concentrators
- Recent trends:
 - high dry solids (75-82%) by super concentrators
 - falling film, up to 7 effects

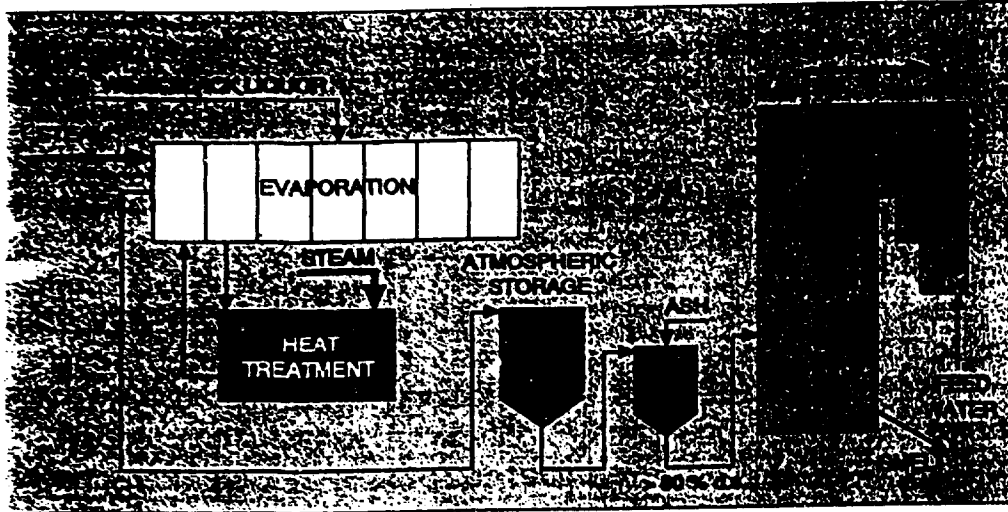
KRAFT RECOVERY

- Recovery of sulphur compounds as sodium sulphide
- Recovery of sodium as sodium hydroxide
- Recovery of energy as steam and electricity
- Minimizing emissions to water and air

UNIT OPERATIONS OF KRAFT RECOVERY

- Black liquor evaporation
- Black liquor combustion
- Reaustisizing of green liquor.
- Lime reburning

BLACK LIQUOR HEAT TREATMENT



ADVANTAGES:

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- LOWER BLACK LIQUOR VISCOSITY
- D.S CONCENTRATION OF 80 % ACHIEVED
- ATMOSPHERIC LIQUOR STORAGE AND ASH MIXING
- INCREASED HEAT ECONOMY OF THE RECOVERY BOILER
- DECREASED FOULING OF SUPERHEATERS
- INCREASED SULFUR REDUCTION GRADE
- MINIMIZED SO₂ EMISSIONS FROM THE BOILER
- MORE STABLE OPERATION OF BOILER
- MORE RELIABLE OPERATION OF ESP

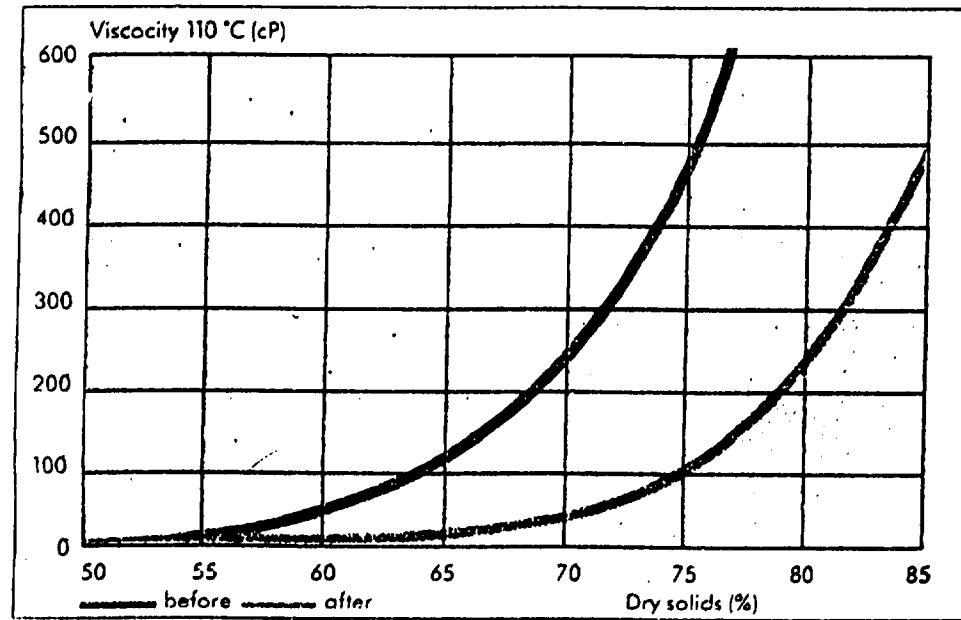
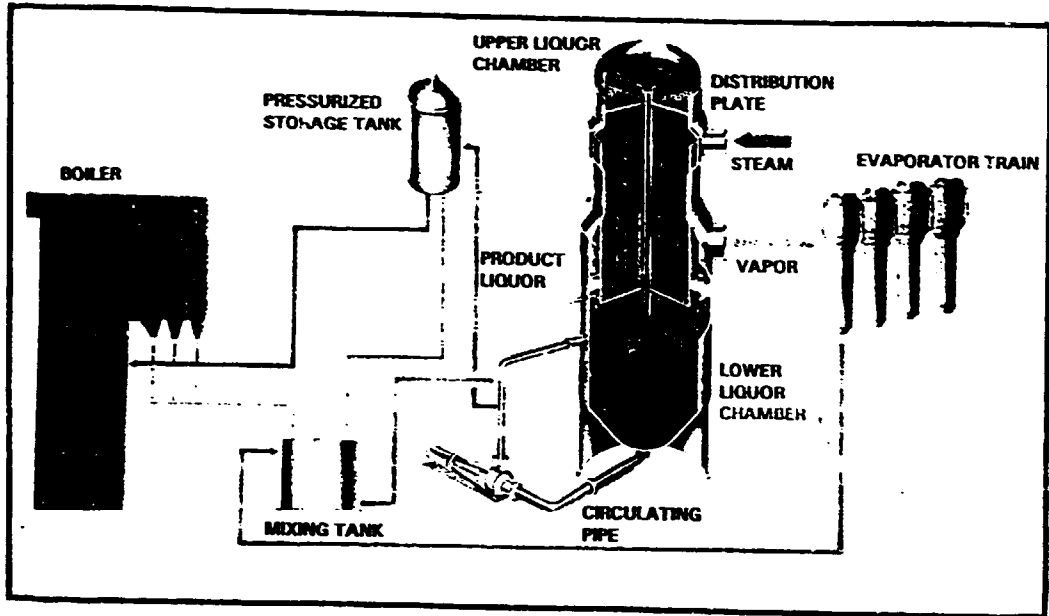


Figure 2. Viscosity of black liquor after Heat Treatment.

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SUPER CONCENTRATOR FLOW SHEET

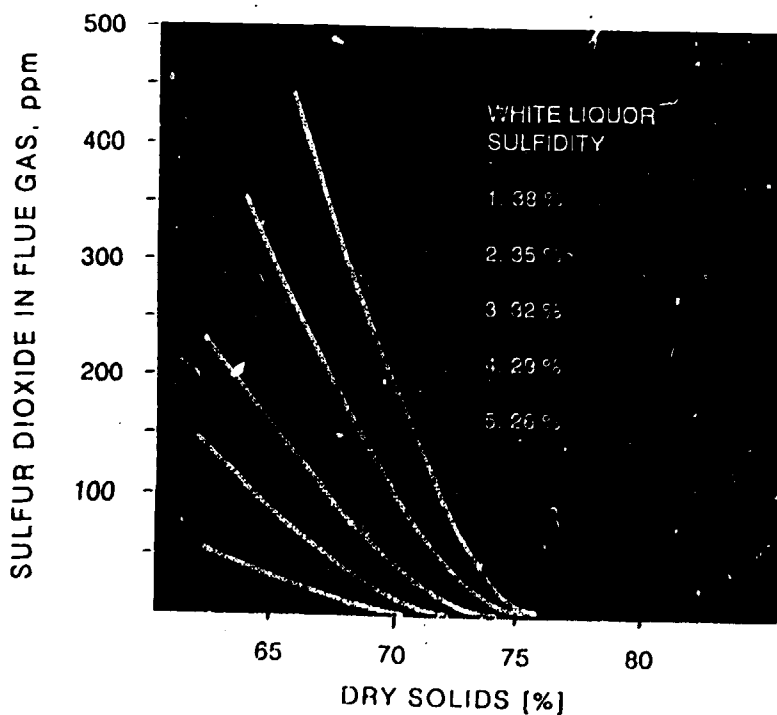


Tampella POWER

RECOVERY BOILER TECHNOLOGY



SO₂ EMISSIONS WITH DRY SOLIDS INCREASE



CHEMICAL BALANCE

RECAUSTISIZING

- Green liquor filtering
- White liquor filtering
- Pressure filters (Ecofilter)
- CD filter

- Sulphur - sodium
- Caustic soda for the bleach plant
- SO_2 and H_2SO_4 for the bleach plant

THE KRAFT RECOVERY CYCLE

Challenges

- Increased capacity
- Increased economy
- Increased environmental protection
- Process sensors and control
- Process simplification

LIME KILN

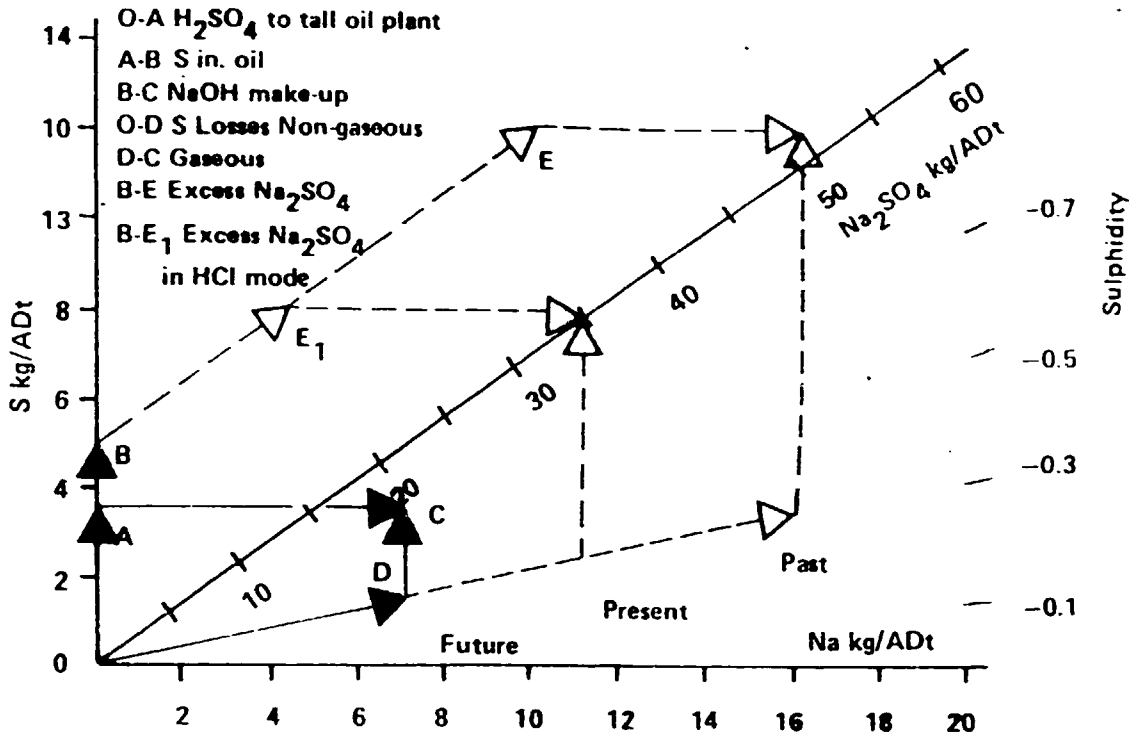
- Capacity growing
- Lime mud drying (LMD)
- Incineration of odour compounds
- Emission control (scrubbers, precipitator)

SODIUM AND SULPHUR BALANCE

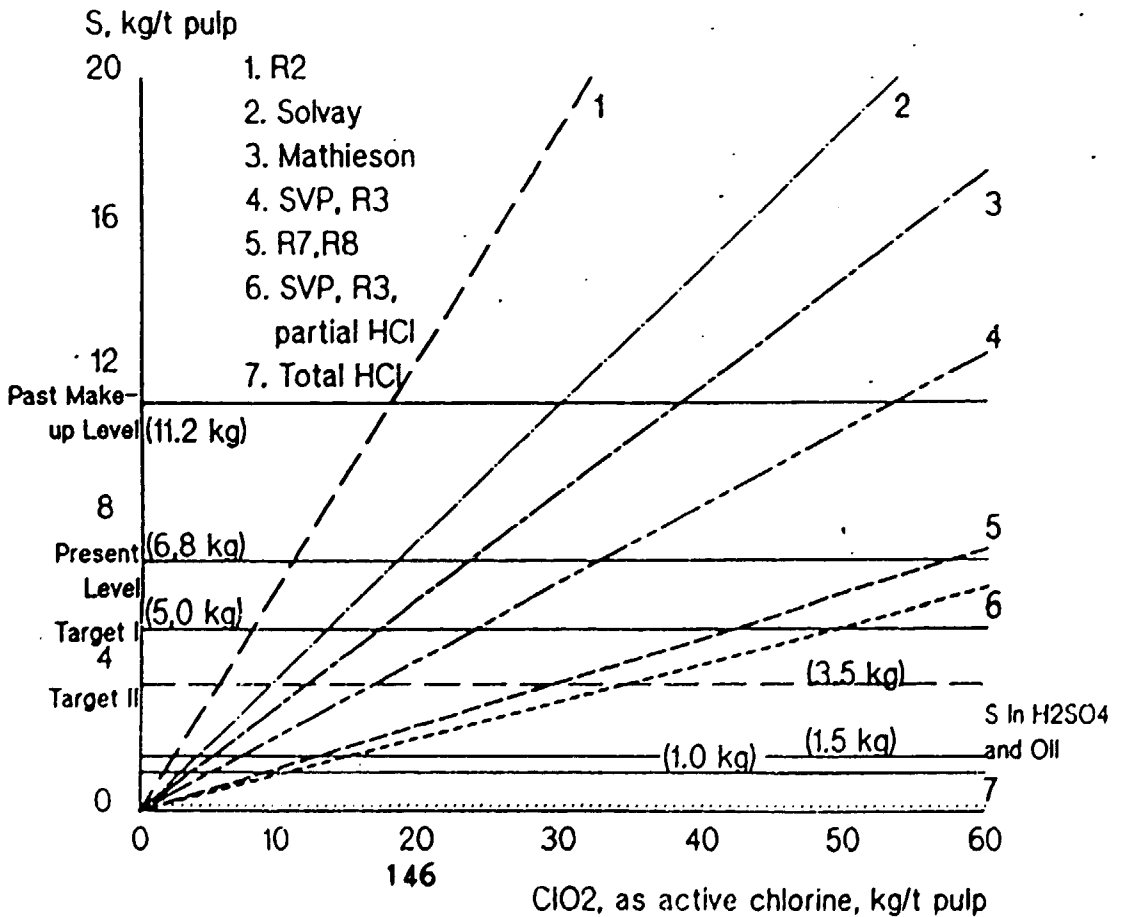
- Green liquor filtering (X-filter)
- Separation of Na_2CO_3 and Na_2S in green liquor
 - green liquor carbonation
 - cooling crystallization of carbonate

INDICATIVE LOSS/MAKE-UP BALANCE
SIMPLIFIED VECTOR DIAGRAM
(40 kg ClO₂/ADt)

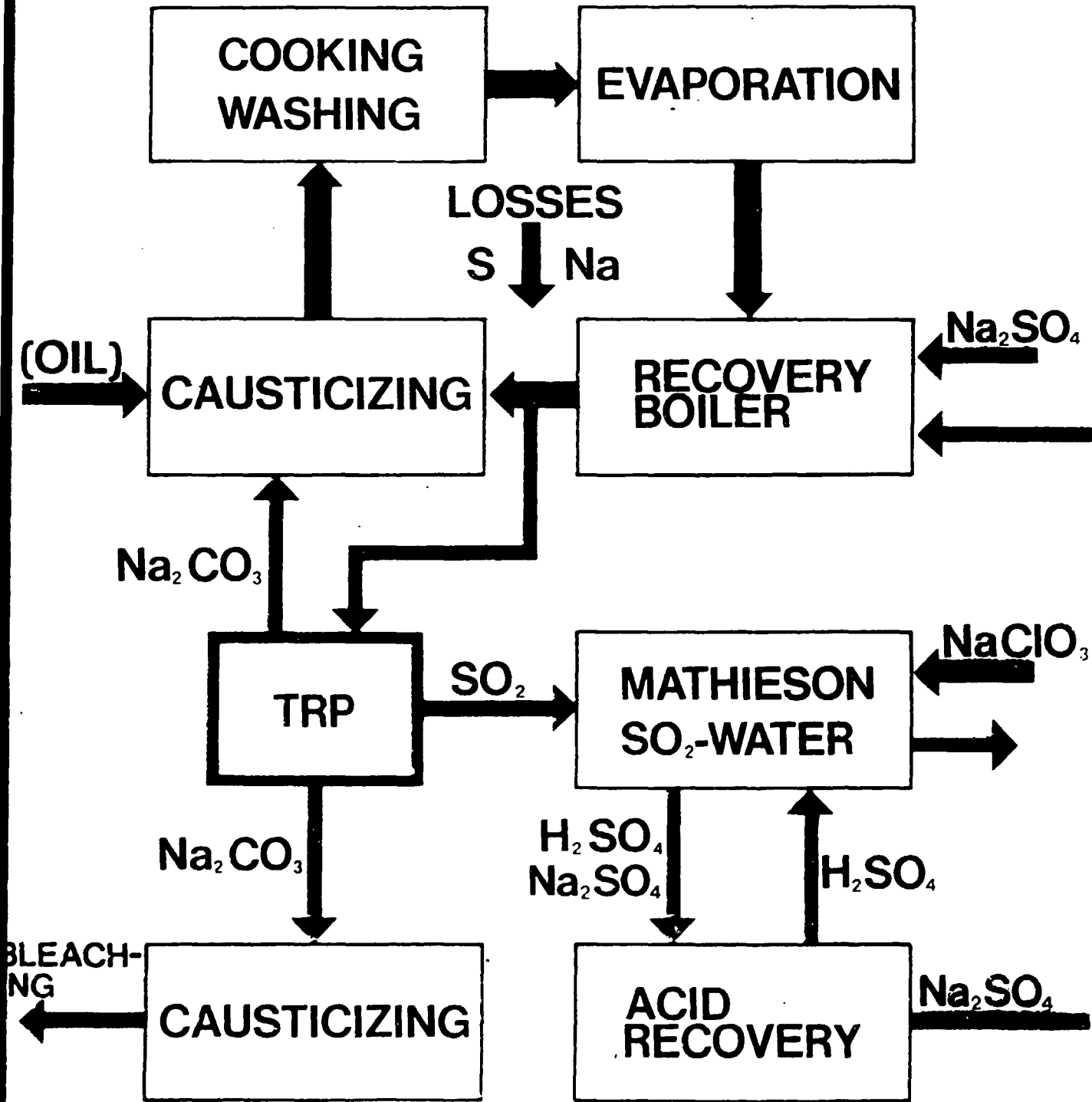
SVP or R3 Process, N & Partial HCl Mode



BY-PRODUCT SULPHUR FROM CHLORINE DIOXIDE PRODUCTION

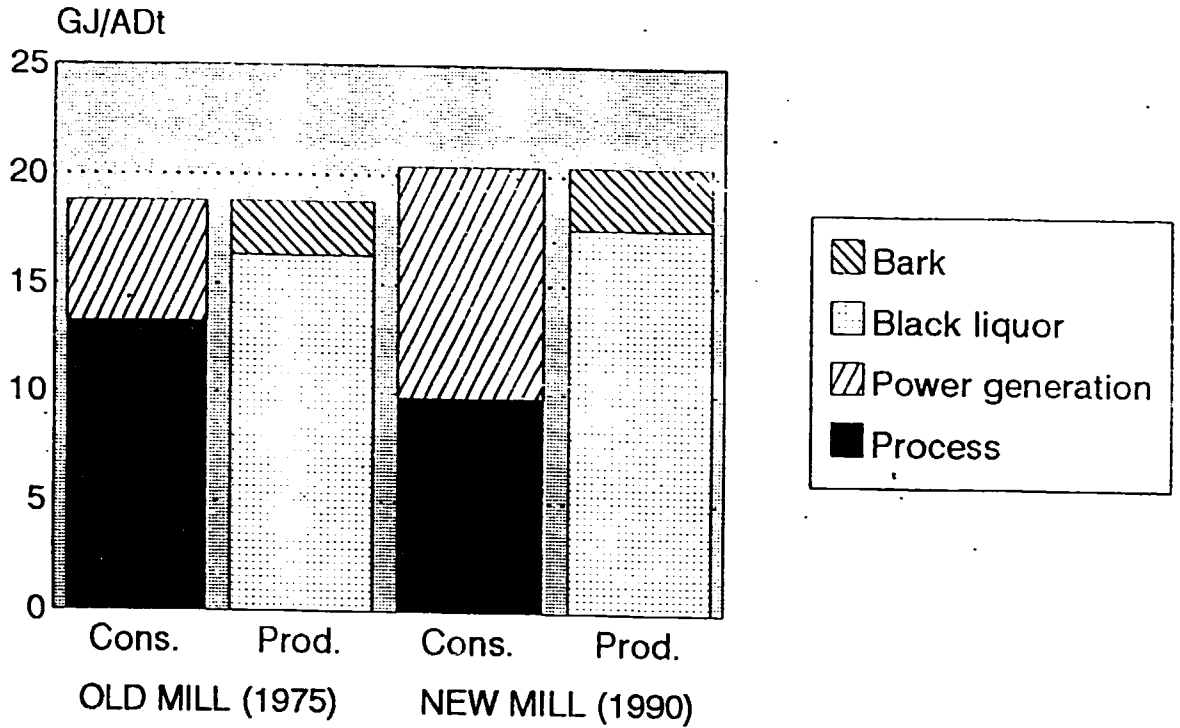


TRP IN KRAFT PROCESS



HEAT BALANCES FOR OLD AND NEW KRAFT MILLS

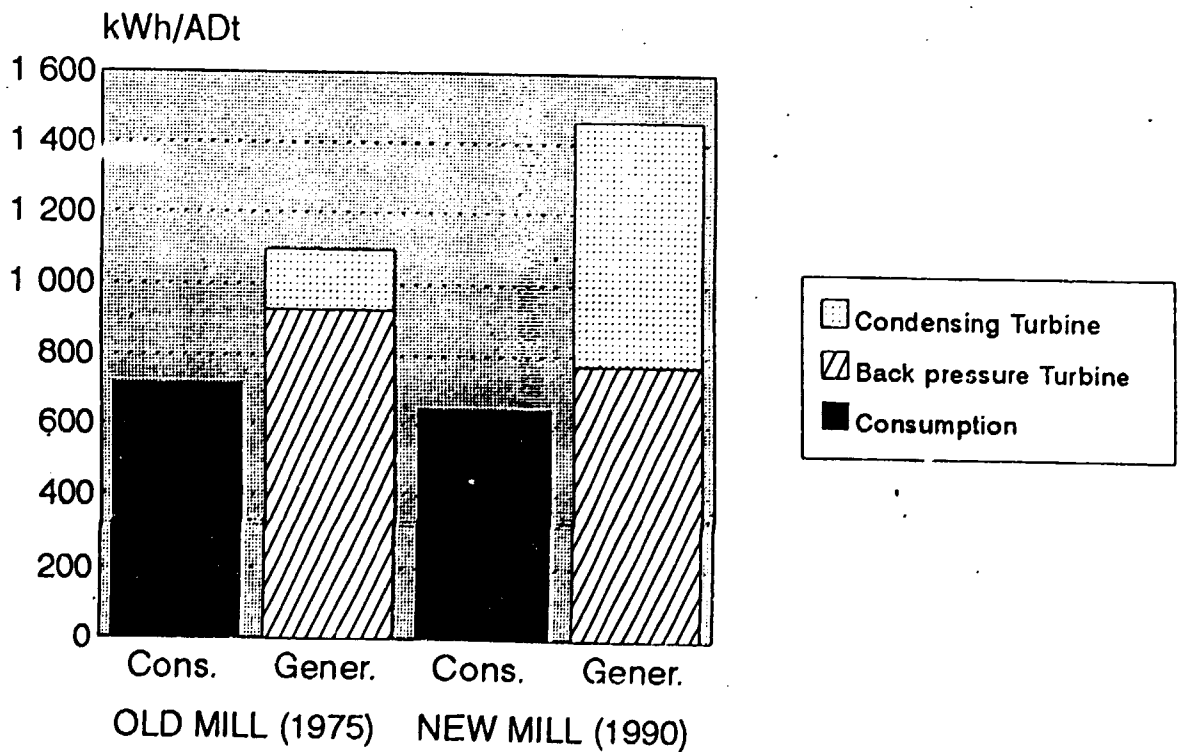
BLEACHED SOFTWOOD



JAAKKO PÖYRY

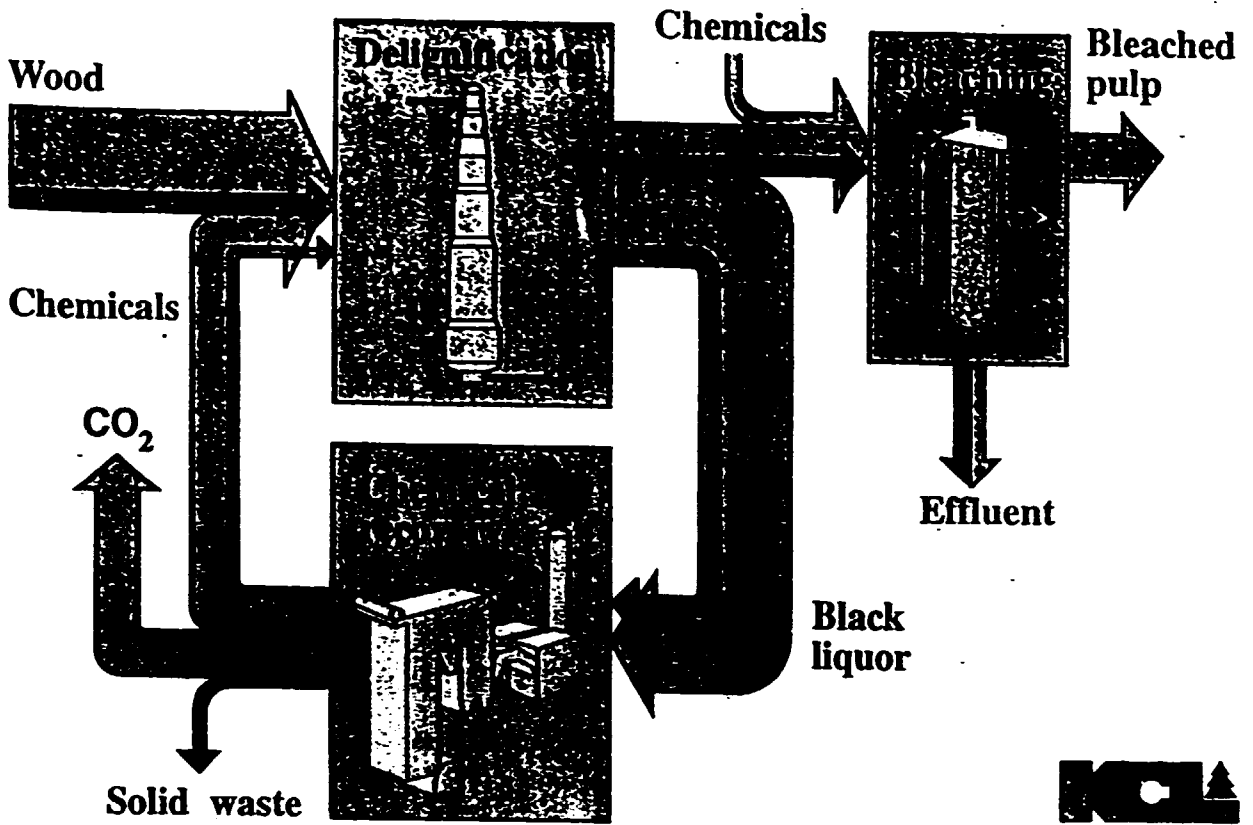
POWER BALANCES FOR OLD AND MODERN KRAFT MILLS

BLEACHED SOFTWOOD

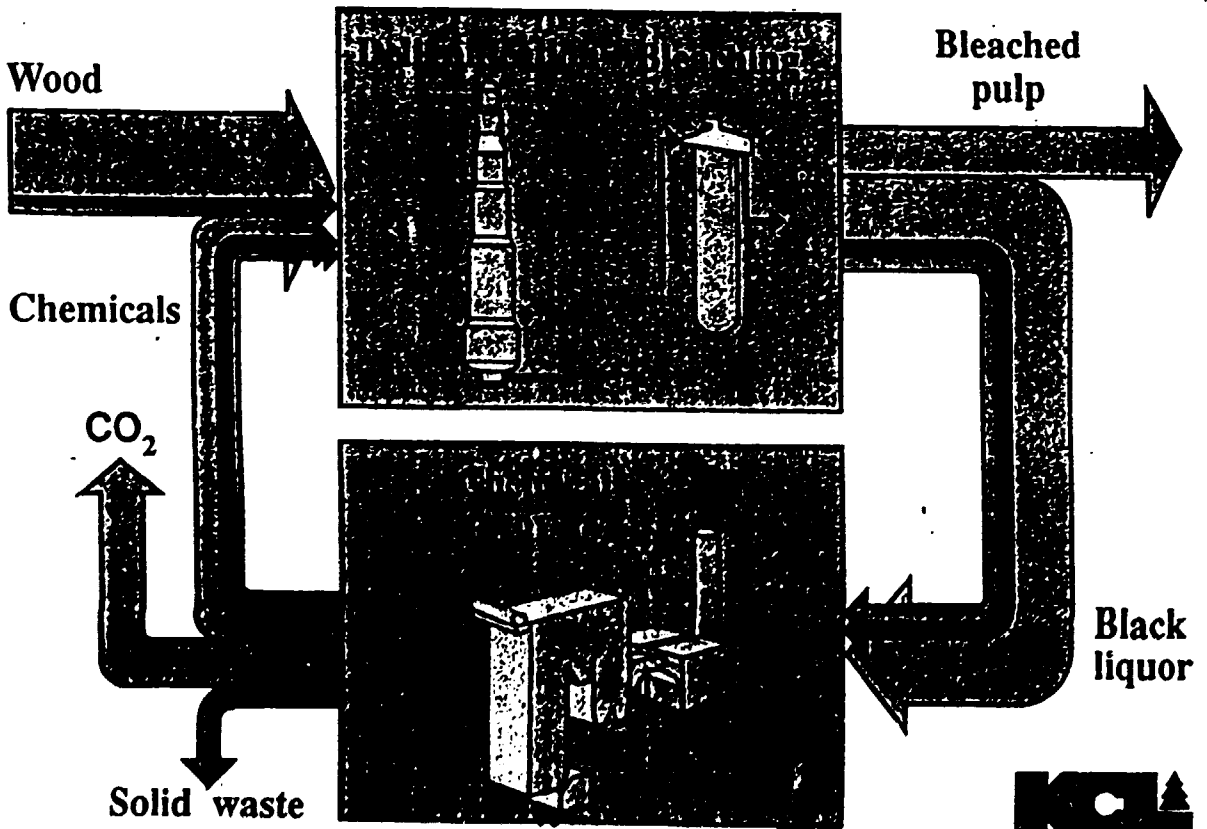


JAAKKO PÖYRY

TODAY



TOMORROW ?



EFFLUENTS OF A BLEACHED KRAFT PULP MILL

	Effluent m ³ /ADt	COD kg/ADt
1980 Average	185	120
1993 Best	35	17

INORGANIC SOLID WASTES OF A PULP MILL, kg/ADt

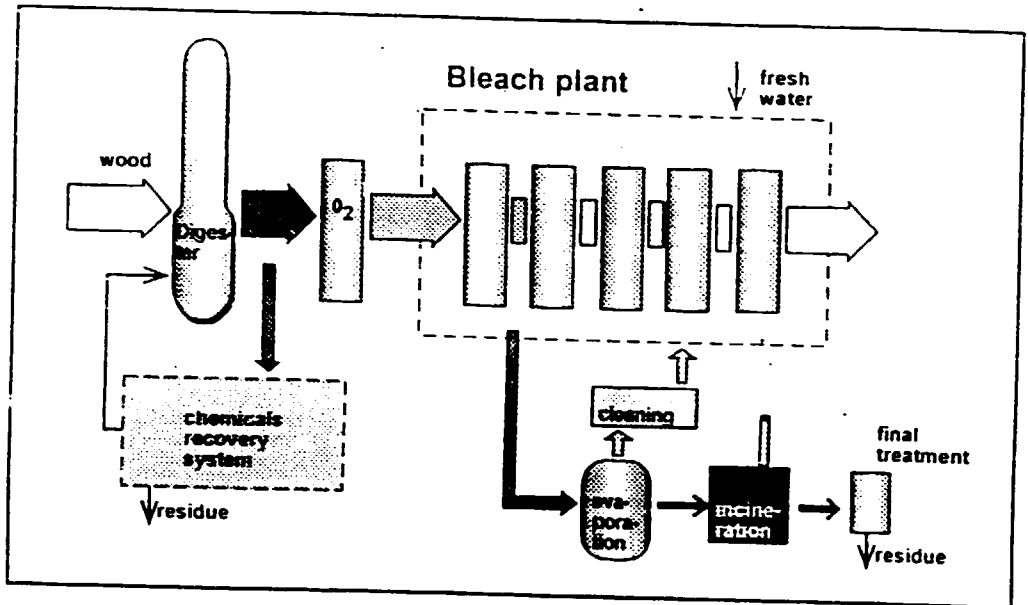
	Present	Closed cycle
Lime mud	15	30
Dregs from liq. preparation	10	15
Bark ash	6	6
Precipitator ash	-	80 (15*)
Total	31	131 (51*)

*) With recovery of bleaching chemicals

NON-PROCESS ELEMENTS IN UNBLEACHED PULP, WHITE LIQUOR AND BLACK LIQUOR, g/ADt

Average figures

	White liquor	Black liquor	Unbleached pulp
Si	490	400	90
Al	35	30	12
P	40	125	40
Mg	2	200	215
Mn	15	110	70
Fe	15	25	15
Ca	50	200	1300
K	28000	27000	300
Cl	4000	6000	35



JAKKO P84R1 2 EKA NOBEL

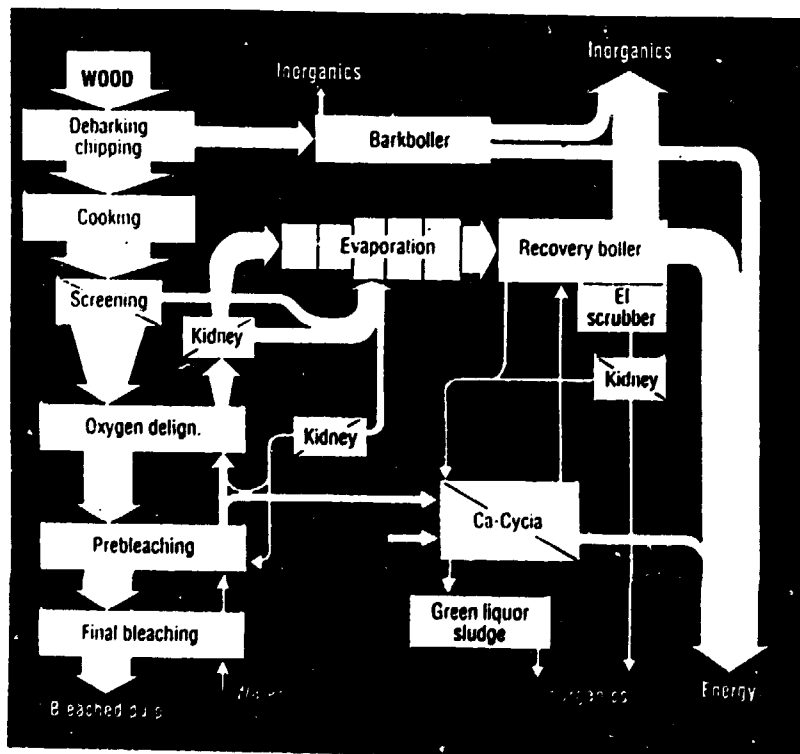
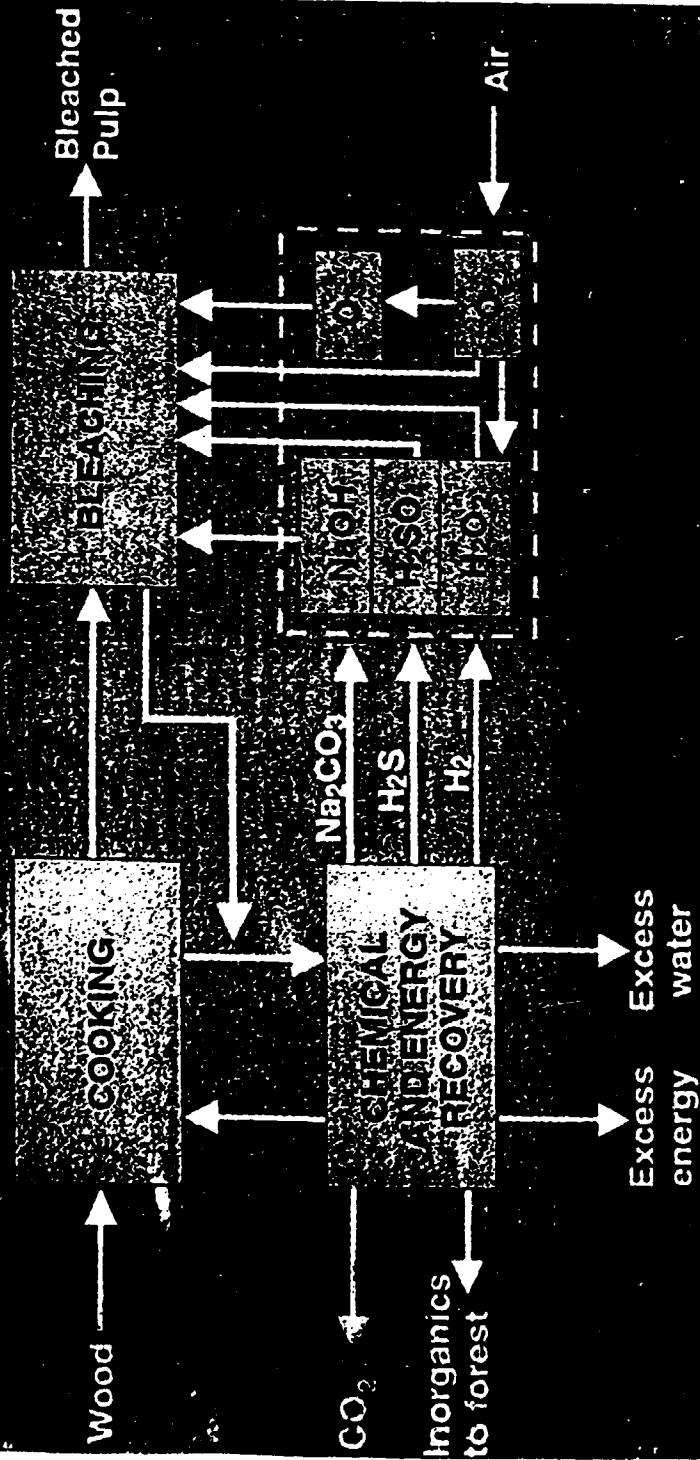


Figure 4. Closed cycle with internal kidneys.

The Vision



KWERNER

One possible configuration for a "closed" pulp mill.

- **TEF eliminates totally effluent problems but not air emissions - TEF increases substantially solid wastes**
- **TEF is extremely expensive for existing pulp mills, without major benefits; for greenfield mills TEF is not necessarily too expensive**
- **The first actual TEF mill after the year 2000, to a larger extent after 2010 if ever.**

**PROCESSES REQUIRED TO BE DEVELOPED
IN A CLOSED CYCLE CONCEPT**

- * **Water purification**
- * **Condensate purification**
- * **Separation of non-process elements**
- * **Separation of potassium and chloride**
- * **Burning/Incineration of organics**
- * **Recovery of chemicals**

CLOSED CYCLE CONCEPT

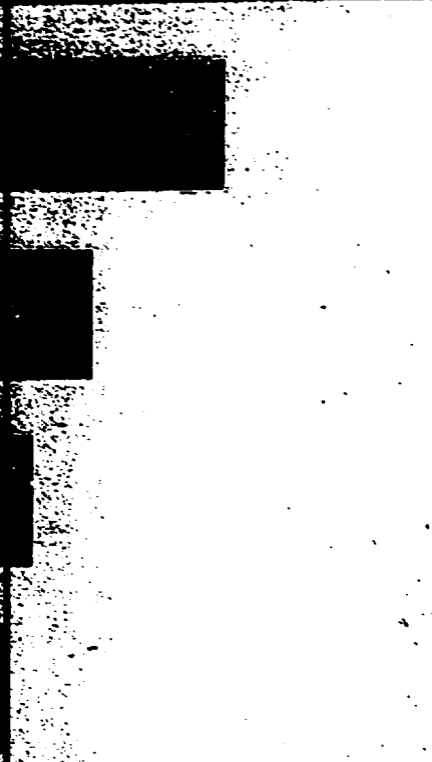
- **Closed cycle concept is gradually being developed and increasingly applied**
- **Closed cycle concept does not directly result in zero effluents but is an essential part of TEF**
- **Environmental impact depends on mill system and environment**

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TEF

- **TEF requires application of numerous new, unproven technologies in the pulp mill**
- **Theoretically, technologies needed are available for TEF**
- **TEF could be applied both for TCF and ECF, slightly easier for TCF**
- **Control and balancing of a TEF mill is very demanding**

(1)



Wilhelm Hantsch-Linhart
(Agiplan, Wien, Austria)

Introduction

The contribution to the this UNIDO workshop for Pulp and Paper Industry consists of three chapters. Chapter 1 gives an overview on the emission legislation in Europe and future trends of regulations. Chapter 2 covers recent developments on Environmental Management Systems and Environmental Auditing. It is based on the British Standard BSI 7750, on the International Standard (currently available as a committee draft) ISO 14.000 and on the Council Regulation #1836/93 of the Council of the European Union. Chapter 3 summarizes the developments in pollution abatement technologies in the fields of waste water treatment, air pollution control and waste management.

- Pollution abatement technologies

This chapter gives an overview on the current situation of pollution abatement technologies and describes some recent developments in air pollution control, wastewater treatment and waste management. The basic materials to elaborate this chapter were found in studies by EKONO/duoplan (Environmental performance, regulations and technologies in the pulp and paper industry, Dec. 1994) and by Jaakko Pöyry (Techno-Economic study on the reduction measures, based on best available techniques of emissions from paper and board manufacturing industry for the Commission of the European Community, Jan. 1994).

Air Pollution Control

The general air pollution problems, or rather the atmospheric emission problems, at paper mills are not directly related to the paper production itself. These problems are related to the power plants installed in connection to the paper mills. Measures are basically the following

Oil-fired boilers	Reducing the SO ₂ emissions by using low-sulphur oil Measures to reduce NO _x formation
Gas-fired boilers	Measures to reduce NO _x formation
Coal-fired boilers	Reducing the SO ₂ emissions by using low-sulphur coal Reducing the SO ₂ emissions by adding limestone to the fuel Measures to reduce NO _x formation

Low-sulphur oil and coal: Reducing the sulphur content of the fuel from 2-3 % to 0.5 % would reduce the SO₂ content of the flue gas from 2000-3000 down to appr. 500 mg/m³ in the case of oil. With coal these figures are more difficult to give, as the ash will absorb some of the SO₂. The same absorption into the ash will occur when burning solid fuel together with oil or coal.

Adding limestone to the fuel: Finely ground limestone is mixed with the fuel or blown into the furnace. The SO₂ removal efficiency is in the range of 50-70 % in furnaces with grates and up to 90% in CFB furnaces (circulating fluidised bed). This method is of particular interest for coal firing. For solid waste firing the method would be basically applicable, but the solid wastes have normally a low sulphur content.

Measures to reduce NO_x formation: NO_x reduction technologies were originally developed for power boilers, particularly for big coal-fired boilers.

Modified combustion: By staging of the combustion air, either in the burners (low NO_x burners) or in the whole furnace, the NO_x emission can be reduced by about 15-25%. By the so-called reburning method the NO_x emission in coal firing can be reduced by up to 70 %, giving an emission of about 100-150 mg/MJ, as NO₂ (additional fuel is supplied above the main combustion zone, without additional air, and additional air for final combustion is supplied at the top of the furnace). Flue gas recirculation (FGR) is successfully applied in coal-powder-, oil- and gas-fired boilers. The NO_x formation is reduced through recycling of cooled flue gas to the furnace, estimated emission levels (as NO₂) are 200-250 mg/MJ for coal, 150-200 mg/MJ for oil and 50-100 mg/MJ for gas firing.

By combining low-NO_x burners and FGR, the NO_x emissions can be reduced to 75-150 mg/MJ for fuel oil and to 30-70 mg/MJ for natural gas

External Measures

External measures are used for treating the flue gases from the boilers, aiming at reducing the emissions of particulates, SO_2 , NO_x .

Particulates: At solid fuel and coal fired boiler the use of particulates removal equipment is normally required.

Cyclones or mutli-cyclones can remove up to 95 % particulates as small as 5 μm .

Fabric filters can remove smaller particles, down to 0.1 μm , with a high efficiency. The use of such filters is restricted to dry, non-agglomerating particles and to flue gas temperatures of maximum 300 °C. Applications are restricted mainly to special incinerators and relatively small gas volumes.

Electrostatic precipitators (ESP) is the most efficient type of equipment; up to 99,9% and above of the particles down to 0.1 μm can be removed.

The particulate emissions from oil fired boilers are normally relatively low, and particulate removal is normally not required. With solid-fuel boilers mutli-cyclones (bark boilers) or ESPs (coal and bark boiler) are generally used.

SO_2 : for the removal of SO_2 from flue gases, various types of scrubbers can be used. The two main types are the wet and the wet-dry scrubber.

In the wet scrubber the flue gas is contacted with a slurry of slaked lime ($\text{Ca}(\text{OH})_2$) or finely ground limestone (CaCO_3), or a solution of sodium sulphite (Na_2SO_3)(sodium carbonate or hydroxide can also be used). The SO_2 is precipitated as calcium sulphite and sulphate. The removal efficiency is 80-90 % for SO_2 , or up to 95 % if soluble alkali is used.

In the wet-dry scrubber a slurry of slaked lime is sprayed as a fine mist into the flue gas. The slurry dries, and a dry product of calcium sulphite and calcium sulphate is formed. This product can be removed in the subsequent particulate removal equipment. The removal efficiency is normally 70-80 % for SO_2 .

These methods for SO_2 removal are usually not used for the power boilers at paper mills, due to relatively small emissions and low cost-efficiency with small boilers. The normal way to minimise SO_2 emissions here would be to use low-sulphur fuels.

NO_x : A number of external flue gas treatment methods for NO_x have been developed, basically comprising wet and dry methods. The wet methods, based on chemical oxidation of NO to NO_2 , followed by absorption an alkaline solution, have not yet been commercialised. The dry methods, which are commercialised, are basically of two types, the SCR method and the SNCR method.

The SCR method (selective catalytic reduction) works basically as follows. Nitrogen oxides are reduced by ammonia into nitrogen over a heterogenous catalyst. The reaction takes

place at 300-400 °C, and the NO_x emissions can be reduced by 90 %. The emissions of ammonia (ammonia slip) are normally low, less than 5 ppm.

The methods have been developed and mainly used in big boilers. Due to relatively small emissions and low cost-efficiency they are generally not used at paper mills.

The SNCR method (selective non-catalytic reduction) works basically as follows. Nitrogen oxides are reduced by urea or ammonia in homogenous reactions in a temperature range of 800-950 °C. The efficiency is lower than for the SCR method, 50-60 % NO_x removal, or maximum 70-80% at stable conditions. The investment and operations costs are, however, lower for the SNCR method.

Measures to reduce VOC Emissions are to reduce or eliminate the use of organic compounds as far as possible. One example is to replace organic solvent-based coatings with water-based types. An other possibility is to collect the VOC-containing air from various positions by a fan system, followed by incineration or treatment in a separate equipment (Biofilter) or in a power boiler

Water pollution control

The main principle of waste water treatment is to reduce the effluent flow by internal measures and by system closure. The advantages of a closed system in papermaking are

- lower fresh water consumption results in lower volumes to external effluent treatment, therefore, effluent treatment can be built with smaller hydraulic capacities and lower investment costs. Contaminants are more concentrated in the effluent, which contributes often to higher removal effectiveness
- lower costs of raw water and savings in raw material costs due to lower losses of fibre and fillers. Additionally, the energy consumption is lower due to less cold fresh water added to the process
- higher temperatures in process white water system, which results in faster dewatering on the paper machine wire due to lower viscosity of the water and faster dewatering results in lower steam consumption in the dryer section. The faster dewatering can also be utilised to increase the production speed.

The drawbacks of system closure are mainly the build-up of suspended solids as well as dissolved organic and inorganic substances in the white water system, which can result in

- increased biological growth in the system, resulting in slime problems causing web breaks and production losses,
- product quality problems: lower brightness and decrease in some strength properties
- increased consumption of many process chemicals, like sizing agents, retention aids and biocides
- corrosion problems
- clogging of pipes, shower nozzles, wires and felts with fibres and fine suspended solids.

There are several techniques available for clarification of white water. However, during the last few years a lot of research has been carried out on the possibility of closing completely the process water flows in the paper mill. This would result in a mill with no effluent and only solid waste. The prerequisite for succeeding with the totally closed cycle mill concept is that the dissolved organic and inorganic materials, not retained in the paper, can be removed from the process water before unreasonably high levels are built up.

Another problem is that pure or almost pure water will be needed in some positions of the process also in the future. If this water is taken from external sources, the same amount of water must be discharged from another part of the mill to keep the mill in balance.

The solution to the problems is a nearly complete separation of all colloidal and dissolved material from the water. The remaining water is used as fresh water and the residuals contain all the contaminants, which have to be removed from the process. There are mainly two possible technologies for the water purification, which are evaporation and membrane filtration.

These technologies have been developed as unit operations, and tested in full-scale usually with mechanical pulping. They cannot be generally applied in full-scale practice in paper mills with current technology due to operating problems and high costs.

However, the technology for fresh water generation can also be used to reduce the fresh water needed in an existing mill without having the target of closing the mill completely. There are today very few installations, most of which are pilot installations. These technologies, including the closed cycle paper mill, will probably reach technical application during the second half of this decade.

External Measures for wastewater treatment are

- pre-treatment-equalisation, coarse screening, temperature control, pH control etc.
- primary treatment (clarification) for the removal of suspended solids
- biological (secondary) treatment for the removal of organic substance with aerobic methods and/or anaerobic methods
- physical-chemical treatment for additional removal of suspended solids, COD phosphorus, colour etc.
- handling and disposal of sludges from the different treatment stages.

Primary treatment

Primary treatment for the removal of suspended solids is the basic effluent treatment to be applied at paper mills. The purpose of the primary treatment is one of the following:

- as the only treatment; to reduce primarily TSS emissions
- as pre-treatment ahead of biological treatment; to protect the biotreatment from high TSS loads, which may disturb its function.

Primary treatment by sedimentation (clarification) is a well-established, extensively used method. Optional methods are flotation and filtration. One of their main advantages is a smaller area demand. Primary treatment will remove approx. 50-90 % of the suspended solids, depending on their properties. The removal of settleable solids is normally higher, appr. 90-95 %. At present, most paper mills in developed countries are equipped with primary treatment alone, primary + chemical treatment, or primary + biological treatment. Primary treatment must be regarded as a minimum requirement for all paper mills.

Biological Treatment - Aerobic Methods

Aerobic biological treatment is the basic method to be used for the removal of oxygen-consuming organic matter, and for the removal of specific organic compounds, including toxic compounds.

The two main types of aerobic treatment are the activated sludge process and the aerated lagoon, both with some advantages and disadvantages. Today, in the pulp and paper industry, there seems to be a trend towards the activated sludge process, due to its potential for higher treatment efficiencies and low susceptibility to cold climate (in northern areas). Current development work aims at reducing some of the disadvantages. For paper mill effluents, the activated sludge is the most common biological treatment method. The aerobic treatment gives high removals of biodegradable organic matter measured as BOD value. Even a removal of over 95 % is possible. Also toxicity can be substantially reduced, giving virtually non-toxic effluents. Total organic matter is removed to a lower degree, up to 80 % for paper mill effluents. If higher COD removal rates are required in the effluent treatment, the biological treatment has to be combined with some type of physical-chemical treatment method.

The aerobic biological treatment is characterised by high installation and operating costs. The possibilities of reducing these costs are mainly the following:

- Further development of the treatment processes, aiming at cost optimisation.
- Reduced emissions from the pulping and papermaking processes.
- Use of anaerobic treatment for removing a substantial part of the organic matter (to reduce operating costs).

A substantial part of the costs of the biological treatment is caused by the organic matter in the effluent. The papermaking process itself gives a rather low emission of organic matter, which means that the high costs here to a large extent originate from the organic matter emitted by the integrated pulp production (if any). In case of a non-integrated paper mill, the costs of the biological treatment are to larger extent caused by the effluent flow. Aerobic biological treatment has been applied for pulp and paper mill effluents for over 30 years. The method is well established, and good experiences exist for different applications. Most types of pulp and paper mill effluent can be treated.

Biological Treatment - Anaerobic Methods

The main reason for using anaerobic instead of aerobic biological treatment is the possibility of lower operation costs. This is primarily caused by the lower electrical power demand but also the lower nutrient demand and lower sludge production. The utilisation of the methane-containing biogas - a by-product of this process - as a fuel can further improve the operation economy.

The two dominating methods are the contact method and the UASB (Upflow Anaerobic Sludge Bed) method, which both can be regarded as well-established methods for certain types of effluent. The UASB method is particularly applied for paper mill effluents at non-integrated and recycled fibre based mills.

Anaerobic treatment is generally a pretreatment stage ahead of aerobic treatment, although the main treatment efficiency in most cases is achieved in the anaerobic stage. The aerobic stage will give a complementary treatment efficiency and remove odorous compounds. Anaerobic treatment has been applied for pulp and paper mill effluents only for about 10 years. With today's technology and development stage only certain types of effluent can be treated. One important pre-requisite for the successful application is a relatively high concentration of organic material.

Physical-chemical Treatment - Chemical Flocculation

The physical-chemical treatment methods aim primarily at removing substances which cannot be removed by biological treatment. Chemical flocculation is the most developed and well-established of these methods. The main types of chemicals used are:

- Metallic salts, like aluminium sulphate (alum)
- Bentonite (a mineral material), combined with an organic polyelectrolyte

Chemical flocculation can be used in different ways:

- "Direct flocculation", in combination with primary treatment, as the only treatment (no biological treatment)
- "Post-flocculation" or "tertiary treatment", after the biological treatment.

"Direct flocculation" will, in certain cases, give COD removals similar to what can be achieved by biological treatment (appr. 50%), and in addition some toxicity removal. It shall be remembered that this COD removal refers primarily to non-biodegradable organic matter, while the bio-treatment removes mainly bio-degradable matter. This kind of treatment may be acceptable and applicable mainly in cases with relatively low total emissions.

"Pre-flocculation" will generally have the purpose of decreasing the load of an overloaded biotreatment, or to remove toxic matter which may disturb the biological process.

Tertiary treatment will have the purpose of improving the result of the biological treatment, in order to achieve an efficient COD removal, including both bio-degradable and non-biodegradable organic matter, and also to achieve very low TSS emissions. The potential for removal of phosphorus may also be of interest.

The main drawbacks of chemical flocculation are the difficulties in sludge handling and disposal, and the high operating costs, particularly when treating effluents from paper mills integrated with pulp production. The reason is that the pulp mill effluent in many cases will consume a rather large amount of chemicals for the flocculation, resulting in high chemical costs, large sludge amounts and high sludge disposal costs.

Sludge handling and waste management

Sludge handling methods are available for all types of sludge produced by the present effluent treatment methods. These include "fibre" ("primary") and "biological" sludges, with a high content of organic matter, and "chemical" sludge with a high ash content. At paper mills which practise deinking of recycled fibres, a "deinking" sludge is obtained. This is usually handled together with the effluent sludges.

The sludge handling includes:

- Dewatering, to reach a dry solids contents which makes the sludge easy to transport and dispose of.
- Final disposal which includes the methods of reuse (of fibre sludge), landfilling and incineration.

The amounts of biological and, possibly, chemical sludges, will increase, absolutely and in relation to the fibre sludge amounts, as a result of increasing application of treatment methods. This will make sludge dewatering more difficult and call for more efficient dewatering processes and equipment.

Landfilling will gradually have to be abandoned due to decreased availability of free land for disposal. Consequently incineration will increase, particularly separate sludge incineration, leaving only the ash to dispose of. But other methods will probably find increasing use, such as using sludge for improving poor soil quality, preparation of soil material or applying sludge on farmland.

Beside sludge from wastewater treatment various other types of waste are generated at paper mills, such as rejects from paper machine, bark and bark waste, waste paper sludges and residue, ash from incineration, scrap iron and other metals, plastics, chemicals, glass, oil and building materials.

The common methods of waste disposal are to dump the waste on landfills or to incinerate it where possible. Scrap iron, oil, plastics and glass are collected and sent for reuse to external partners. Additionally, the usage of wastepaper sludge as additive for the production of bricks and cement are under investigation in Austria.

Pollution Abatement Technologies

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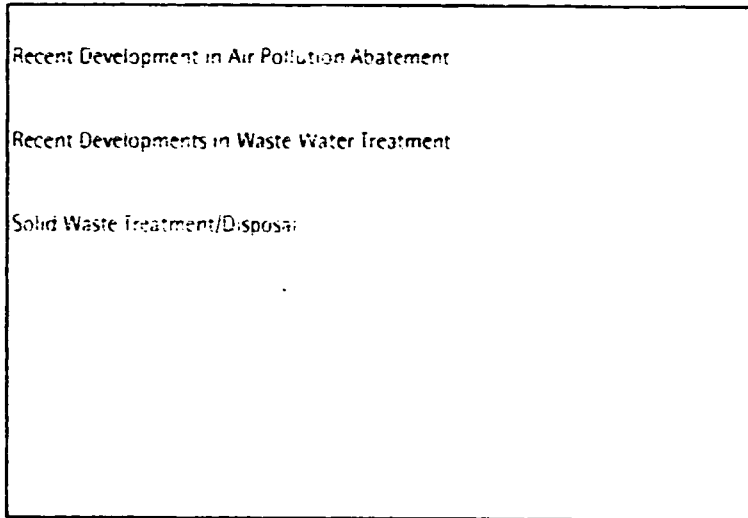


Figure 1

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Emissions to Air from a Bleached Kraft Pulp Mill

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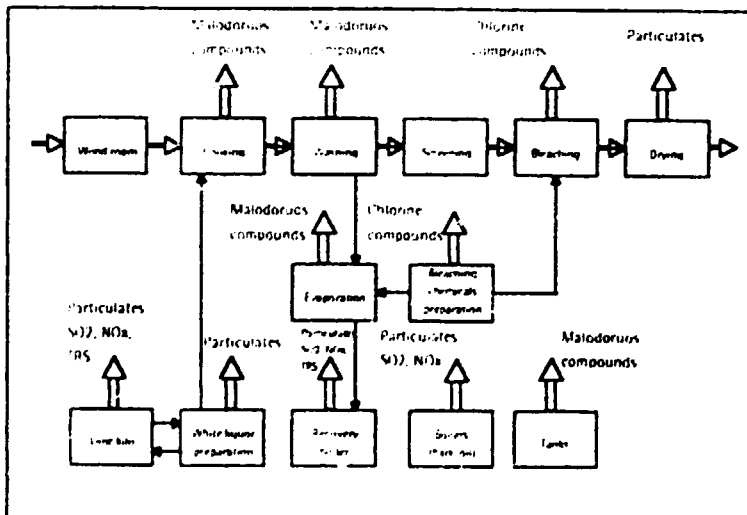
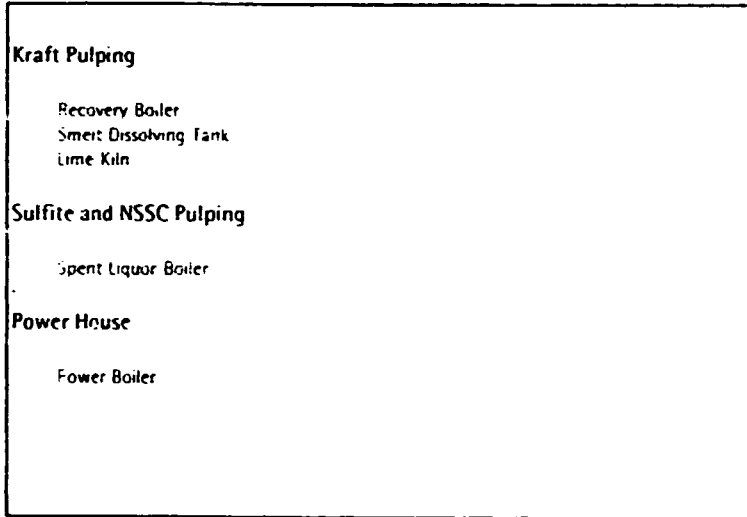


Figure 2

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Main sources of Particulate Emissions

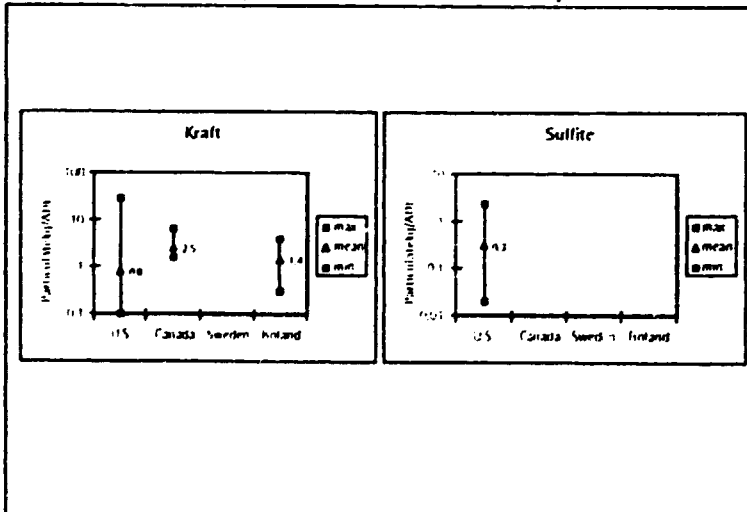
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Annual Averages of Particulate Emissions in the U.S., Canada, Sweden and Finland - 1/2

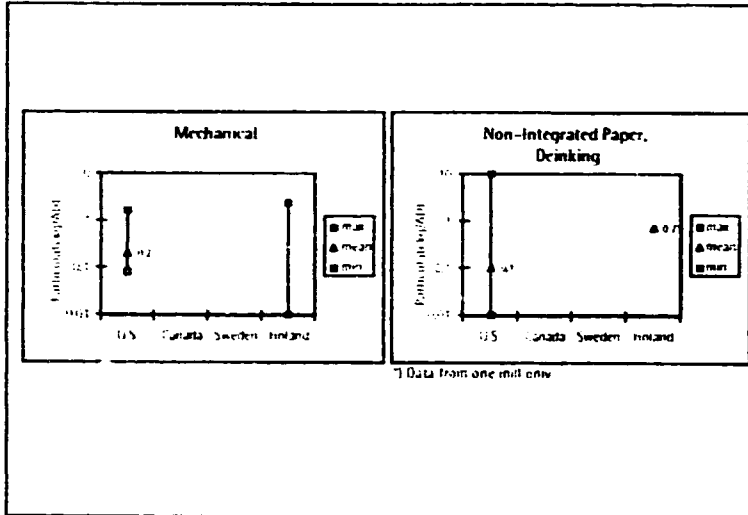
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Annual Averages of Particulate Emissions in the U.S., Canada, Sweden and Finland - 2/2

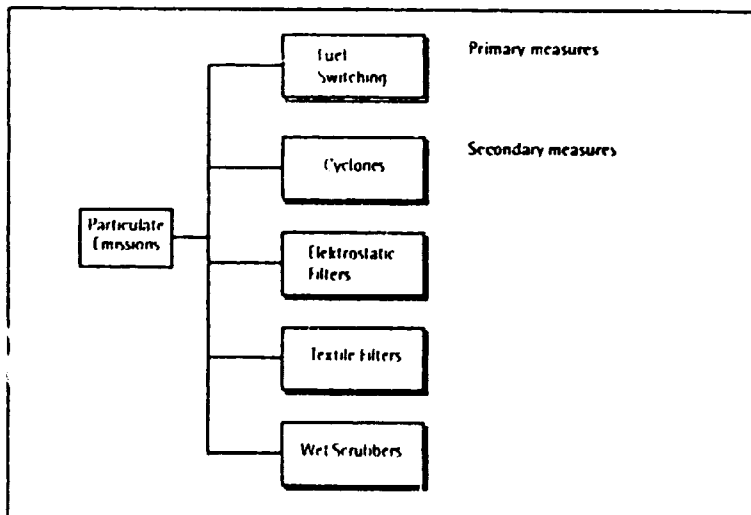
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Reduction of Particulate Emissions (Overview)

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Main sources of SOx Emissions

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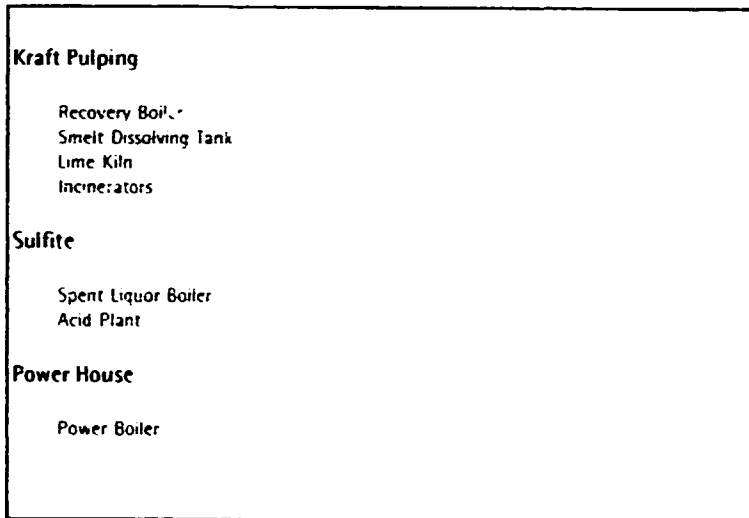


Figure 10

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Annual Averages of SOx Emissions in the U.S., Canada, Sweden and Finland - 1/2

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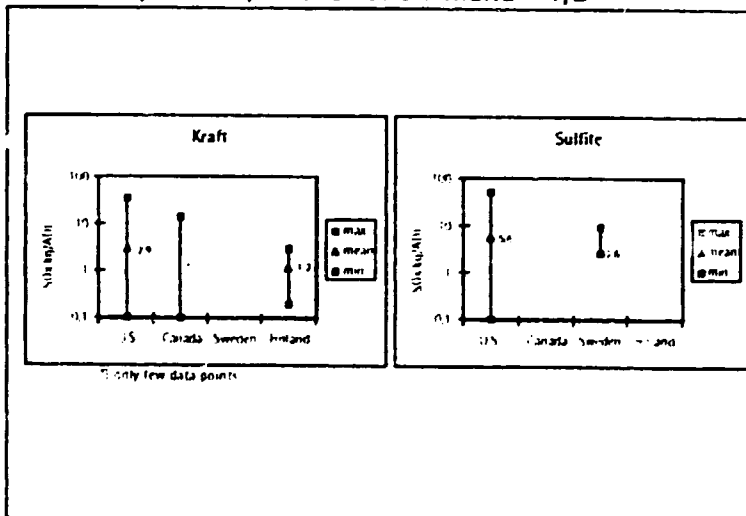
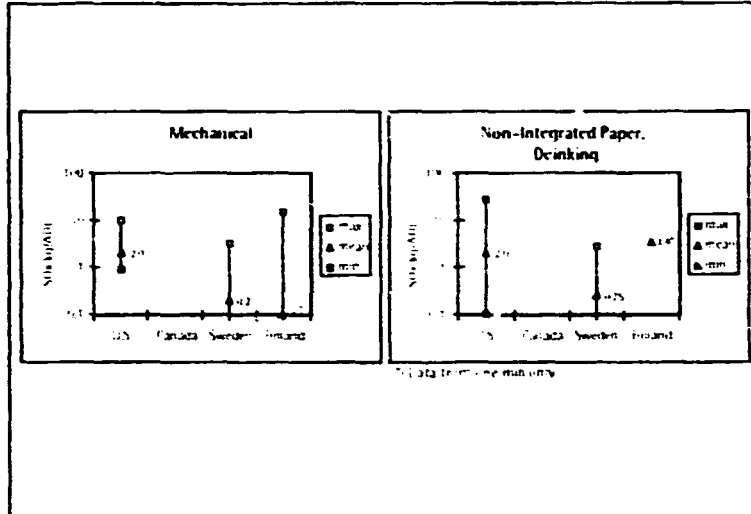


Figure 11

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Annual Averages of SOx Emissions in the U.S., Canada, Sweden and Finland - 2/2

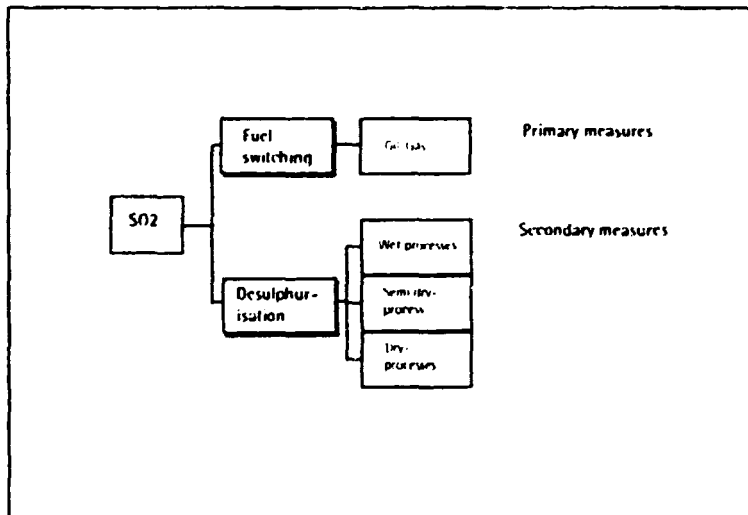
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Reduction of SO2 (Overview)

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Reduction Potential of Sulphur Emissions from Kraft Pulp Mills (in kg S / t Pulp)

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		Current situation	Development potential
Recovery boiler:	with scrubber	0,1-0,2	<0,1
	without scrubber	0,5-2	
	75 % dry solids	0,2-0,5	<0,2
Lime kiln:	without strong gases	0,03-0,05	<0,03
	with strong gases	0,1-0,5	<0,1
Strong gases:	Incineration	0,1-0,2	<0,1
	No measures	2-5	
Weak gases:		0,1-0,4	<0,1
Steam boiler		0-0,2	<0,1
TOTAL		0,4-8	<0,3

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Main sources of NOx

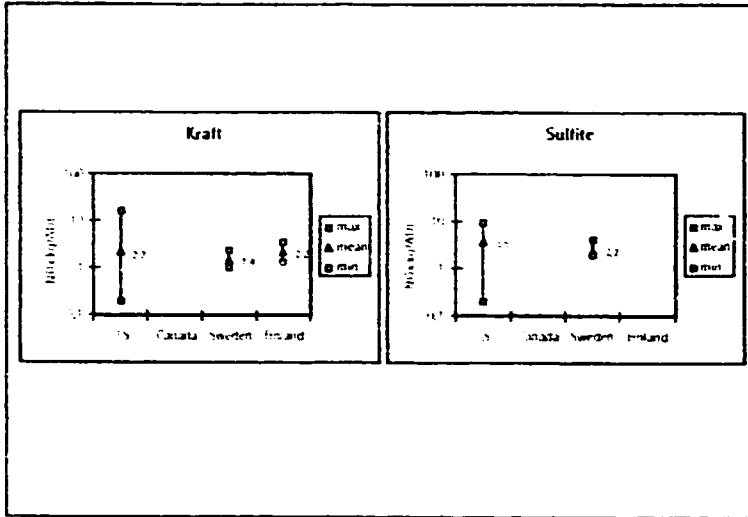
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Chemical Pulping
Recovery Boiler
Lime Kiln
Incinerators
Power House
Power Boiler

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Annual Averages of NOx Emissions
in the U.S., Canada, Sweden and Finland - 1/2

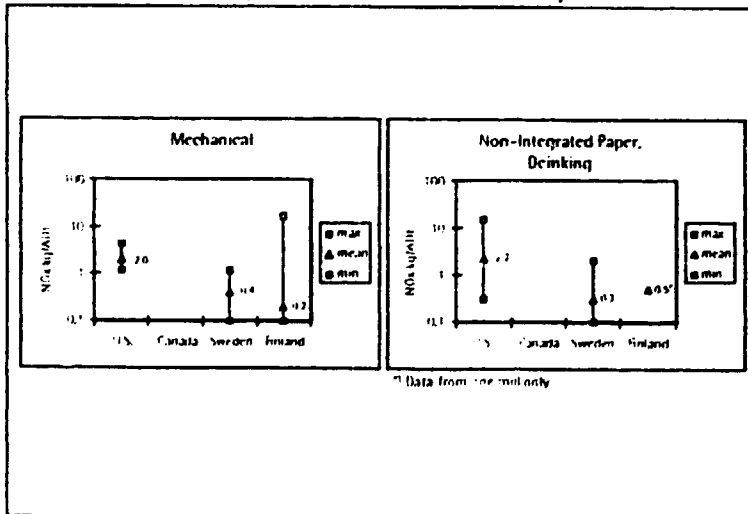
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Annual Averages of NOx Emissions
in the U.S., Canada, Sweden and Finland - 2/2

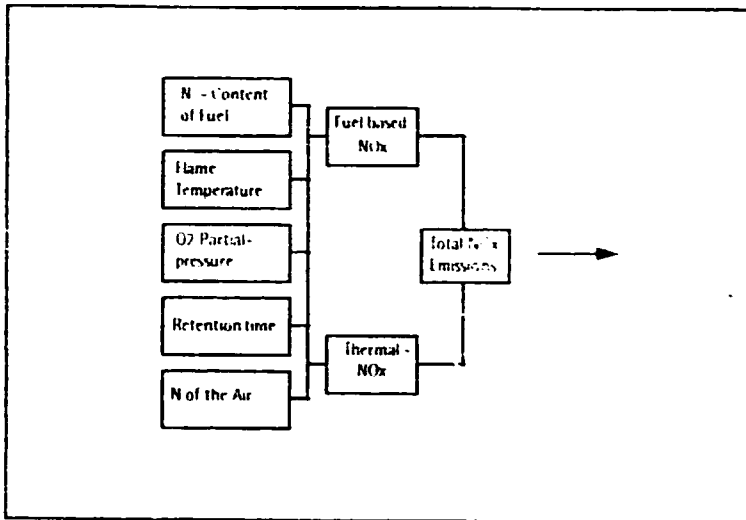
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Formation of NOx (Overview)

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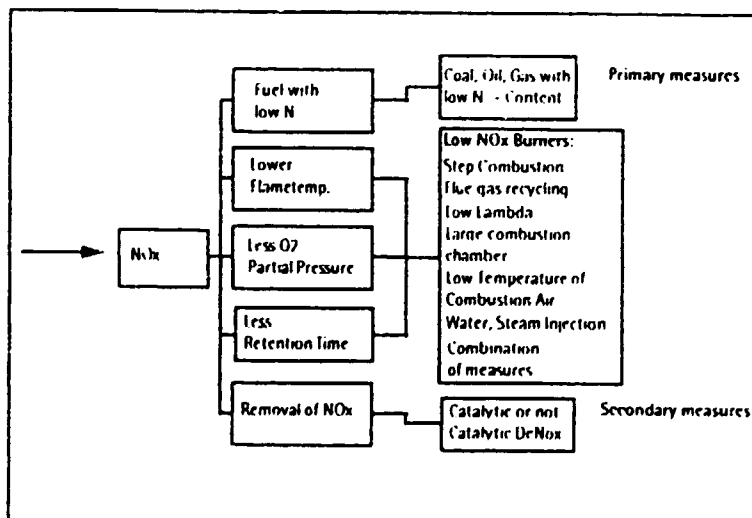


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Reduction of NOx (Overview)

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Reduction Potential of NOx Emissions from Kraft Pulp Mills (in kg NO2 / t Pulp)

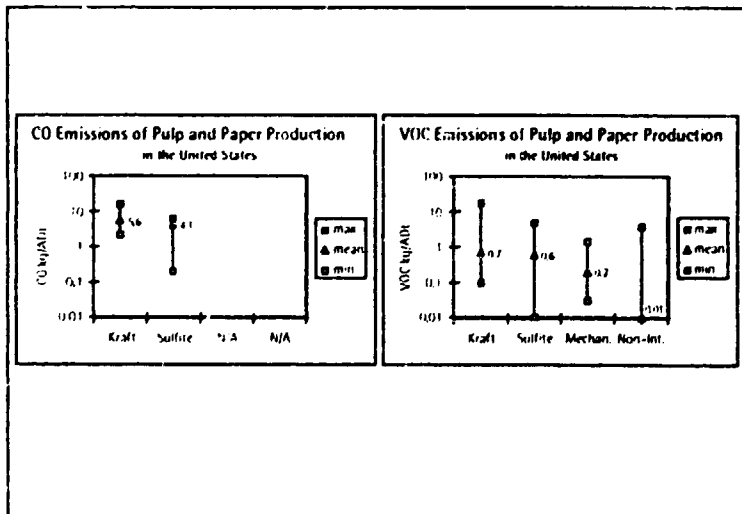
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	Current situation		Development potential	
	mg/MJ	kg/t	mg/MJ	kg/t
Recovery boiler	40-80	0,5-1,2	15-25	0,2-0,4
Lime kiln:				
oil fired	130-200	0,7-0,3	100-150	0,15-0,25
gas fired	200-320	0,3-0,4	150-200	0,25-0,35
Steam boiler:				
only bark	70-90	0,5-0,7	40-50	0,3-0,4
Bark and oil	100-120	0,7-0,9	50-60	0,4-0,5
TOTAL		1,0-3,0		<1

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Annual Averages of CO and VOC Emissions in the U.S.

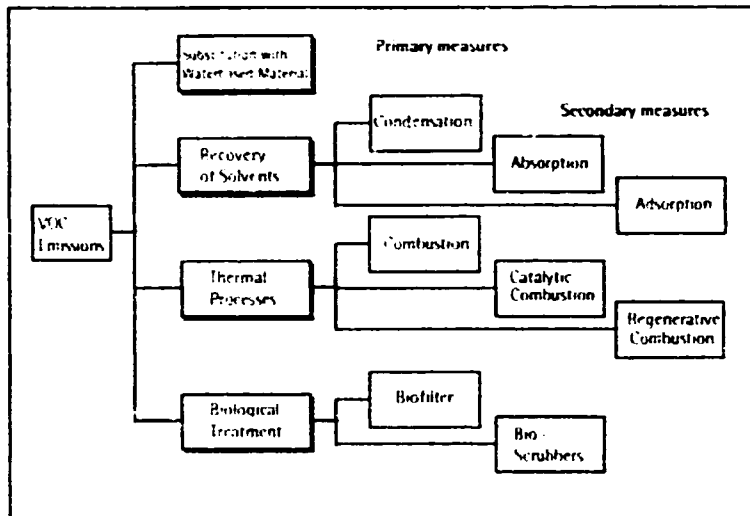
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Reduction of Volatile Organic Compounds (Overview)

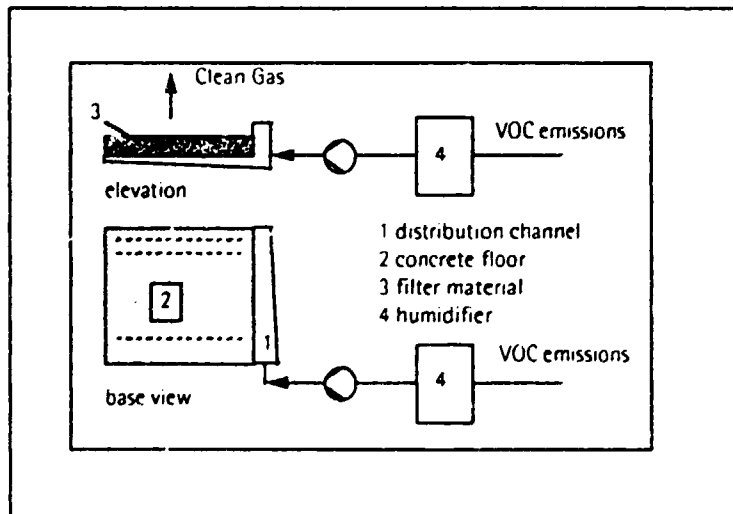
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Example: Biofilter

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Internal Waste Water Reduction Potential

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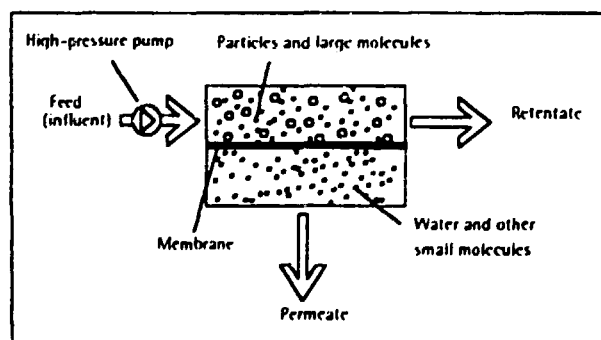
Discharges of COD from various parts of the Process before Treatment (kg/t pulp)

	Current situation	Development potential
Barking	<1-10	<1
Condensate, softwood	3-6	2
Condensate, hardwood	4-7	3
Spillage	1-7	<1
Washing loss, softwood	<1-10	4
Washing loss, hardwood	8-12	6
Bleachery, softwood	6-60	<2
Bleachery, hardwood	1-50	<2

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Example: Membrane Filter

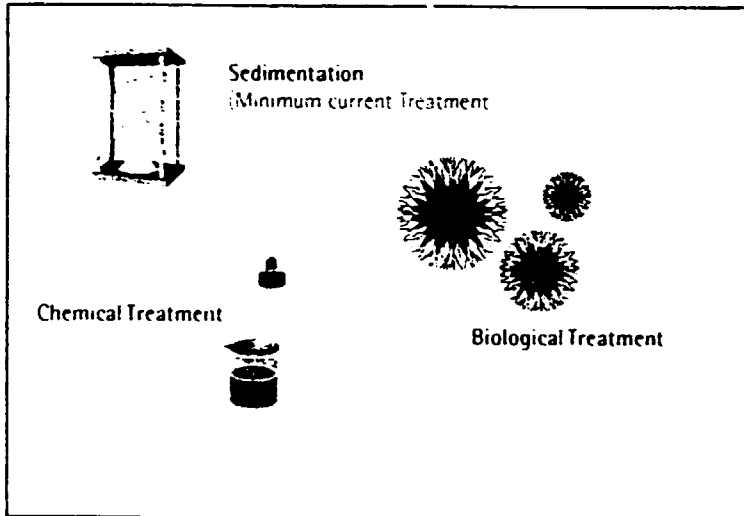
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External Waste Water Treatment

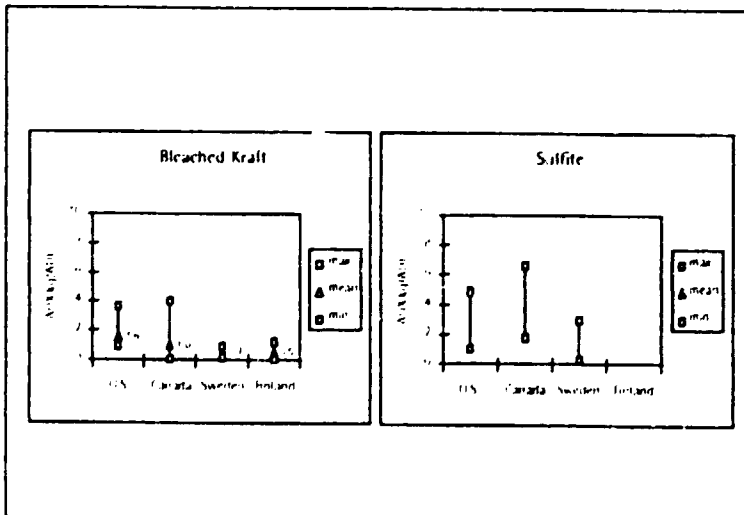
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AOX Discharges from Bleached Pulp Mills, kg/ADt

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Treatment Effects as Percentage Removed

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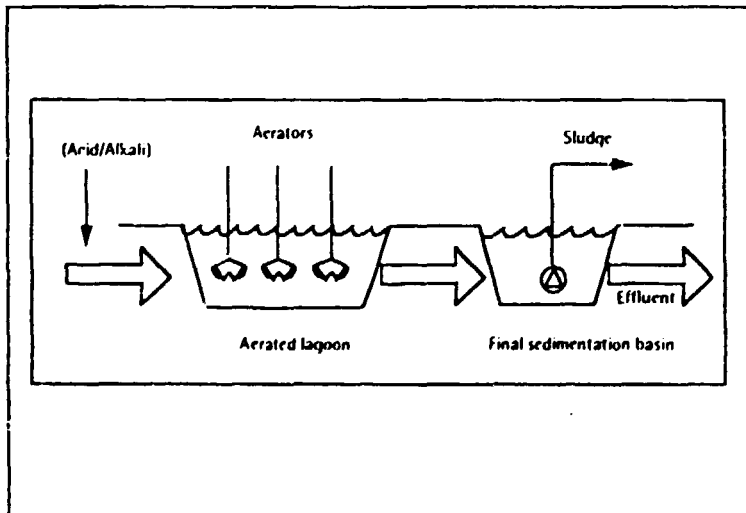
	BOD ₅	COD	AOX	P	N
Aerated Lagoon (AL)	50-80	20-45	20-45	0-10	0 ¹
Activated Sludge (AS)	90-98	40-60	40-60	30-60	0-50
AL + Chemical Precipitation	70-90	70-80	70-80	80-90	60-80 ²
AS + Chemical Precipitation	95-99	80-90	80-90	80-90	30-60 ²

1. At some aerated lagoons, the nitrogen concentration increases.
 2. Swedish Pilot Plant Studies

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Aerated Lagoon

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Activated Sludge Treatment

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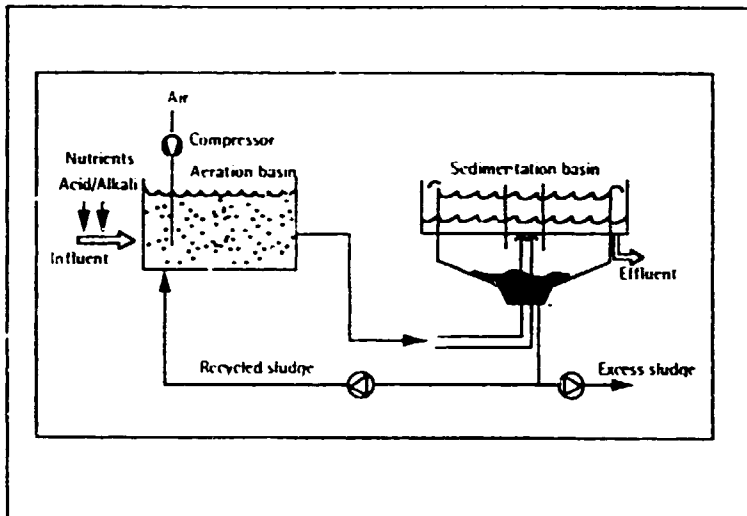


Figure 10.1

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Discharges to Water for Sulphite Pulp Industry

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Discharge Levels after Biological Activated Sludge Treatment
(kg/t bleached pulp)

AOX	COD	P	N
< 0,1	50-70	0,08-0,15	0,3-1,5

Discharge Levels after Biological Activated Sludge Treatment
and after Chemical Precipitation
(kg/t bleached pulp)

AOX	COD	P	N
< 0,1	30-50	0,02-0,04	0,2-0,5

Figure 10.2

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A Complete Treatment Plant for Pulp and Paper Mill Effluents

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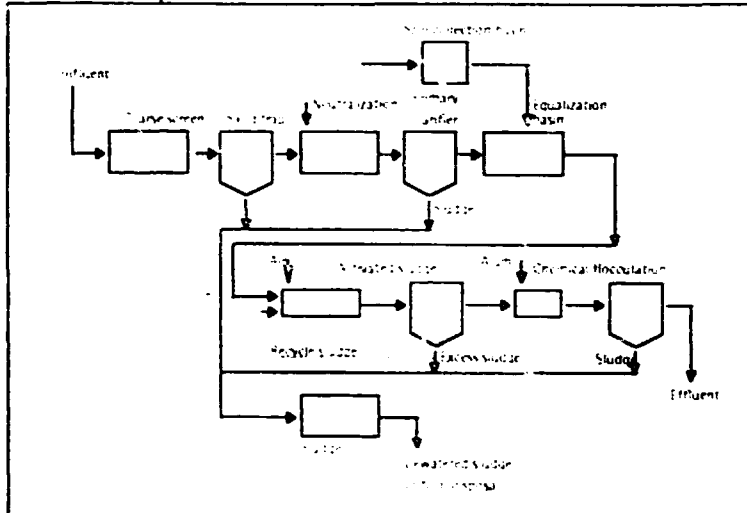


Fig. 10.10

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Discharges to Water for Kraft Pulp Industry

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The following levels are achieved at mills using only primary treatment (kg/t pulp):

	AOX	BOD ₅	COD	P	N	SS
Bleached	0.2-0.5	10-13	35-40	0.05-0.0	0.2-0.3	1-5
Unbleached	NI	1-2	20-30	0.02-0.0	0.2-0.3	1-5

The following levels are achieved at mills using secondary treatment (kg/t pulp):

	AOX	BOD ₅	COD	P	N	SS
Bleached	0.1-0.3	1-7	20-30	0.04-0.0	0.2-0.3	1-5
Unbleached	NI	1-2	10-15	0.01-0.0	0.2-0.3	1-5

The following levels can be achieved at mills using secondary and tertiary treatment (kg/t pulp):

	AOX	BOD ₅	COD	P	N	SS
Bleached	0.1-0.2	0.5-2	10-15	0.01-0.0	0.1-0.2	1-5
Unbleached	NI	0.6-1.2	5-10	0.005-0.0	0.1-0.2	1-5

Fig. 10.11

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Anaerobic Wastewater Treatment - Contact Reactor

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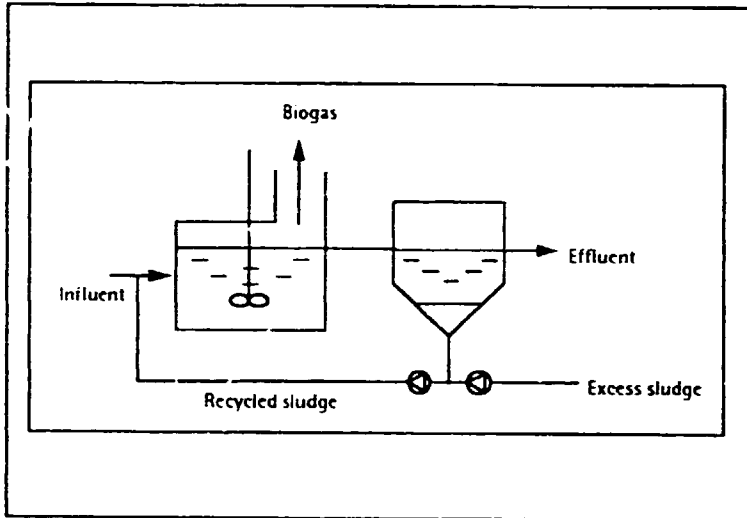


Figure 10.1

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Anaerobic Wastewater Treatment - UASB Reactor

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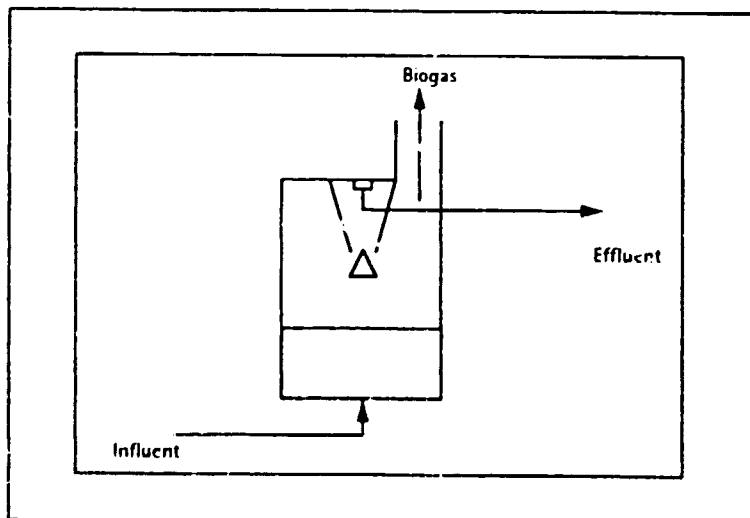
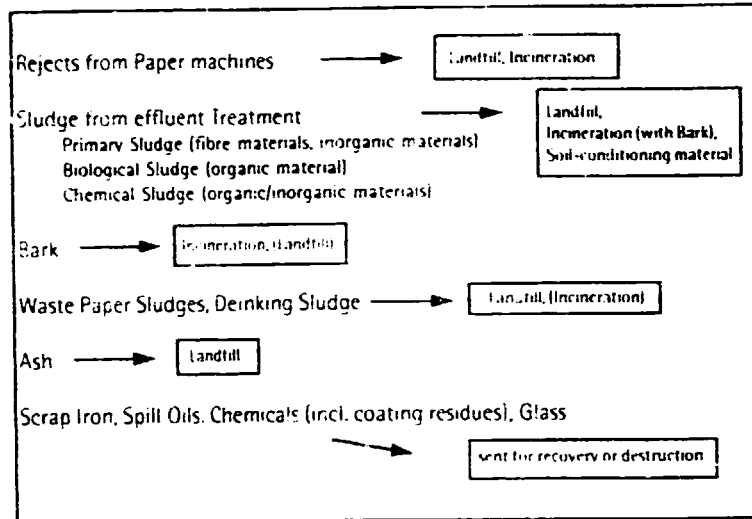


Figure 10.2

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Waste Treatment in Paper Production

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Agip

H. Traussnig, (Mayr-Melnhof Karton, Austria)

RECYCLED FIBRE BASED BOARD PRODUCTION

For many years environmental discussions used to concentrate especially on emissions of mills. Nowadays a development to a more global way of thinking can be recognized - a thinking in cycles.

Today we are not only concerned with the problem of emissions, also with the problem of waste, energy and wateruse; the role of the forest regarding the green-house effect as well as our responsibility to safeguard the biological variety of species.

People are more and more aware of ecological issues. We have changed away from a wasteproducing consumer society into an avoid and reuse society.

Packaging material made of cartonboard follows exactly this trend: it is made of renewable raw materials and the fibres can be recycled several times and subsequently it represents a precious biological fuel. Also it is possible to compost the cartonboard.

The recycling economy in the paper- and board industry started in the early fifties.

The board industry was the very first branch that converted used paper beside wood - often, not very sensible, defined as waste paper - as a perfect raw material for manufacturing their products.

At the beginning recycled fibres were used for economical reasons. Very soon, however, ecological advantages were recognized.

Today the paper- and board industry uses recycled fibres as raw material whenever it is technically and economically feasible. By doing so, economical benefits are combined with ecological advantages.

The paper- and board industry is one of the few industries that has long term collection systems for recycled fibres to its disposal, combined with recycling skills.

The use of recycled fibres for paper- and board production is important for the environment. This decisively contributes to the reduction of waste volumes and enables a better use of existing land-fill areas.

Recycled fibres also pay a positive contribution to the efforts of the paper- and board industries to minimize energy- and water consumption.

Therefore recycling is the latest trend of today. Recycled fibre cartonboard has only got a value if the industry - be it non-food or food industry - has the guarantee that secondary fibre is not waste but a very acceptable and proven usable fibre resource.

The European production of cartonboard is split up into approximately 34 % primary fibre board, 38 % coated recycled board and 28 % uncoated recycled greyboard. That means the relationship between primary and secondary fibre based board is one to two.

The next charts show you the collecting rate in different countries, the percentage of recycled fibre input in Europe and Austria and the use of recycled fibres in different products.

Secondary fibre does not only consist of waste paper which is known from the collecting box in front of houses. More than 40 different grades of used papers are listed, standardized and quality wise exactly described. The list is divided up into 4 groups depending on the origin of the used paper:

1. So-called mixed paper from private households
2. Packaging paper from the so-called open out industry, mainly from supermarkets
3. Printing and writing papers from the administration offices
4. Waste paper from the board converters.

The recycled fibre cartonboard industry uses around 20 different recycled papergrades out of these four groups.

The possibility to use such an amount of different grades is given by the construction of the board.

Recycled board is built up in different layers with different behaviours and different demands. Therefore fibres with different characteristics are needed.

Less printed, less used material, so called PIW (Post Industrial Waste) is mainly used in the outer layers, while several time recycled material, so called PCW (Post Consumer Waste) is used for the middle.

I would like to explain it by this schematic graph, which shows the construction of a GD-board.

To those, who are not familiar with the expression „GD“ which derives from the german word „gestrichener Duplex“, the translation is „white lined chip-board“ - the common name for this board, internationally used. This is a coated cartonboard based on recycled fibre.

I would like to give you some examples of GD, GT respectively FBB, WLC. There are often differences in the meaning. SBS, FBB and WLC are the international used terms.

Such a board normally is two- or three times pigment coated. The toplayer is made from bleached chemical pulp with variable portions of woodfree office paper (computer printout) depending on the quality of the board.

The bright underlayer must cover the grey filler to enable the use of the expensive toplayer as thin as possible. The preferred raw materials for this layer are recycled cartonboard boxes made from virgin fibres. Some grades could be produced without an underlayer.

A cartonboard with high stiffness is constructed according to the principle of an iron girder.

The fibres of the outer layers need high strength while the fibres of the middle layer are responsible for the volume of the board.

Therefore the middle layer mainly consists of household collecting papers because of their high portion of newspapers, magazines, old containers and cartonboard boxes.

For the grey backside, which is the innerside of the box, secondary fibres of our own production and fibres of the converters are used (PIW).

For particular pretension and for sensitive packaging devices a bright backside made of unprinted recycled fibres can be produced.

The portion of secondary fibres in this just described board is 96 %.

Today 52 % of packaging cartonboard is used for non-food applications and 48 % for food packaging. There are strict regulations concerning the application of cartonboard especially concerning food in contact with cartonboard. That means that modern companies plan and build their production sites, especially the stock preparation plant, according to the highest possible requirements.

We operate 5 separate fibre stock preparation systems:

The virgin pulp line

A recycled paper line - both for the toplayer

Another recycled paper line - for the underlayer

A filler line

A backlayer line

The biggest unit is the filler line. It handles in terms of impurities the most critical raw material. Therefore I want to explain the configuration of this line as it is used in our mill at Frohnleiten.

Stock preparation starts with a pulper where the fibre raw material is dissolved with water. The pulper is equipped with a screenplate with 20 mm holes so that plastic bags, steel bands or other insoluble substances remain in the pulper. The pulper has a continuously working pulper cleaning system to remove this waste.

The next step is the separation of heavy contaminants like small stones, glass or paper clips. The separation of the heavy particles takes place with high hydromechanical centrifugal forces. The separation is not only important for the quality of the board but also for the long life time of the stock preparation machinery.

Next stage are the pressure screens. These are sorters with a screen plate of 2,2 mm diameter.

They remove smaller plastic, paper and wood pieces from the fibre suspension. After a further dilution again centrifugal cleaners are used to separate sand, glass, hard plastic and metal particles. These cleaners work with centrifugal forces which are three times higher than the earth gravity.

After the centrifugal cleaners there are low density cleaners for the separation of foam rubber, polyethylen foils and styrofoam or polystyrol.

And then we have pressure screens again, but now with slotes instead of holes. The width of the barrier is indeed very narrow - only 0,22 mm. Smaller than a finger nail thick and smaller than the thickness of our lowest grammage of board which is about 300 microns. Despite of this sophisticated cleaning technology we haven't removed all the contaminants from the fibre stock.

Printing inks, hotmelts, small pieces of bitumen, paraffin, wax and grease are partially still in the fibre suspension.

We don't remove all of them because they can hardly be totally removed but we have to make them harmless and invisible as far as possible. Therefore the stock is heated up to 95° C and so the particles become soft and we can disperse them. That means that we mix them intensively with the fibres. The result is a fibre material of uniform light grey colour without dirty spots.

Although this is one of the most modern equipments, let me tell you something about other new technologies in the waste paper preparation now.

The toplayer is the major influence of the quality of the board. Therefore the quality of fibres used depends on the quality of the board from 100 % of bleached pulp to 100 % of waste paper, mainly mixtures of both. The requirements are equal to coating base-paper regarding to brightness, cleanness, opacity and so on. There must be a high stiffness, a good greasing property and a good printability on fast running printing machines. For production reasons there should be a good porosity and vapour transmission, too.

I will not describe the equipment of the pulp line, because I think that it is well known. I will give you an example of the waste paper preparation which is used in two factories in middle Europe, using mainly less printed waste papers.

The preparation starts with a HC-pulper (high-consistence) where 15 - 18 % fiber raw material is dissolved in water. After the separation of the heavy contaminants a screen plate with wholes of a diameter of about 1,8 mm and a screen plate with slotes of a diameter of about 0,25 mm cleans at a stock consistency of about 4 %. After dilution to about 1,3 % follows a flotation step and the other usual cleaning steps. The described system is equipped with an ash removing washing step at the decler. As a last step disperging is necessary. Here, it is believed, that a high speed disperger with toothed rim is the best solution. A control of the specific power by changing the distance of the plates is preferred to systems of constant distance. The specific energy consumption of such systems is between 60 - 100 kWh/to. Some plants have a HC-bleaching equipment to increase brightness.

Other companies use waste paper with less ash and dispense the ash removal. If they use unprinted or only a little amount of less printed waste papers, they will dispense the flotation step.

The advantages of the flotation step is an optimal increase in brightness and a removal of dirt particles up to 300 μm and the removal of stickies. The advantages of the washing (ash removal) step is the possibility to use more grades of waste paper, the disadvantage the necessity to deposit the ash. So you have to decide on your return of invest.

The underlayer should cover the grey middle-layer to the top. So a high opacity and an acceptable brightness is necessary. There are many systems existing, for example own stock preparations lines for the underlayer or a mixture of top layer and backlayer. The separation of heavy contaminants and the low density cleaners are operating at 1 % stock consistency, the screens at about 4 - 4,5 % followed by a disk filter. Because it is not necessary to disperse at the same specific energy as the top layer, 40 - 60 % kWh/to are enough. So a higher freeness, a better opacity and a better vapour transmission is the result and therefore often defibrators instead of high speed disperger are used.

For the backlayer there are also many different systems. If there is an own line mostly the same system as in the underlayer is used, except a better dispersing system. For backlayers in direct contact with foodstuff only selected qualities of wastepaper are used.

I have told you about the filler line before. The latest development (a plant for about 400 t/ato filler started 3 years ago) describes a two steps heavy density cleaning. The screen plates should operate with a minimum stock density of 4 %, the low density cleaners should operate at about 1 %. This would extend the dwell time of the screen baskets and no monthly purification of the baskets is necessary.

After disk filters long and short fibres are separated in a proportion of 40 : 60. The short fibre fraction is clean enough, no dispersing step is necessary; the long fibre fraction is dispersed with a specific energy of 40 - 60 kWh/to. Also a defibrator could be used.

Now I will give you some new consideration for the future of stock preparation. New screen baskets with fine slots and new developed fractionation- and separation technologies open new aspects. For this reason some people believe that a two line stock preparation including fractionation followed by mixing this ingredients to the four layers will be the common way in the future.

A part of the top layer will be mixed with the backlayer to the underlayer.

The filler line will be fractionated, the short fibre is used for the middle layer, the long fibre is cleaned and mixed to the underlayer. The rest goes back to the middle-layer.

The advantages are the investment costs and the selective treatment of the fibres. Disadvantages are that the system is less flexible and that there are less possibilities to use raw materials due to recommendation XXXVI.

Let me give you some more details about the watersystem and the dispersing.

The water circuits are divided into two parts. We have one loop for the board machine and another for the stock preparation.

The raw material comes from the stock preparation to the board machine. The water goes the opposite way, it enters the board machine clean in the process and leaves the mill in the stock preparation in direction to the water clarification plant.

That means the wastepaper is washed in a so called counter stream process. Respectively the cleanest water is used in this area where the board is formed. To support this water exchange process, on the border between stock preparation and board machine several double wire presses are installed. The water which is removed by the press goes back to the waste paper dissolving system whereas the dilution after the presses is done with fresh water and hydrogen peroxid treated cleaned back water. No biocide is used in the water system of most of the MM-mills.

I just mentioned the double wire presses. They are not only a barrier in the watersystem but they also prepare the stock for the disperging process.

During this preparation step the fibres are heated up to 95° C with steam of a temperature of 165° C. The twell time at that temperature within the disperging apparatus is about 10 min. Caused by the twelltime and the high temperature - similar a pasteurization - most of the bacteria and germs in the fibre stock are killed.

Unfortunately the use of waste paper causes some problems. The biggest problems are stickies. In the chest the stock is free of visible troublesome adhesive impurities. Nevertheless there are some troubles caused by stickies because of their deposits on wires, rolls and so on. Neither high sophisticated cleaning systems nor chemical aids have entirely solved this problem. The cleaning steps and the disperging steps could only remove the stickies at an efficiency of maximum 80 % due to the different dimensions of the stickies.

Disperging aids or chemicals for reagglomeration of stickies are used to separate them, retention aids or cationic aids are used to fix the stickies to the fibre or minerals like talkum or bentonite to cover the stickies. The nature of the stickies and the changing of the stickies which depends on different sources of waste paper as well as shear force, differences in temperature and pH reduce the efficiency of all these methods.

Another problem is the increase of coated and/or high filled paper. So the ash content is increasing and volume and stiffness of the board decreases. Washing steps (ash removal) as described before will be necessary in the future when using such big amounts of wastepaper in the cartonboard industry.

The last problem is the reject. The industry is not able to influence this problem in an adequate way. If allowed - energy recovery of the reject would be the best way. I will tell you more in the case study of Frohnleiten mill.

Technical equipment is not the only precondition for success. A company philosophy and a clear system as well as consistant quality delivered are necessary. As we meet the requested

standards our board mill has got the ISO 9001 certificate. There are clear regulations for the production of each individual grade, steady controls of production process, steady control of the products after production and climatisation - there is a double check system. In order to meet all these requirements most modern equipments in our laboratories which are in operation enable adequate physical, chemical and microbiological examinations.

An important that should be mentioned point to be made is the fact that a lot of recycled fibre boards meet the strict European regulations concerning foodpackaging. Why can we guarantee that ?

- First of all there is existing the XXXVI. rec. regarding food stuff in direct contact with the packaging, published by the German Health Ministry.
- This recommendation is the result of work done by a committee in close cooperation between specialists in the field of foodstuff chemistry and toxicologie of the Ministry of Health as well as lawyers and engineers of the paper and chemical industry.
- The XXXVI. recommendation makes no difference between virgin and recycled fibres., This means for both of them the same limits are valid.
- According to the rec. XXXVI only selected fibres are allowed.
- Only additives, which are certificated acc. to the XXXVI. rec. can be used.
- There are also strict limits for dangerous contaminants e.g. Pentachlorphenol, Polychlorinated Biphenyle, Formaldehyd and some other organics and heavy metals.
- Microbiological laboratories control the mill's hygienic situation and sensoric laboratories control taint and odour of the board by so called Robinson Tests.
- We also cooperate with external instituts and laboratories for selfcontrol and to make sure that our figures are correct.

I will give you an example of such testings of board and will also tell you something about the Robinson test. In Frohnleiten we are on trials with an electronic nose, where six sensors measure the air above the board and a panel of six examiners enter the result of the Robinson test into a PC. A neural network compares the results of the sensors with the panel and after many comparisons, the electronic nose should be able to tell you, what the panel would have said. So we hope to increase the number of measures.

But there are also some other important things. So every supplier has to accede requirements. If these requirements are not fulfilled, the supplier will not allowed to deliver in the future. All chemicals must fulfill the requirements of the rec. XXXVI of the BGA and the suppliers have to confirm this and they are responsible for any changes of their products. Every charge of waste paper is marked, so that it is possible to claim to the suppliers who are delivering paper that can not be used or that must not be used or causes any other problems.

The water - you will see it in the case study, we are using only a little amount of fresh water - is treated by hydrogen peroxide and peracetic acid. They will decompose in acetic acid, water and oxygen. The rate of killing germs is satisfactory and the oxygen removes a possible bad smell from the water. No biocides are used.

That was some information about cleanness.

I think we should not talk too much about converting of recycled board in comparison to virgin fibre board. For many years there are experiences with both qualities. The fact that the products are well accepted by the market, shows that the converting process must be economical for both.

Nevertheless that, let me give a short advise regarding stiffness, which is always considered as an argument against recycled board.

But in reality it isn't. Every board has its stiffness. The level of stiffness only depends on the substance of the board.

This chart should clear a mistake which is very often made in this context.

Many people think that stiffness and substance go proportional and that for example 20 % higher stiffness on the other hand means twenty percent lower substance for the stiffer board. That is not correct !

If you compare the figures of different boards you will find in the average that 18 % higher stiffness brings about 10 % lower substance, respectively the FBB with the same stiffness as the GT board has only 10 % lower substance.

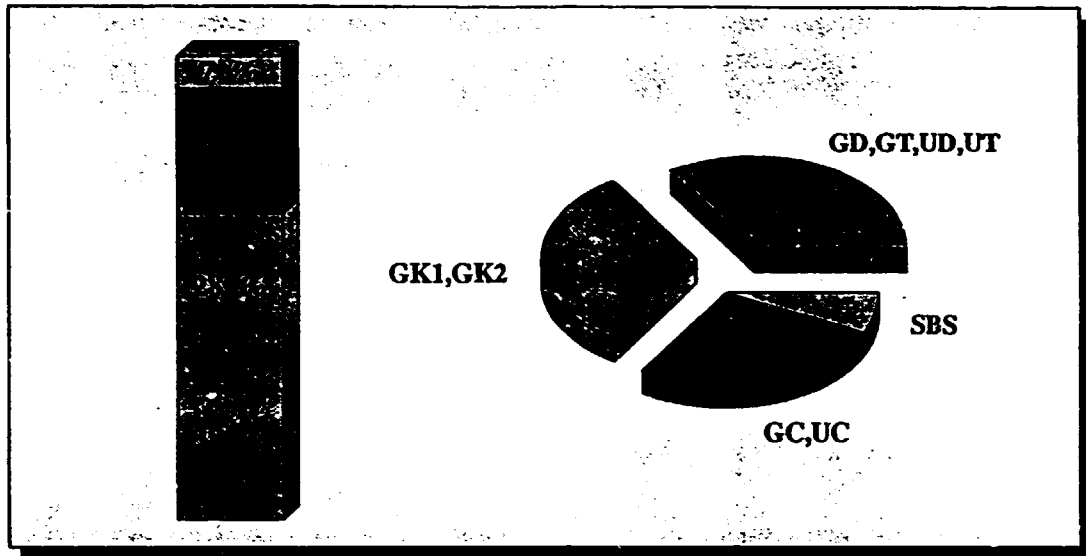
But among all these pros and cons for recycled or virgin board remains one fact: Beside the ecological advantages it is the economy.

I am sure that from the economical and ecological point of view recycled board is not only a good alternative for today but also for the future.

But we have to consider a change due to the „Verpackungsverordnung“ (packaging waste directive) in some countries. Therefore qualities which are not in the waste paper system yet will be collected more and more. So PE-laminated papers will increase and the industry has to install the necessary equipment. In the Frohnleiten mill it is also possible to use packagings, that are laminated on both sides, but they must be collected seperately. The bigger problem is the reject and the costs for the landfill. We have to consider the change in legislation and in the customer's mind and we have to react on it that cartonboard will be the best ecological/economical solution for packagings also in future.

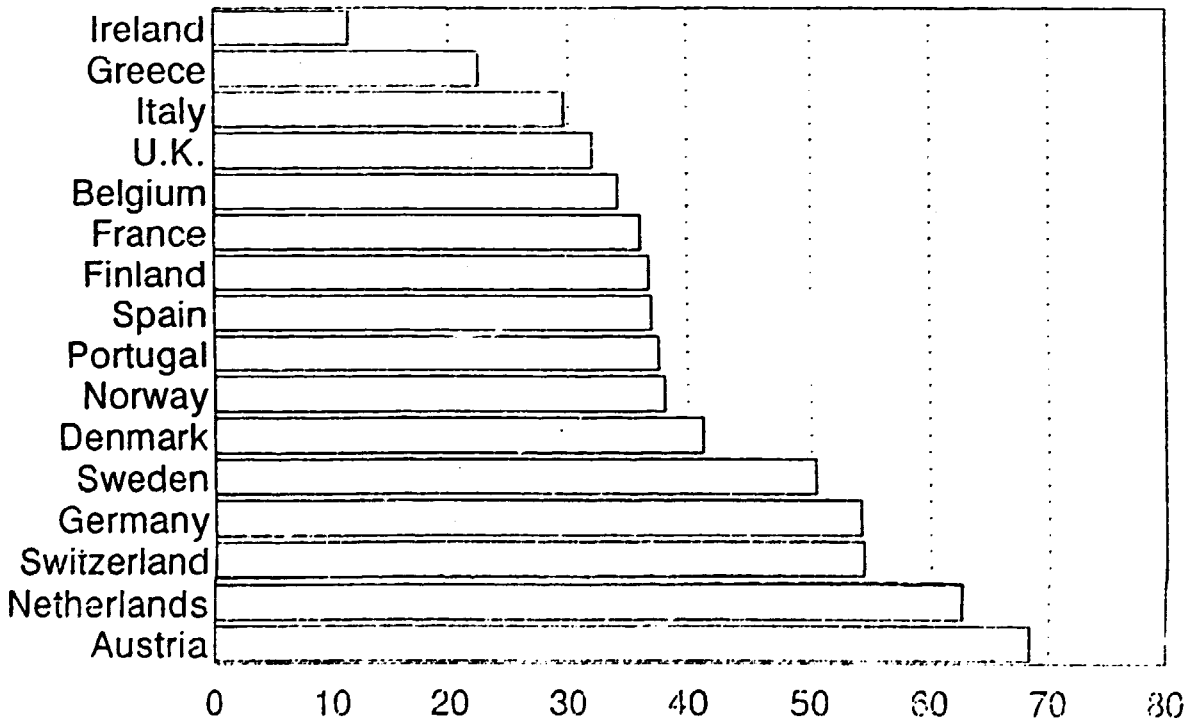
I will tell you more about environmental aspects and the use of board made from recycled fibres in the case study.

EUROPE : PRODUCTION OF COATED AND UNCOATED CARTONBOARD

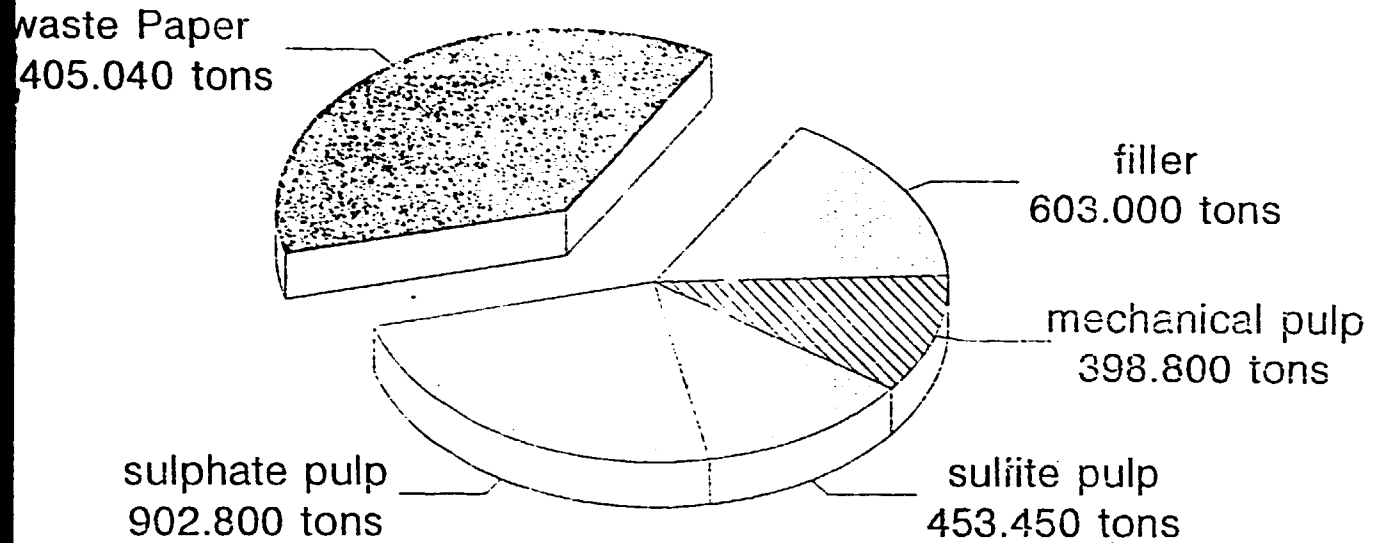


SBS	SOLID BLEACHED SULPHATE
GC, UC	COATED AND UNCOATED FOLDING BOXBOARD
GD, GT, UD, UT	COATED AND UNCOATED RECYCLED FIBREBOARD
GK1, GK2	UNCOATED; UNLINED CHIPBOARD

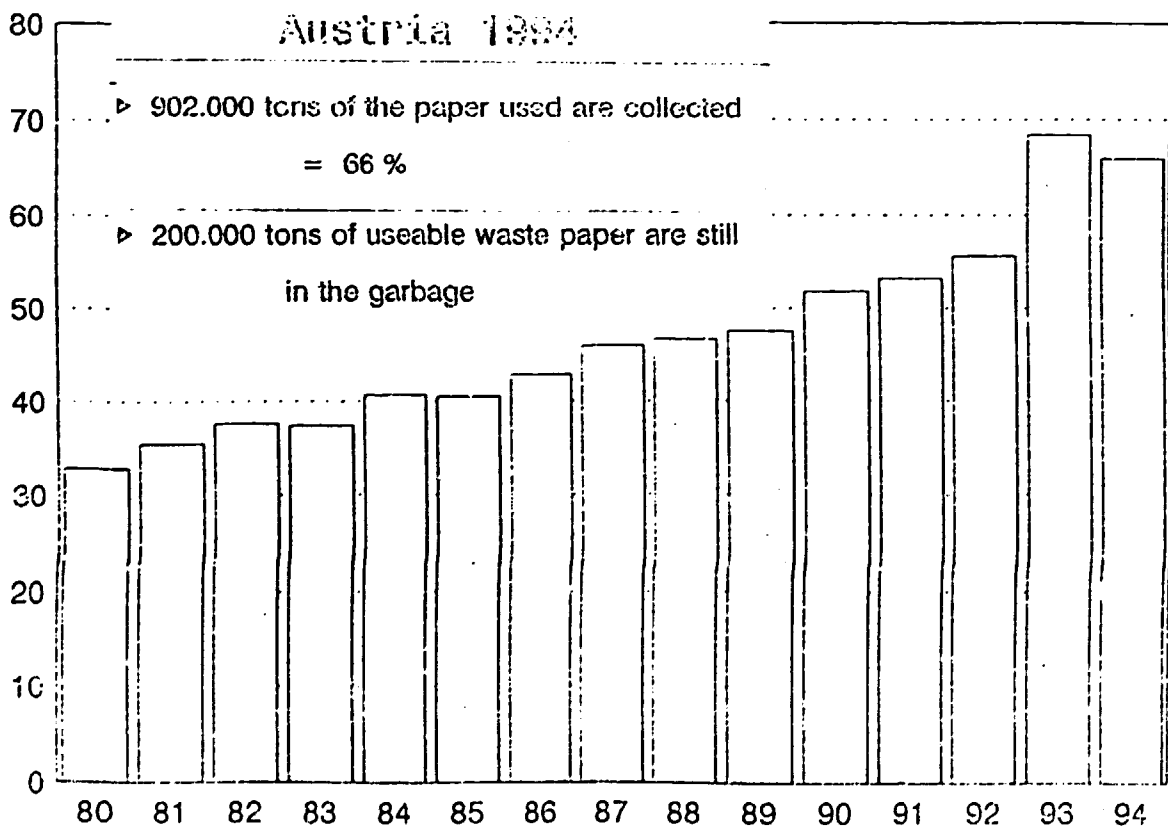
Recycling 1993



Use of raw materials 1994



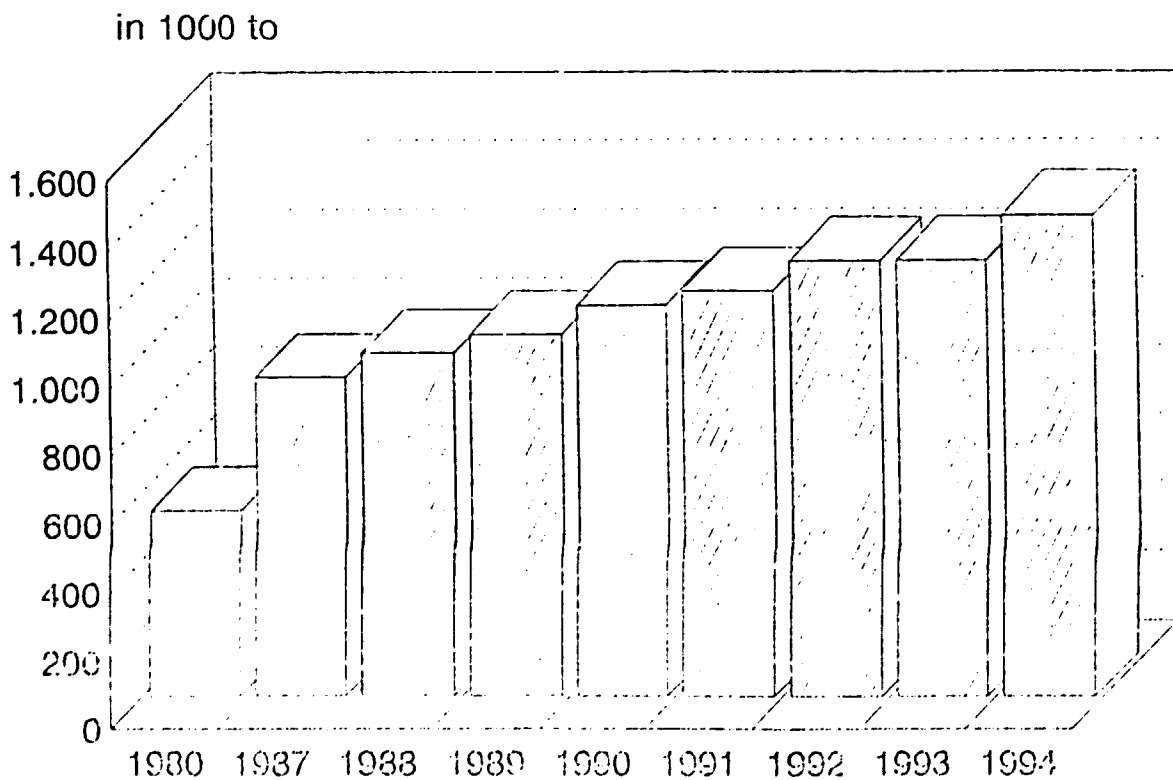
Development of Recycling in Austria



Comparison Production / Waste Paper Use



Development of Waste Paper Use in Austria



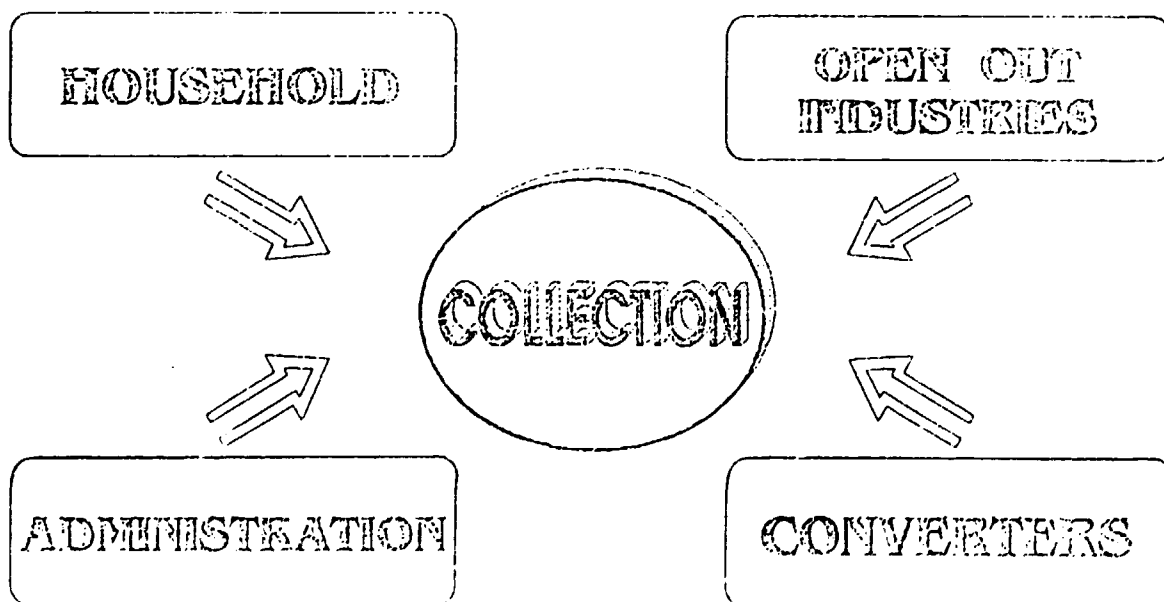
BOARD STRUCTURE

MCM 300 gsm
Mill Fil. 10/10/10



COATING	20 gsm	CARBONATE, CHINA CLAY, TITANIUM DIOXIDE, BINDER
TOP LAYER	50 gsm	OFFICE PAPERS, PULP
FILLER	130 gsm	NEWSPAPER, OCC, MAGAZINES, HOUSEHOLD COLLECTINGS
BACK LAYER	45 gsm	BROKE, BOXES, UNPRINTED NEWSPAPER

RECYCLED FIBRE



RECYCLED FIBRE



INPUT RATE 1990 in the FRG for PACKAGING

parted in different grades

GRADES	INPUT RATE in %
CORRUGATED BOARD RAW PAPERS	107
bleached and unbleached PACKAGING PAPERS	55
FOLDING BOX BOARD	78
other PACKAGING PAPERS and BOARD - without TUBE BOARD	86
AVERAGE	92

RECYCLED FIBRE



INPUT RATE 1990 in the EC's PAPER INDUSTRY

parted in different grades

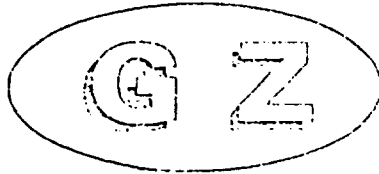
GRADES	INPUT RATE in %
PACKAGING PAPER and BOARD altogether	92
PRINTING and WRITING PAPERS / NEWSPAPERS " WOODCONTAINING "	60
HYGIENIC PAPERS	55
PRINTING and WRITING PAPERS " WOODFREE "	18
AVERAGE	49



KARTONSORTEN
board grades

GZ
SBS

K 1.0.0.



Gestrichener Zellstoffkarton
(coated cellulose board)



Solid Bleached Sulphate

Anwender
(end user)

— Pharmazie
(pharmacy)



— Kosmetik
(cosmetics)



— Zigaretten
(cigarettes)



— Lebensmittel
(food stuff)



KARTONAUFBAU
board structure

GZ
SBS

K 1.1.0.

Strich (coating)

Leimung (sizing)

**mehrere Lagen gebleichter
Sulfazellstoff**

**(multiple layers of bleached
sulphate pulp)**

Leimung (sizing)

Strich
coating

Kreolin, Karbonat, Binder
caolin, carbonate, binder

Lagen
plies

100 % gebleichter Sulfazellstoff
100 % bleached sulphate pulp

Leimung
sizing

Stärke, synthetische Leime
starch, synthetic sizing





KARTONAUFBAU
board structure

GC
FBB

K 2.1.0.

Strich (coating)

20 gsm

Decklage (top layer)

50 gsm

Einlage (middle layer)

grammaturbedingt
(substance made)

Rückseite (reverse side)

50 gsm

Präparation (preparation)

5 gsm

Strich
coating

Kaolin, Karbonat, Binder
caolin, carbonate, binder

Decke
top layer

100 % Zellstoff
100 % pulp

Einlage
middle layer

100 % Holzschliff
100 % mechanical pulp

Rückseite
reverse side

100% Zellstoff, Halbzellstoff oder Holzschliff
100% pulp, semi-pulp or mechanical pulp

Präparation
preparation

Stärke, Kaolin
starch, caolin



MAM KARTON

TKS / LAB

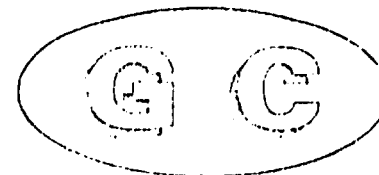
195



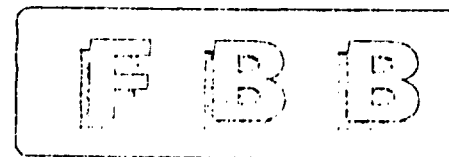
KARTONSORTEN
board grades

GC
FBB

K 2.0.0.



Gestrichener Chromekarton
(coated chrome board)



Folding Box Board

Anwender
(users)

— Pharmazie
(pharmacy)



— Kosmetik
(cosmetics)



— Zigaretten
(cigarettes)



— Lebensmittel
(food stuff)



MAM KARTON

TKS / LAB



KARTONAUFBAU
board structure

GD
WLC

K 3.1.0.

Strich (coating)

25 gsm

Decklage (top layer)

45 gsm

Einlage (middle layer)

grammaturbedingt
(substance made)

Rückseite (reverse side)

45 gsm

Präparation (preparation)

5 gsm

Strich
coating

Kaolin, Karbonat, Titandioxid, Binder
caolin, carbonate, titanium, binder

Decke
top layer

50 % Zellstoff, 50% sortierte Altpapiere
50 % pulp, 50% post industrial waste

Einlage
middle layer

100 % gemischte Altpapiere
100 % post consumer waste

Rückseite
reverse side

100 % sortierte Altpapiere
100 % post industrial waste

Präparation
preparation

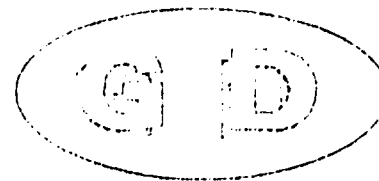
Kaolin, Stärke, Binder
caolin, starch, binder



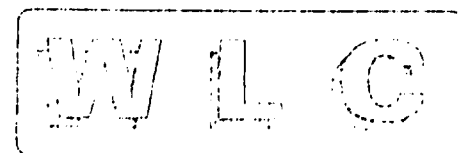
KARTONSORTEN
board grades

GD
WLC

K 3.0.0.



Elektrischer Duplexkarton
(coated duplex board)



White Lined Chipboard

Anwender
enduser

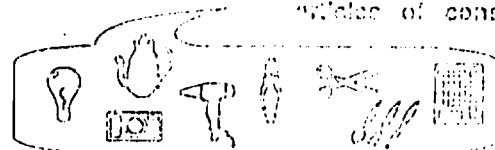
– Lebensmittel
food stuff



– Waschmittel
detergent



– Gebrauchsgüter
articles of consumption



Manz, Melnhof Karton

TKS / LAB



Manz, Melnhof Karton

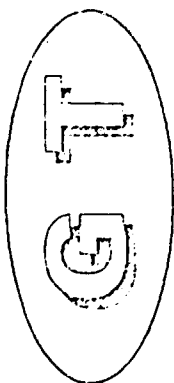
TKS / LAB



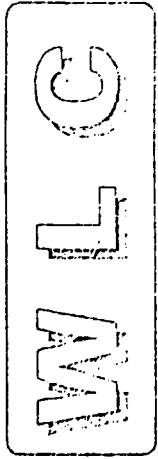
KARTONSORTEN
board grades

GT
WLC

K 4.0.0.



Gestrichener Triplexkarton
(coated triplex board)



White Lined Chipboard

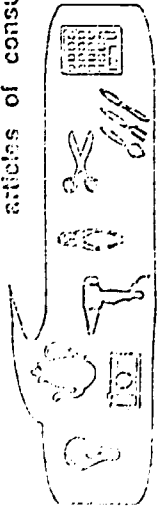


Lebensmittel
food stuff



Waschmittel
detergent

Gebrauchsgegenstände
articles of consumption



White Lined Chipboard

TKS / LAD



KARTONAUFBAU
board structure

GT
WLC

K 4.1.0.

Stich (coating)	25 gsm
Decklage (top layer)	45 gsm
Einlage (middle layer)	
Rückseite (reverse side)	45 gsm
Präparation (preparation)	5 gsm

grammatubedingt
(substances made)

Stich
coating

Kaolin, Karbonat, Titandioxid, Binder
caolin, carbonate, titanium, binder

Decke
top layer

50 % Zellstoff, 50% sortierte Altpapiere
50 % pulp, 50% sorted industrial waste

Einlage
middle layer

100 % chemische Altpapiere
100 % post consumer waste

Rückseite
reverse side

50% Holzschliff, 50 % sortierte Altpapiere
50% mechanical pulp, 50 % sorted industrial waste

Präparation
preparation

Kollatypische Binder
collatypic binder



White Lined Chipboard

TKS / LAB

RECOMMENDATION



of the

**GERMAN FEDERAL
HEALTH MINISTRY**

valid for

**PAPER
and
CARTONBOARD**

used for

**PACKAGING of FOODSTUFF
in
DIRECT CONTACT**

DIN 10955



SENSORY ANALYSIS

The **VALUATION** happens according to a 5 grade scale

- 0 = no perceptible difference in taint/odour
- 1 = just perceptible difference in taint/odour
- 2 = slight difference in taint/odour
- 3 = distinct difference in taint/odour
- 4 = strong difference in taint/odour

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XXXVI . RECOMMENDATION of the GERMAN HEALTH MINISTRY

- no DIFFERENCE in the REGLEMENTATION between WLC and PBB
- SELECTED FIBRE MATERIALS
- POSITIVE LISTED ADDITIVES
- LIMITS for CONTAMINENTS
- SEPERATION of WATER CIRCUITS in the STOCK PREPARATION
- WATER TREATMENT with PERONIDE
- DISPERGING of STOCK SUSPENSION
- HYGIENIC CONTROL by the own MICROBIOLOGICAL LAB
- controlled by INDEPENDENT INSTITUTS



DIN 10955

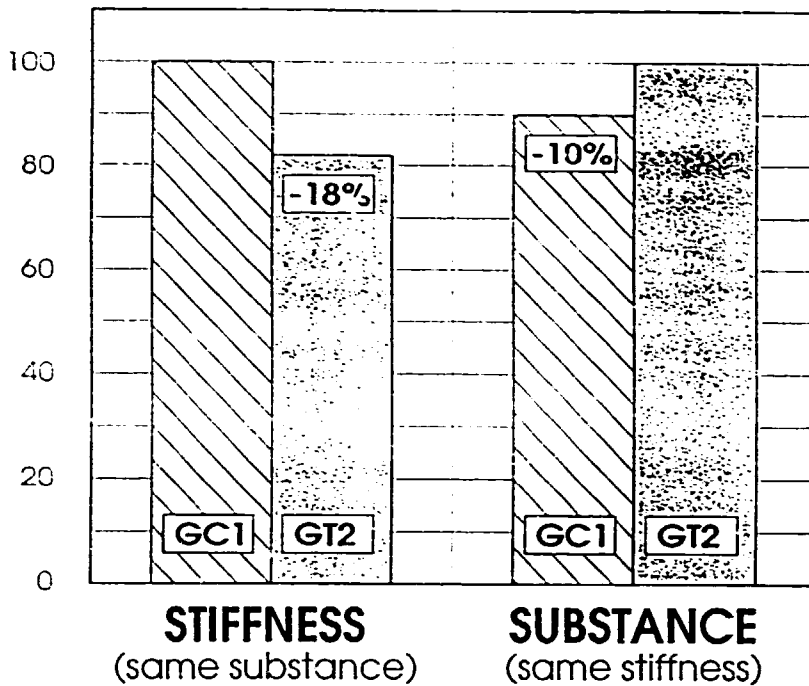
SENSORY ANALYSIS

Subjektive Impressions of mind like

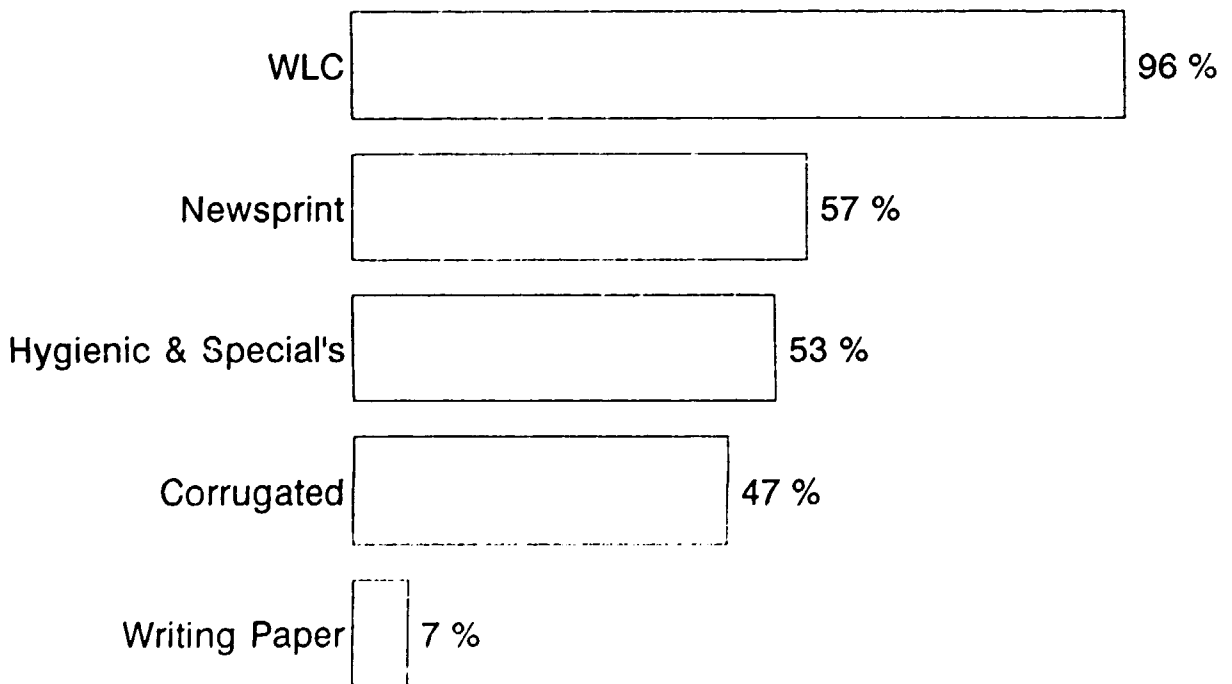
- RECEPTION
- RECOGNITION
- COMPARISON
- REMEMBERING
- DESCRIPTION
- VALUATION



comes under this method to an objektive statement

COMPARISON GC1 / GT2



Waste Paper Ratio in fibrous materials



	ALTPAPIERSORTEN waste paper grades	K 0.0.2.
	<p>UNTERE SORTEN / low qualities</p> <p>B 12 Sortiertes gemischtes Altpapier sorted mixed waste paper</p> <p>B 19 Kaufhausaltpapier I (min. 80 % WP) warehouse waste paper I (min. 80 % corrugate)</p> <p>B 42 Grau- und Mischpappen grey- and mixed card board</p> <p>D 31 Zeitungen und Illustrierte II (min. 60 % Zeitungen) newsprint and magazines II (min. 60 % newsprint)</p> <p>MITTLERE SORTEN / middle qualities</p> <p>E 11 Zeitungen gemischt (mit Illustrierten Beilagen) newsprint, mixed (with magazine inserts)</p> <p>H 12 Kartonagen (ohne Sorte B 42) folding boxes (without type B 42)</p> <p>BESSERE SORTEN / good qualities</p> <p>K 59 Endlosformulare, H'fr, weiß, rein frei von färbenden Selbstdurchschreibepapieren frei von Kohlepapieren endless forms, woodfree, white, sorted free of selfduplicating- and carbonpapers</p> <p>L 11 Hellbunte Späne, mehrfarbig lightcolourful trimmings, multicolor</p> <p>O 14 Holzhaltige weiße Späne mit leichtem oder hellem Druck wood containing white trimmings with slightly or lightcolour printings</p> <p>P 22 Zeitungsrotationsabrisse, sortenrein, weiß newsprint rotations offcuts, sorted, white</p> <p>Q 14 Weiße Späne mit leichtem oder hellem Druck, holzfrei white trimmings, with slightly or lightcolour printings, woodfree</p> <p>T 14 Chromoersatzkarton, mit leichtem oder hellem Druck imitation chromoboard, with slightly or lightcolour printings or unprinted</p> <p>KRAFTHALTIGE SORTEN / kraft containing qualities</p> <p>W 12 Sorten reines Kraftpapier, gebraucht, naturfarbig pure kraftpaper, used, naturalcoloured</p>	
	Mayr-Melnhof Karton	TKS 1/93

H. Traussnig (Mayr-Melnhof Karton, Austria)

Case-Study of MM-KARTON
(MM-mill Frohnleiten)

First of all I would like to tell you something a little about the MM-cartonboard group, then I will inform you about the Frohnleiten mill and the environmental impacts of this mill, the changes during time and so on.

With a capacity of more than 1 million tons cartonboard and approximately 2200 employees. MM-Karton is Europe's biggest producer of coated cartonboard and market leader in recycled cartonboard.

The philosophy of the whole group is to use all possible synergies in the various departments such as sales, purchasing, production and R & D as well as transport to meet the increasing quality requirements both now and in the future and at the same time keep production costs as low as possible. The central R & D department in Frohnleiten guarantees that all synergetic effects can be used in the whole group, but every factory also does her own specific R & D.

Starting with 50 000 tons in 1970, the capacity increased to 100 000 tons by installing a new machine at Frohnleiten in 1971 and reached 155 000 tons with the acquisition of Neupack, Austria in 1973. In 1984 an international expansion started with the purchase of FS-Karton in Germany (at Neuss and Baiersbronn) which brought the capacity to 420 000 tons. In 1990 KNP Vouwkarton, Netherlands, as well as Karton Deisswil, Switzerland, were bought. At the same time the construction of the new BM V at FS-Karton Neuss was finished and as a result the production reached 890 000 tons. In 1991 Colthrop Board Mill in England and in 1992 Laakmann Karton in Germany were taken over with the result that the Mayr-Melnhof group reached its current capacity of more than 1 mill tons per year. 90 % of this board are based on recycled fibres, 10 % from groundwood.

In addition to its cartonbaord activities, the Mayr-Melnhof group is also active in the waste paper and converting sector. The waste paper division collects and converts, with a staff of 750 people, about 1,4 million tons in Austria and Germany.

The main policy of acquisition was always to choose mills in strategically important locations to make sure maximum possible proximity to customers, to assure the best service possible, while at the same time produce constant quality at a high level. The building of BM V at Neuss was MM's commitment to the increasing demand for high quality recycled board. Today Mayr-Melnhof Karton offers a wide range from greyboard to high quality chromo board from 230 g/m² to 800 g/m² with special grades up to 2000 g/m² and beyond.

MM-Karton Frohnleiten was one of the first cartonboard mills which received the ISO 9002 certificate and in the meantime ISO 9001 and further mills have been registered. It is MM's aim to have all Mayr-Melnhof mills registered by the end of 1995.

One of the major emphasis is put on Research and Development. For special critical applications a variety of answers can be found such as the development of the high quality triplex cartonboard Topcolor produced from waste paper from the first cycle which can be used in direct contact with wet or greasy food. Companies such as McDonald's already count on this quality. In order to support these activities a microbiological laboratory was built in Frohnleiten where all grades from the whole group are regularly tested, e.g. a panel for taint and odour examination has been set up (Robinson test).

Another success of the R & D was the creation of a board made of recycled fibres which could be used for cigarette-boxes. This year Philip Morris will use this board for one brand. At the moment we are developing a waste-based liquid packaging board for liquid detergents. The first trials in practice are finished and we hope that we can start with little improvements this year in the market. We also force the development of a grease-resistant and vapour-resistant board without PE-laminating, that could be recycled without any rejects. First results do already show us that we follow the right path. First deliveries to the pet-food industry and to pack doughnuts were successful, though there are still something that need to be improved.

As a converter of more than 900 000 tons of waste paper per year the company is totally committed to environmental manufacturing. Special emphasis is also put on to effluent systems and boiler or power house emissions which are in all cases well within legal requirements, were often 10 times under the legal requirements.

MM-Karton regards environmental protection as a responsibility which provides a basis upon which to develop. Therefore we have also started to work on an environmental management audit system. We hope to install this system in Frohnleiten at the end of this or at the beginning of the next year. Like ISO all other mills will follow within some years.

Let me tell you more about Frohnleiten.

The first board machine which was owned by the Mayr-Melnhof group was installed in Frohnleiten, Styria in 1913. In 1950 the KM II board machine heralded the start of a new era in board production for Mayr-Melnhof and in 1971 the introduction of the board machine III was another highlight in the MM-history.

The Frohnleiten factory, the main plant in the MM-Karton group, is Europe's largest manufacturer of cartonboard and market leader in the recycled board sector.

The main share-holder, the Mayr-Melnhof family is one of the biggest owner of woodland in Austria. This fact does already explain their close affinity to nature. Although wood is a renewable resource, the forest stand in Europe is being greatly affected by environmental damage. Simply landfilling or incinerating packaging materials made from virgin fibres is not sufficient. Thanks to new technical developments in production and cleaning processes it is now possible to use recycled cartonboard for almost all applications. By using packaging made of recycled cartonboard an evergrowing number of leading companies are showing great concern for conserving resources and preserving the environment. Mayr-Melnhof has paid tribute to this development investing large sums of money in one of the most modern recycling technologies. It is obvious that the environment benefits from this expenditure: in Austria alone over 350.000 tons of waste paper and scrap cartonboard are used for the manufacture of recycled cartonboard each year - waste paper that would otherwise have ended up at the landfill site.

But now more facts. The factory in Frohnleiten was built in 1888 as a saw-mill including a ground wood mill and the production of core board. 1913 the first boardmachine started with a production of 6000 tons a year. Till 1950 this was the mill's constant production. The beginning of the dynamic growth of the Frohnleiten mill and the group was caused by the marshall-plan: in 1950 the production on the new board-machine II started (machine width 290 cm). The ERP-credit was twice the amount of the annual turnover in those days. The old board machine I (width 170 cm) which had survived the Great Depression of the thirties and the Second World War produced 17 tons net daily. This old machine was of course shut down some years ago. The new machine II started with 50 tons. At the same time the raw material

changed consequently from ground wood to waste paper. Then production was increased to 150 tons, to 200 tons and to more than 300 tons net per day (350 - 500 gsm) by a variety of technical improvements. At the same time the quality was improved continually, for instance by a Jagenberg coating equipment, by computerization etc.

In 1970 the next great achievement was the start of machine III (width 440 cm) with 200 tons/day, by several improvements the output was increased more than three times. Of course on this machine also is produced only coated white lined chipboard by means of the most modern technical equipments.

Though since that time no board machine was started in Frohnleiten, the mill is in the state of the art, due to optimisation and rebuilds. Today BM II is producing more than 300 tons a day and BM III more than 600 tons/day. Last year sometimes both machines together even produced more than 1000 tons/day.

BM II operates from 350 - 500 g/m² (mainly only up to 450 g/m²), the board consists of 10 layers produced by former vats. BM III operates from 230 - 350 g/m², the 9 layers are formed by two fourdriniers (top layer and back layer) and 7 former vats. (The new board machine in Neuss is a 4 fourdrinier machine).

The beginning of the coating was a pigmentation with an air knife in 1953. At the end of the sixties a metering bar coater was installed for a precoating. It was the first double coated board. At the beginning of the eighties some other companies started with bladecoaters. We in Frohnleiten started in 1985 and some qualities of board were produced with a triple coating. In 1975 we started to use a pigmentation of the backside in order to solve the problems of dust.

But now some more details about the environmental aspects of board production. Today authorities adapt the limits of emissions to the state of the arts and if you want to increase the production you will only get the allowance if the emissions are not higher than before. That is why you have to decrease your specific emissions every day. I will show you some examples and tell you, how this was done.

Between 1980 and 1990 320 million Austria Schillings were invested in environmental projects. Recently we invested more than 10 Million Austrian Schillings every year. This sum does not include operating costs.

- 1962: A mechanical water treatment plant was installed, so that most of the fibres could be used in the production again.
- 1970/71: A new power plant (60 to/d) which is able to use natural gas was started. SO₂ was reduced from 800 tons a year to 30 tons and dust from 150 tons to zero.
- 1985: The last oil operated part of the power plant was changed to gas operated run, so that SO₂ went to zero.
- 1987: A biological water treatment plant (aerob/anaerob) can clean the waste water with an efficiency of 95 %. The plant is covered to avoid smells in the neighbourhood.
- 1988: Installation of a gas turbine, waste heat-boiler and steam turbine attained an efficiency of 90 %, so that electric energy from outdoor could be saved.

1980 - 1990: We were also busy in optimization of the board machines. The heat-re-use and optimization of primary energy use decreases the specific power use dramatically.

1991: A biological exhaust air treatment plant to hinder the smell of H₂S was installed. Since this time we had no claims concerning bad smell in the surrounding area.

From 1989 to 1990 the amount of reject in relation to the used waste paper decreased 37 %. This was done by optimizing the stock preparation in view of a better yield of fibers and a better dewatering of the reject. Roughly the reject consists of:

32 %	plastic
8 %	textiles and so on
46 %	not useable papers
5 %	metals
5 %	wood
1 %	sand, glass, stones

The whole reject goes to a landfill. We are not allowed to burn it and to use the energy. The sludge from the water treatment plant also goes to a landfill.

Our other mill in Austria which is located at Hirschwang is allowed to deposit their sludge of the water purification plant at their own landfill if they mix the sludge with lime to inert the sludge.

All other wastes like oil and greasy cleaning rags are collected and burnt in a plant at Vienna.

Emissions to the air are minimized by the cooling of the exhaust air and using the condensed water in the production process. So no organic emissions, except a little amount of organic acids, are leaving the factory. The air, about 600 000 m³/h (like a cubic with a length of 85 m) is mainly dry air (540 000 m³/h). 50 000 m³/h are water vapour and about 8 000 m³/h CO₂ and 0,35 m³/h CO. That means that 1,3 vol % CO₂ and 0,00005 vol % CO in the exhaust air of the mill. (For comparison cars 15 vol % CO₂, smoke of cigarettes 9,5 % CO₂ and 4,2 vol % of CO).

The emissions to the river are minimized by our biological water treatment plant. Water from the board machines is settled in two sedimentation tanks. The fibres are used for production in the middle layer again. Every board machine has to take back its own fibres. The mechanically cleared water passes a sand filter under pressure and is treated with hydrogen peroxide and peracetic acid before it is reused by the machines. The little amount, that is not used by the machines is leaving the mill after the biological water treatment plant. After phosphoric acid and urea is added as nutrient (the water from the offices and the washrooms is treated in the communal water treatment plant of the community of Frohnleiten) the water passes two anaerobic treatment plants in parallel connection and afterwards two aerobic plants, also in parallel connection. A little amount of the waste water goes directly to the aerobic plant so that enough nutrients come to this part of the plant. At last a sand filter will collect possible solids. So the plant works with an efficiency of about 94 % degradation of COD and more than 99 % degradation of BOD. About 5000 m³/day of the biologically treated water leave the mill. The river has a water flow of 60 - 95 m³/sec, so that the mill does not influence the quality of the river.

Before showing you some comparisons of specific figures I would like to give you some ideas concerning the future of the mill. The increase of recycling, fillers and ash in paper makes it necessary to react. As we don't want to higher the grammage of the board to get stiffness, we have considered a washing step (ash removal) or to add more groundwood. For political reasons we are not allowed to burn our wastes, therefore the ash has to taken to a landfill (brigg-factories as well as the cement industry do not want to use the ash, because they are frightened to encounter resistance in the neighbourhood). So we have decided to build up a little groundwood mill. By doing this we will be able to use more grades of waste paper and by mixing with about 10 % of groundwood pulp we reach the necessary stiffness without raising the grammage.

Another idea is to install a compressor which works with the energy of the gas pressure reduction. The natural gas with a pressure of 44 bar from the net is reduced to 3,4 bar for the use in the power plant. Attached to it an energy of 350 kW can be used and some compressors which are working with outdoor electric energy could be saved.

Nowadays much work and discussion is done in ecobilances. I will give you a short survey of some specific dates as maxima, minima, weighted averages of 14 mills and the position of the Frohnleiten mill and then I will show you a comparison of different qualities of board made by BUWAL in Switzerland. But this last figures are only typical for production, they don't consider packaging units, they don't consider that all fibre packaging could be used again and they don't make an allocation of the loads due to the possibility to use fibres several times. There is no agreement how to do such an allocation.

Unfortunately I could not tell you everything I wanted to tell you. But I hope that my short report covered the major figures. I am looking forward to answering all other questions in the discussion.

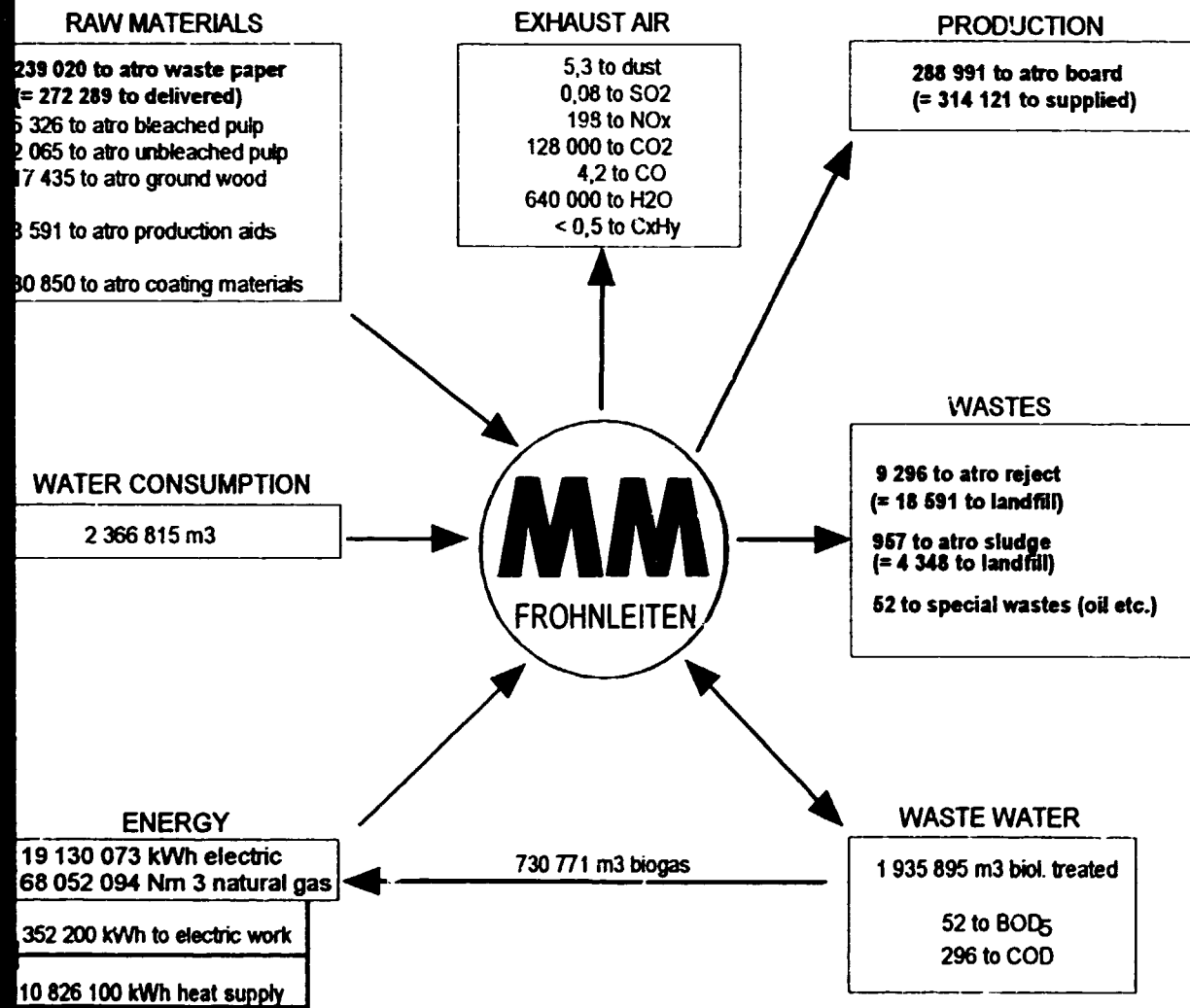


Fig. 1

DEVELOPMENT



of SO₂ - Emission

to SO₂/a

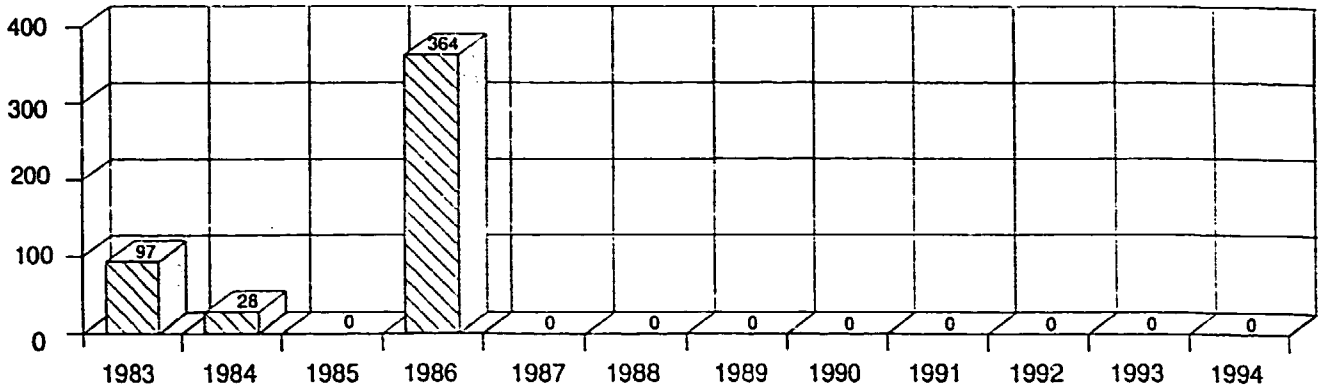


Fig. 2

DEPOSIT - DISCHARGE



according to the use of WASTE PAPER

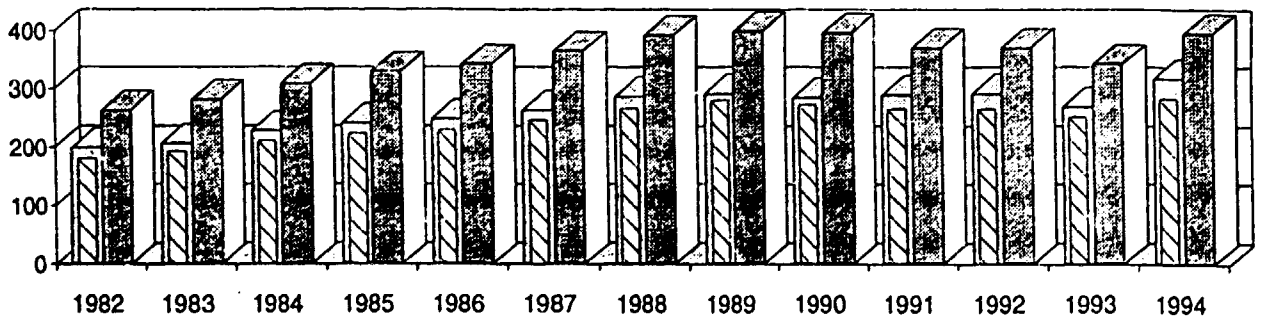
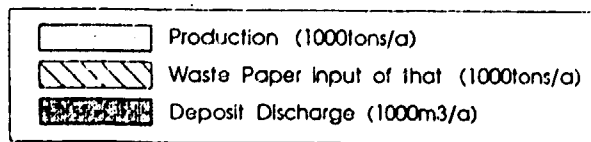


Fig. 3



DEVELOPMENT of



specific Steam and Energy Consumption

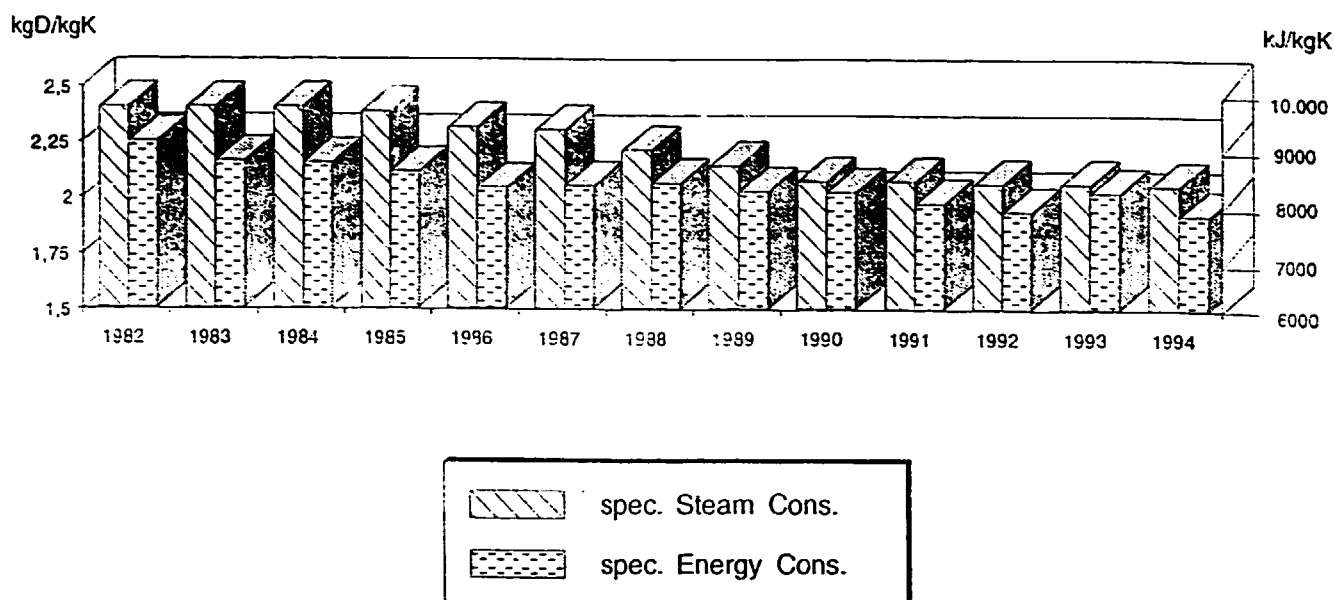


Fig. 4

BOARD MILL Frohnleiten



Development of specific Energy-Consumption

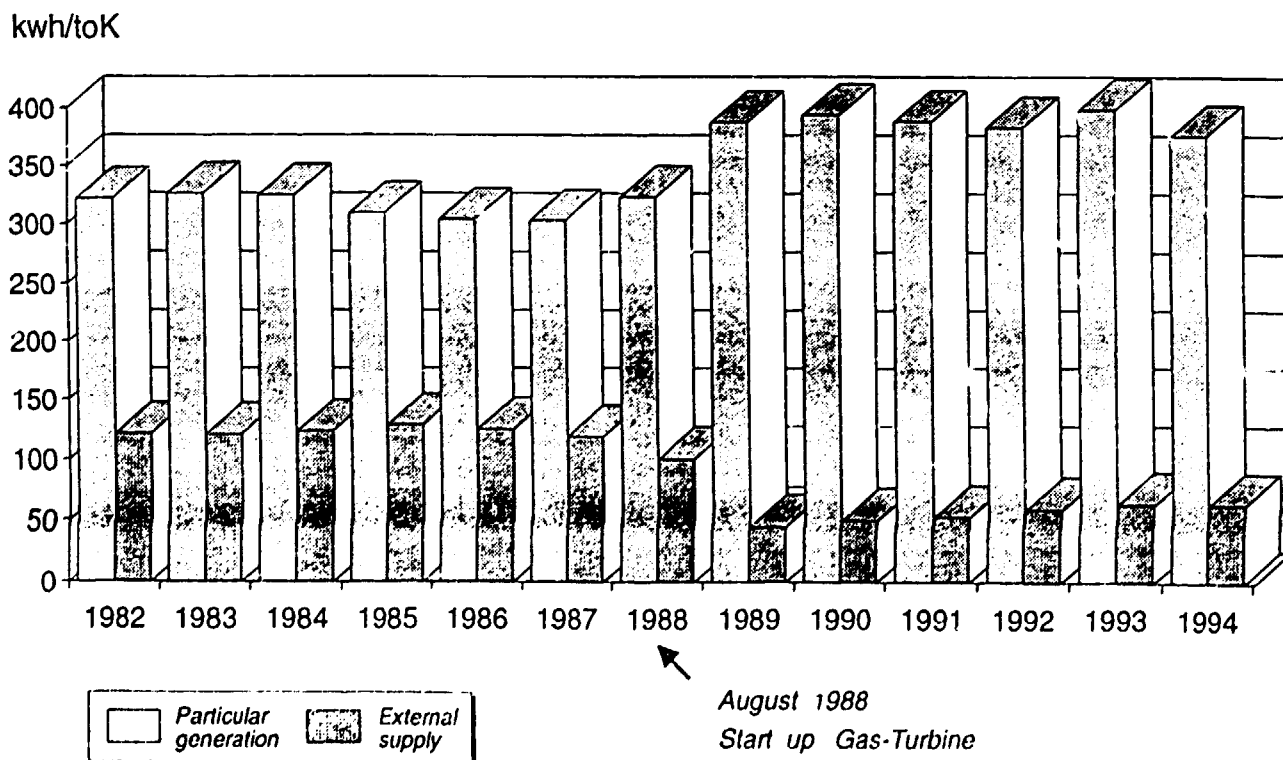


Fig. 5

DAILY RATES of BOD₅ and COD

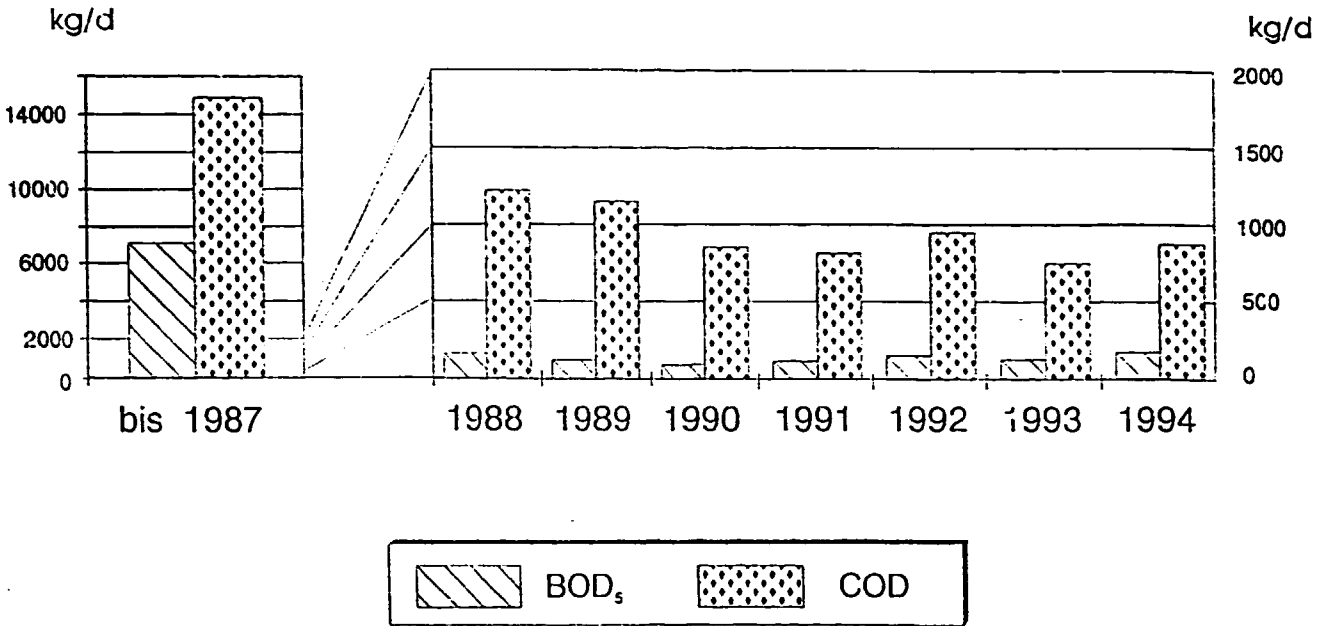


Fig. 6

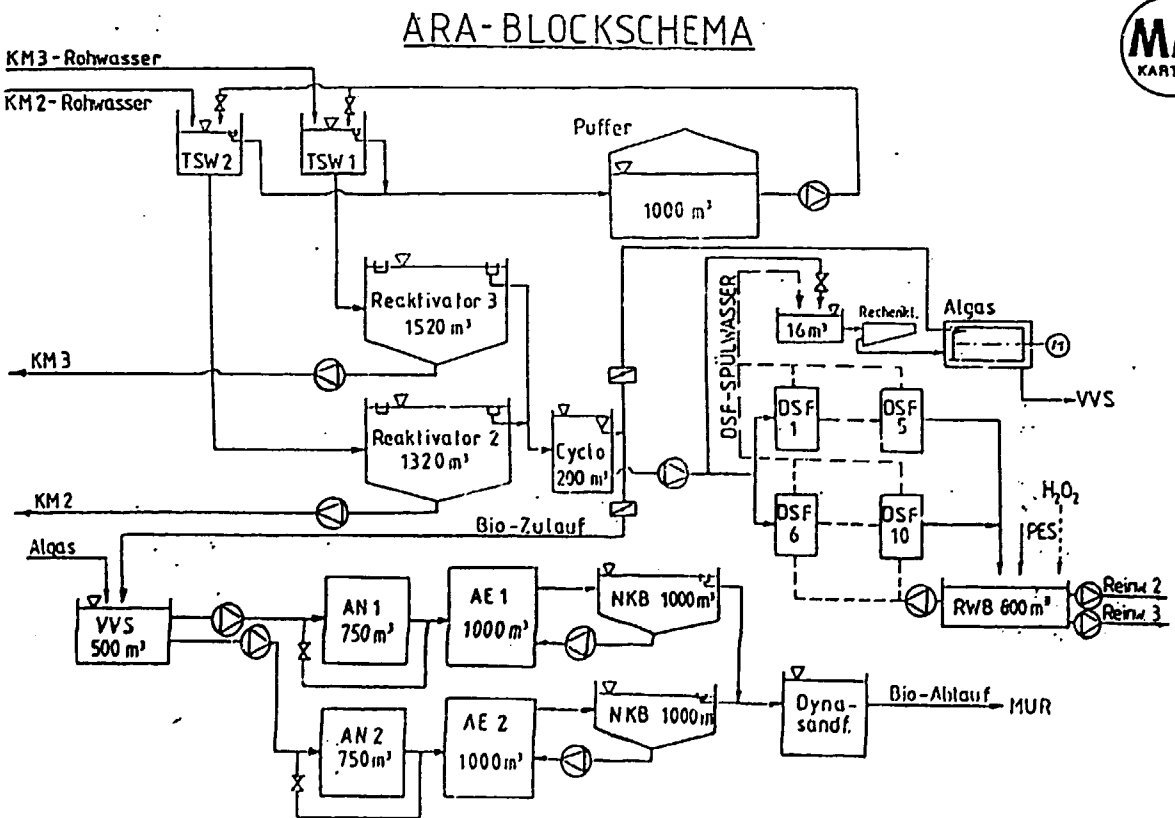
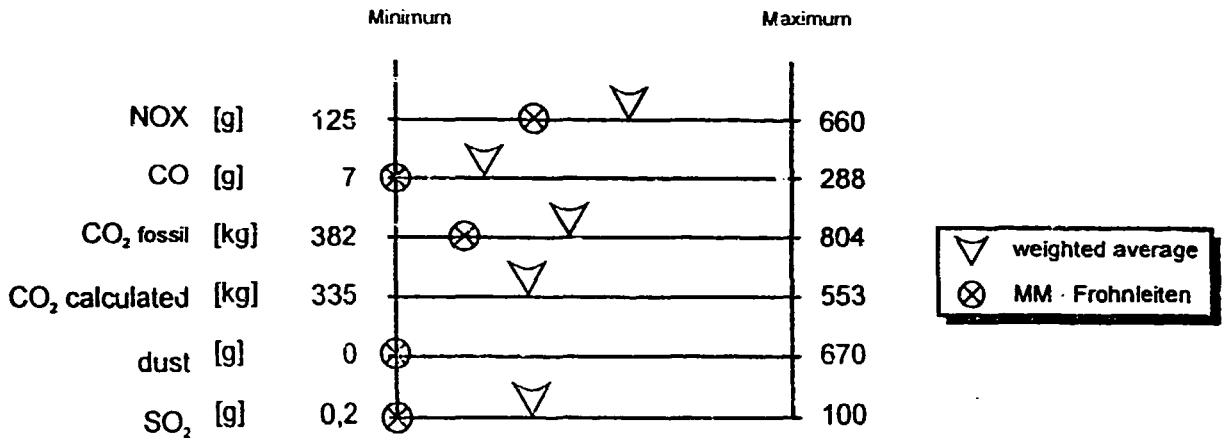


Fig. 7

Emission figures in the board industry



figures per 1 ton of board

Waste water in the board industry

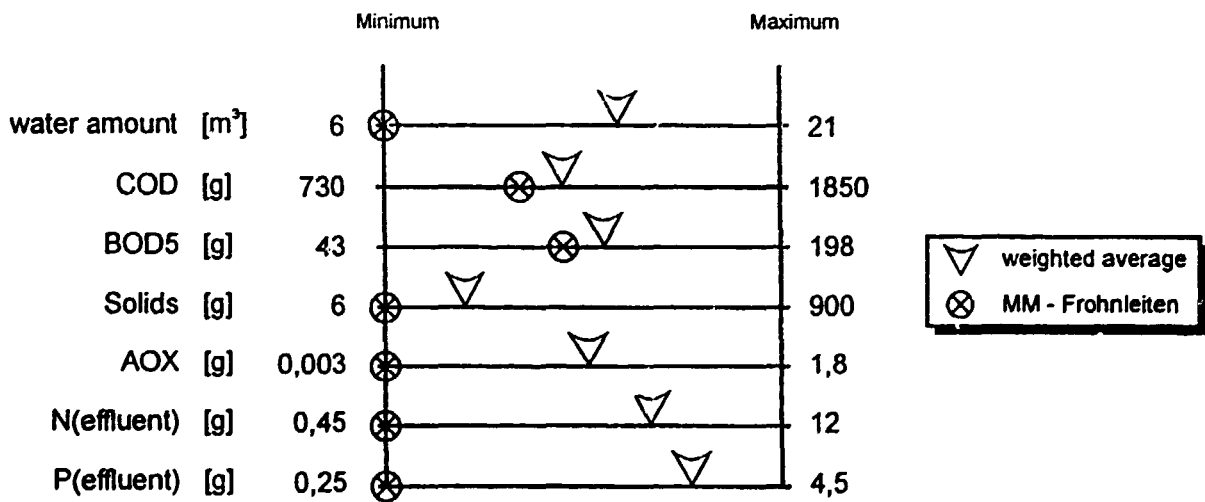


Fig. 8

figures per 1 ton of board

I. HAMPEL (KNP LEYKAM)

Use of Secondary Fibres in Publication Paper Mill - KNP LEYKAM - Bruck (Austria).

INTRODUCTION

Before I start my report on the specific case of an Austrian papermill it may be allowed to recall that recycling in context with papermaking is an old idea. It is a fact that the initial motivation for the invention of papermaking by the Chinese 2000 years ago was recycling of silk textiles.

Even deinking of paper is not really new.

About 200 years ago, when textil rags as only raw material source for papermaking became scarce alkaline treatment of wastepaper prior to a washing process was known and practiced in Germany, UK and France.

My presentation will show how the use of secondary fibres for publication papergrades has developed in the Bruck mill of KNP LEYKAM over a period of about 20 years.

It is not intended to give a plane historical review. I shall try to line out the most relevant experiences we have had in order to direct your attention toward the more important issues of waste paper processing.

The Bruck mill is one of five mills of KNP LEYKAM, a company which has been established in 1994 as a merger of the Dutch-Belgium KNP and the Austrian Leykam-Mürztaler. In Europe KNP LEYKAM is marketleader in WFC grades and a medium sized supplier in the publication papermarket and belongs to the KNP BT Group.

key figures

total sales of	1,7 Bio\$
production	1,6 Mio to/y
employees	6.000

The Bruck mill had from the seventies till 1989 a production capacity of 100.000 to/y of newsprint. As single machine operation this mill always had to bear a pronounced cost pressure. This led to the use of secondary fibres in the early seventies.

The use of waste paper always was considered as an economic move with the product quality target as fully competitive quality specification. Even later when recycling papers became fashionable we always withstood the temptation of so called "eco marketing". And as the ecologic issues develop now our initial policy proves to stay sustainable.

Fig. 2

The furnish of the newsprint machine clearly reflects the developments till today. With regard to this graph I'll explain how wastepaper processing technology including the deinking process advanced over the years for newsprint focussing on the initial rather simple process and a major development period between 1982 till 84.

In 1989 a LWC-machine was installed which added another 200.000 to/y capacity for a total of over 300.000 to/y now.

Since 1993 Deinked Pulp (DIP) is used in the LWC furnish following the same policy as with newsprint. This latest development will be a part of my paper as well.

I shall finish my paper with a brief presentation of a rather complex program covering improvements of product quality, costs and environmental issues at same time.

Due to the limitations of our time I will only comment in principle findings. Further details may be discussed in the panel discussion or in individual talks.

II. THE DEINKING PROCESS

Almost all deinking operations in Europe and Japan use the flotation process. On a global scale about 1/3 of the capacity uses the washing process. Therefore a brief comparison between these two technologies should be given.

A) The flotation process

uses the hydrophilic properties of fibrous material and the hydrophobic properties of inks as phenomenon of different wettability in order to separate the inkparticles by using a physical-chemical process in a very selective way.

B) The washing process

is basically a physical washing step to remove the inkparticles from the stock.

C) In comparison

the flotation results in 10 – 15 % a higher yield of accepted stock and consequently less residuals and wastewater discharge, while the washing deinkprocess produces a stronger pulp due to less fines and requires less investment in equipment as well lower chemical cost. Environmentally the washing needs more attention.

III. THE FLOTATION DEINKING TECHNOLOGY

The flotation deinking concept is based on an US-Patent from the thirties, but as it was developed for production scale in the fifties by Müller-Ried and Ortnier. In its basic features it is still in use today.

The first deinking line in the Bruck mill was installed in 1973 by Voith for a capacity of 50 to/day.

The complete process consisted of five process steps:

- A pulping
 - B prescreening
 - C flotation
 - D fine screening
 - E post treatment
- Fig. 3

At the beginning a blend of 50 : 50 of newspaper and magazines was supplied.

With increasing ratios of household collection versus supplies from trades firms problems in the process aggravated because of a wide variety of impurities in the wastepaper: adhesives, coatings, varnishes, hot melts but as well dirt, textiles and book binding material. Further on more and more coated and offsetprinted wastepaper was supplied.

The adhesives, thermoplastic and related components became by interactions and agglomerations the nightmare of all wastepaper users called "stickies". In addition the fast growing offsetprinting process which replaced the letter press printing resulted in problems of insufficient loosening of the inkparticels from the fibers due to stronger inkbinders in offset in particular if a certain aging had happened.

Gradually control on the process could be restored by developing improvements for the single process steps as eg. multistage flotation, multistage screening with holes and slots, modification of chemicals and of their applications etc.

In course of these improvements the capacity grew continuously to about 120 to/day allowing 40 % of DIP in the furnish.

In 1984 a major rebuild took place aiming at an almost doubling of capacity to 220 to/day, but also incorporating other latest technical developments.

..... **Fig.4**

As mentioned before I shall refer to this program at the end of my paper. I now proceed on the single steps of the deinking process technology.

A) Pulping

The initial step determines largely the efficiency of the total process.

Three operations take place side by side:

- mechanical fiberizing of the wastepaper
- chemical loosening of the ink from fibers
- splitting off the inkparticles from fibers by a swelling of fibers in alkaline surrounding.

For these actions the most important process parameters are:

1. temperature
2. consistency
3. chemical formulation
4. reaction time
5. ph level

1. Temperature:

a compromise at 40° C balances required level for support of the chemical reaction and minimizing the temperature to prevent desintegration of thermoplastics for better screening operations and less sticky troubles in all consecutive stages.

2. Consistency:

the low consistencies of 5 – 7 % in the early days have been raised to 12 – 15 % in MC-Pulpers and using nowadays preferably drum pulpers at consistencies of about 18 %. Main objectives are again support of chemical reaction and avoid desintegration of plastics.

3. Chemical formulations:

this is in each case a very specific and individual issue depending on wastepaper quality, equipment and deink quality targets. Therefore only limited general remarks can be given.

For purpose	needed/used	chemicals
saponification		NaOH peroxide
peroxide stabilizer		silicates organic compounds
prevent catalytic decomposition of peroxides		chelating agents
collecting of ink and hydrophobic impurities		soaps, fatty acids surfactants

As an example of our Bruck mill we have varied the ratio of NaOH and silicates.

Low dosage of NaOH and higher for silicate resulted in high DIP-brightness. But, silicates had adverse impact on PM-retention and significant build up of deposits and scales all over the PM-system. This led to partly replacement of silicates by organic stabilizers with the additional benefit of reducing lime deposits in screens, flotation cells etc.

It is of major importance where the chemicals are added into the process. Not all of the chemicals resp. their full dosages have to be added necessary into the pulper.

4. Reactiontime:

depending on consistency level in the pulper different reaction time is needed

low consistency	20 – 25 min
medium consistency	10 – 15 min
drums	15 – 20 min.

If no HC-reaction tower is available a reaction time of 1 – 2 hours in swelling bins after pulping is required.

5. pH-Level:

Up till now a level of pH 10 – 11 has been maintained at the beginning of the pulping process, but recently neutral deinking at pH 7 is an alternative.

B) Prescreening

In order to remove all potential sticking material as soon as possible and to prevent desintegration as much as possible the very first screening should take place immediately after pulping before the stock enters HC-towers or swelling bins. Even if this first screening is a very coarse one by secondary pulper or in the drum itself it is one of the most effective steps in preventing various troubles along the on going process.

After the swelling stage another screening has to be done usually by a combination of hydrocyclones and pressurized screens or the latter equipped with hole and slotted plates.

C) Flotation

After diluting the stock to 0,8 – 1,4 % in order to provide appropriate flotation conditions the stock enters the flotation cells. These are nowadays different types of closed design without agitators and paddles for removing accumulated froth from surface, instead using suction type or plain overflow for this function.

There can no general preference be given to any of the numerous different makes. A ten point brightness increase should be achieved and usually is reached.

Flotation parameters of relevant importance are to be controlled:

- hardness of processwater
- inkparticle size (should be smaller than 160 μm)
- velocity and flow conditions of suspension
- rate of air flow and size of air bubbles.

A flotation operation usually is designed as 2 stage flotation. Advanced deinking lines contain for better selectivity two flotation operations in course of the total process.

In the Bruck mill all slurries from froth discharge of second stage cells are collected, dewatered in twin wire presses and incinerated for energy generation in a fluidized bed boiler.

D) Fine screening

As final process step for obtaining a maximum clean deinkpulp a highly effective screening for removal of even smallest impurities is essential. After applying various systems combining pressurized screens with holes and slots, as well with degasification cleaners, today in most cases pressurized screen with slots of 0,2 mm and even less proved to be most efficient.

For the overall results in pulp quality of an entire deinking line this last process step is of comparable importance as pulping as the first step.

E) Post treatment

In this step modifications on the ready to use stock for specific purposes are applied.

Eg. High consistency homogenizing disperses residual inkparticles below limit of perceptibility leading to a cleaner looking sheet.

De-ashing: for sanitary grades or ashcontrol in printing grades.

F) Operating Data

With references to a wastepaper blend of average 50 : 50 between newsprint and magazines this is nowadays quite different as compared to 20 years ago since newsprint today shows substantial contents of secondary fibers and magazines have significant higher ash content due to much heavier coating weights.

Some key figures of Bruck mill should indicated the present status:

DIP yield (as calculated from o. o. finished stock on air dry wastepaper input)	76% otro/otro
Fiber yield (at 15 % ash in DIP)	65%

Consumption figures/to od DIP	(1994)
power	< 300 kwh
steam	80 MJ
water	4,5 m ³
chemical costs	300 AS

G) Quality Data of DIP

Fig. 5a shows actual datas on pulp properties compared to pressurized groundwood which is the second component in the fiber furnish.

H) Summary over DIP for Newsprint

As final statement some key words should recall core issues:

- wastepaper furnish largely determines deinked pulp quality achievable
- pulping at high consistency preferred
- maximum elimination of contaminants in particular those with sticking potential is essential
- flotation process as selective as possible with regard to wastepaper supply, available equipment and DIP quality targets
- maximum efficiency for fine screening essential
- post treatment according individual requirements.

IV. DIP FOR COATED GRADES

As mentioned already in 1989 a second papermachine in the Bruck mill for initially 135.000, finally 200.000 to/y LWC went in operation.

On PM 3 meanwhile the DIP content of the newsprint furnish had reached about 80 %, sometimes even more.

In order to make full use of all know how available inhouse on secondary fiber processing a strategic move with two key targets was decided:

- another increase of DIP content in Newsprint (up till 100 %)
- development of a DIP quality applicable for mechanical coated grades, namely LWC.

Since the second target was globally unprecedented a R&D project with title "DIP 75" was initiated, by the title indicating a brightness target level of ISO 75.

A) Development project "DIP 75"

It was evident from the beginning that additional process steps had to be considered as:

- double flotation
- high temperature homogenizing
- 2 stage bleaching (oxidized and reduced)
- de-ashing
- additional pulpwashing and whitewater cleaning.

But also the process design as a whole needed in depth studies in order to define an optimized solution.

Fig. 6

Several possible process patterns were investigated, in fact alternatives B and C are based largely on the existing plant configuration as working hypothesis for a rebuild.

Alternative A was called the Japanese, because there HC-stage is used immediately after pulping. But, experimental trials simulating this configuration even with Japanese wastepaper didn't show any benefits in DIP quality.

After two years of development work alternative D turned out as technically the best solution. A rebuild of the existing plant didn't prove to be economic, therefore basically erection of a new line was chosen and decided.

But, since investment costs were considered to high a slightly reduced version was approved for realization.

B) Investmentproject "DIP 75"

Main features which were incorporated in realization of Project DIP 75:

1. Pulping by a drum pulper
2. Screening: each operation applied only once :
 - HC-cyclones after drum
 - pressurized screens with hole and slots each in a 3 stage configuration before flotation
 - as only fine screening 4 stage heavy reject- and 3 stage lightrejectcleaners after flotation
3. Limited de-ashing via prethickeners
4. Flotation: double flotation appeared to be indispensable. At a moderate gain of brightness, dot count and sticky content improved considerably
5. Whitewater clarification allows extensive reuse of effluent and by this tightening "white water cycle"
6. Postrefining: as compensation for strength reduction because of loss of fines in the washing stages regaining of strength properties and scattering coefficient is achieved.

According to our proved practice in the past the machinery was not purchased from one supplier as a turnkey order. Instead, every process step was chosen from respective best supplier in this field.

After a construction- and erection time of 10 months the start up was in August 1993 - some weeks before target.

Only one month after start up the DIP from the new line could be added to the LWC furnish and about 3 months later the pulp was stabilized in its quality properties to an extent that 25 % of fiberfurnish was run on DIP 75.

The brightness level of ISO 75 could clearly be achieved, maximum limits for dots and stickies were maintained and as a final overall result all quality standards did not deviate from virgin fiber products. This matches our policy that recycling product must fulfill regular market quality standards.

For specific markets the new DIP is also used in a smaller percentage in WFC grades without any adverse effect on the visual appearance of the product and on the efficiency of papermachine operations.

V. A MORE COMPREHENSIVE CASE

In my final part of the paper I return to PM 3 of Bruck mill to give you an overall view of the total program carried out from 1982 – 84, because it may demonstrate that simply, only punctual target do not produce always the effect desired as it is quite often the case on environmental issues.

By persueing only one single target it sometimes happened that solving the problem was indeed only a shifting to another sphere. E. g. from power plants: when SO₂ in fluegas from boilers was cleaned by lime additives in the gas scrubber the residual sludge with Calcium sulfite became the new problem as consequence of cleaning the fluegas.

We think the approach to 3 interlinked targets gives evidence that elsewhere a wide as possible span of considerations has to be taken.

The story started in 1982 when fairly at the same time a bundle of three new requirements out from different sources afforded to find an overall solution:

- Introduction of multicolour offsetprinting for newspaper announced by the largest newspaper printshop required improved printability and runability (product quality!)
- A former domestic competitor announced to return to the newsprint business with a new papermachine. This required to improve our costposition significantly (product costs and quality!)
- Limitations in potential landfill facilities forced to reduce residuals (environment!)

These demanding requirements were fulfilled by a rather complex pattern of interactive measures and was realized by an investment program of about AS 450 Mio.:

Quality:

- Stoneground wood (Roberts Grinders) replaced by Pressurized Groundwood:
resulting in improved
 - strength of pulp
 - internal bond
 - scattering coefficient

- Topformer
 - prevent linting
 - more even web forming

- Costs:**
- reduction:
 - DIP increased to 60 % by rebuild of deinked line
 - reduced chemical pulp furnish to 3 %
 - energy from biogenic residuals via installation of a fluidized bed boiler

 - increase: Topformer reduced PM-efficiency by 2 – 3 % (stickies)

Environment: reduce landfill by 2/3: via fluidized bed boiler (emissions significant below legal limits).

Results:

- Quality:**
- washing intervals on multicolour offset press raised from below 60.000 copies to 100 – 120.000 copies
 - print quality improved by more dense and even sheet forming
 - runability improved: satisfactory for highspeed presses with extreme long draws (up till 48 m) between printing units

- Costs:**
- raw material cost reduced by 20 % and
 - due to better marketposition in product quality pay back of capital investments less than 4 years

Environment:

- reduction of landfill quantities by 2/3
- professional handling of all applications for legal permits led to gain of public reputation as ecologically responsible enterprise.

I hope this last case could make understood the benefits of an overall approach for tackling targets as specified above.

The KNP LEYKAM Group

DIMENSIONS

Sales volume	NLG 2.6 billion
Employees	6.000
Paper production	1,5 M t/a
Market share WFC	15%
Market share MC	9%

Western European Market

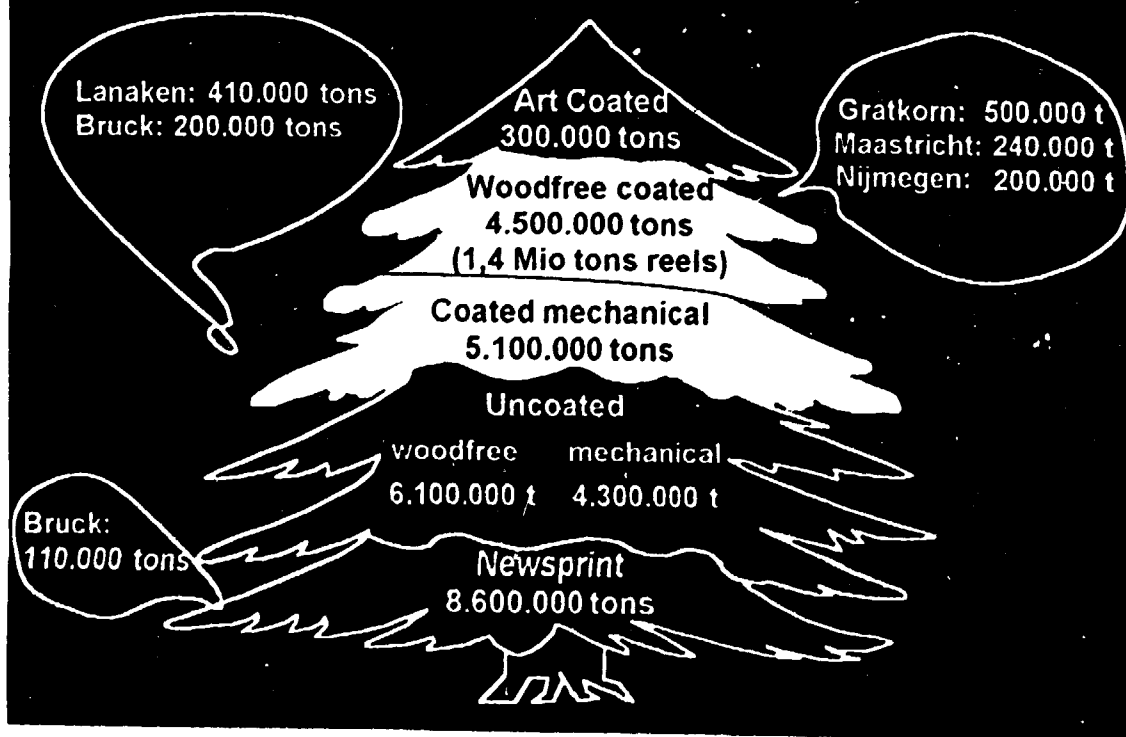
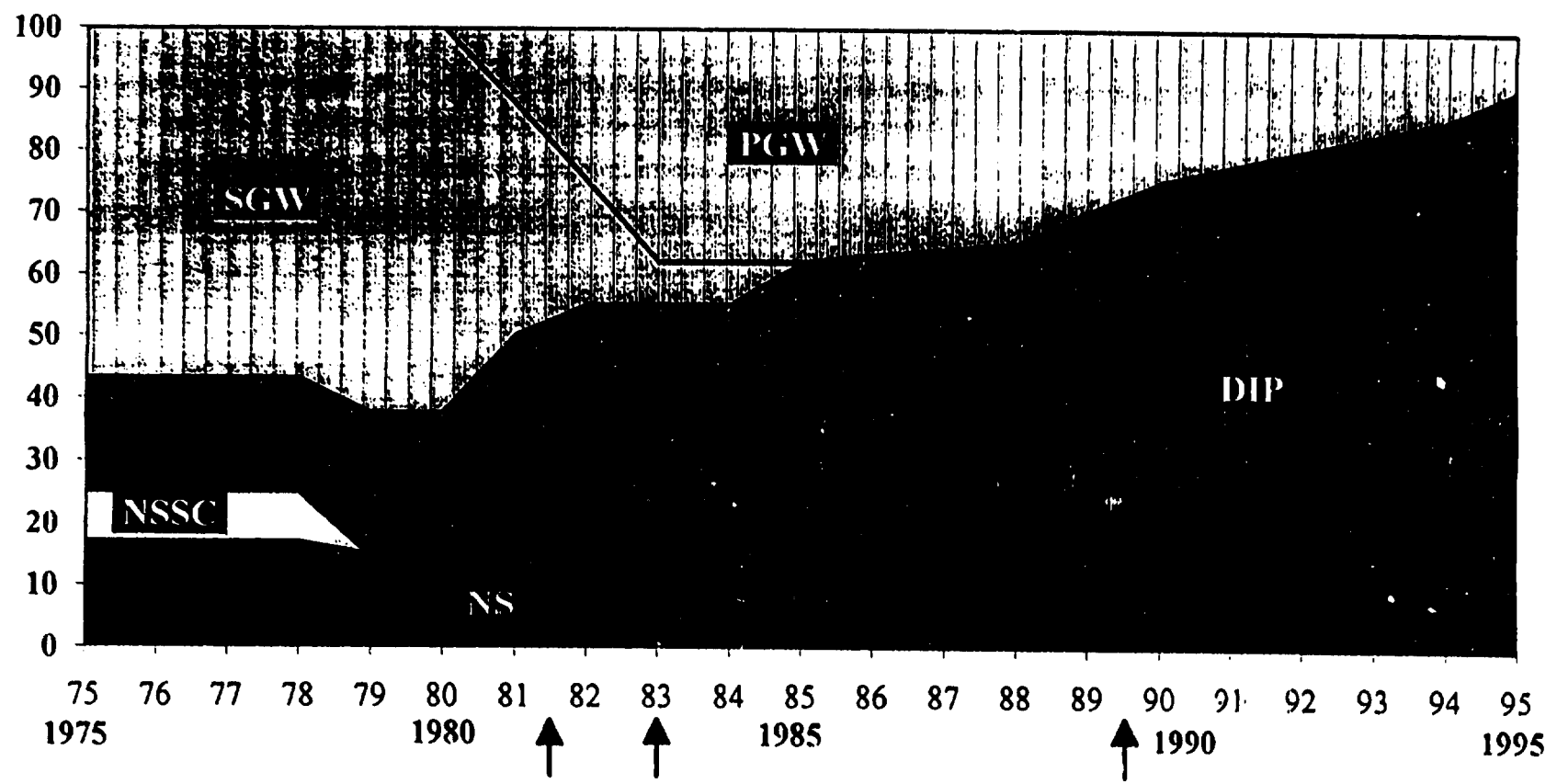


Fig. 1

FIG. 2

229
% Furnish



1. Water for repulper
2. Chemicals
3. Sorted waste paper
4. Repulper
5. Swelling chest
6. Vibrating screen
7. Landfill
8. Chest
9. Hyarocyclon
10. Contrifiner 2m holes
11. Dilution water tank
12. Sandtrap
13. Flotation cells
14. Vertical screen holes 2m slots 0.5
15. Black stock
16. Accepted stock
17. Thickener
18. Amidification
19. Chest
20. Recycled water tank
21. Paper machine

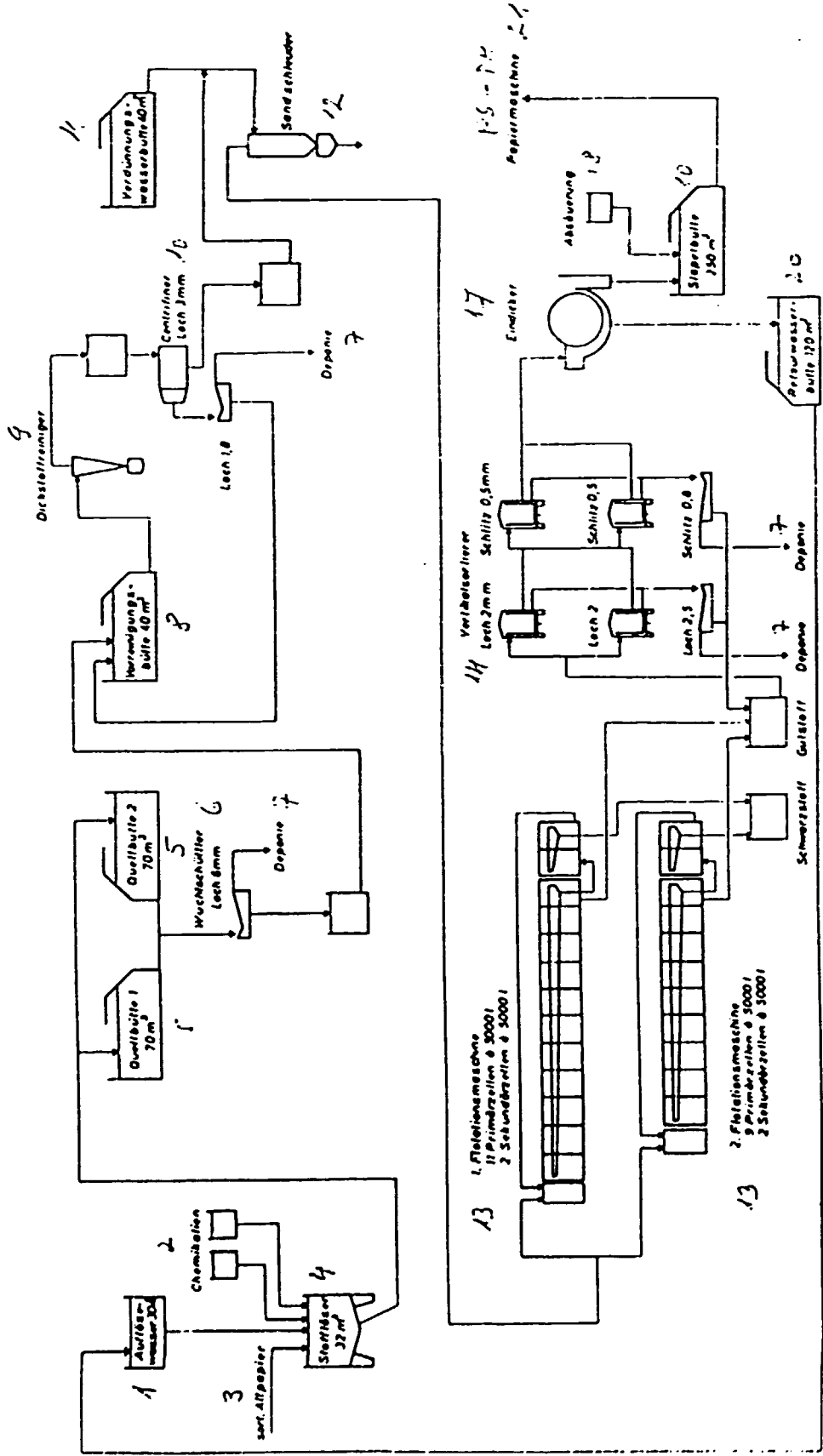
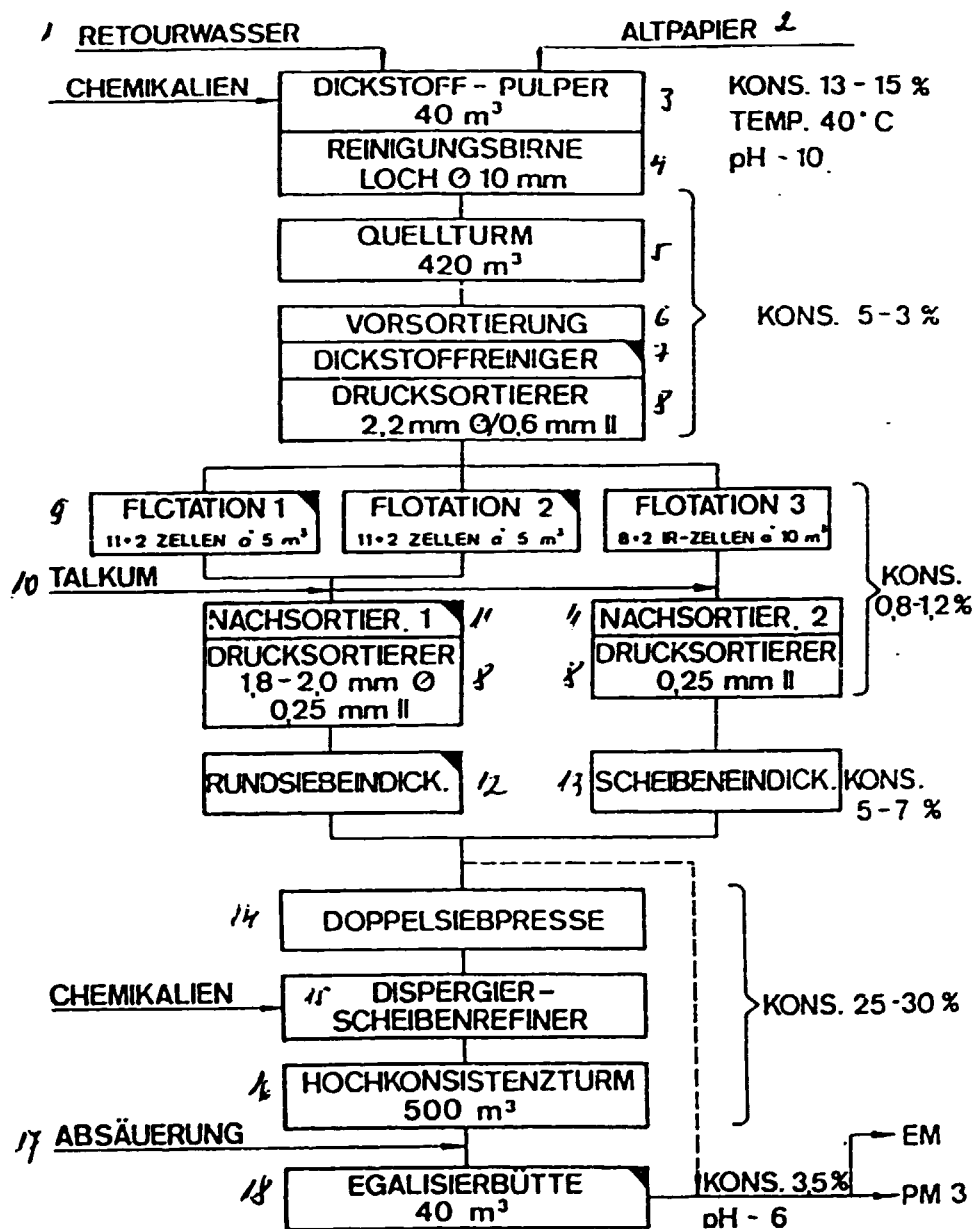


Fig. 3



- | | |
|--------------------------|-----------------------------|
| 1. Recycled water | 10. Talc |
| 2. Waste water | 11. Post - screening |
| 3. HC chest | 12. Drum thickener |
| 4. Screening holes 10 mm | 13. Disk - thickener |
| 5. Swelling chest | 14. Double wire press |
| 6. Pre - screening | 15. Disperging disc refiner |
| 7. HC screen | 16. HC tower |
| 8. Pressure screen | 17. Acidification |
| 9. Flotation cells | 18. Egalization chest |

Fig. 4

1. Fiberizing/prescreening
2. HS stage - Reaction tower
3. Flotation 1
4. Fine screening
5. MC - HC dewatering
6. Hot dispersing - brightening
7. Latency treatment
8. Flotation 2
9. Deashing wash
10. MC dewatering
11. HC dewatering
12. Oxidation brightening
13. Back water cleaning 1
14. Back water cleaning 2
15. Waste water treatment

	A	B	C	D	Realisierung
1 Auflösung / Grob- und Vorsortierung					
2 HC-Stufe + Reaktionsturm					
3 Flotation 1					
4 Feinsortierung					
5 Entaschungswäsche					
6 MC-HC-Eindickung Heißdispersierbleiche Latenzbehandlung					
7 Flotation 2					
8 Entaschungswäsche					
9 MC-Eindickung					
10 HC-Eindickung					
11 Oxidative Bleiche					
12 Reduktive Bleiche					
13 Rückwasserreinigung 1					
14 Rückwasserreinigung 2					
15 Abwasserreinigung					

J. Fellegi (Private Consultant)

Š. Boháček, M. Vrška (Pulp and Paper Research Institute)

V. Uličný, J. Šavrnok (North Slovakian Pulp and Paper Mills)

**NORTH SLOVAKIAN PULP AND PAPER MILLS RUŽOMBEROK:
AN EXAMPLE OF CONSECUTIVE HARMONIZATION OF
INDUSTRY WITH ENVIRONMENT**

Introduction

The pulp and paper industry in the town Ružomberok has a long tradition. Two industrial - scale pulp and paper mills are in operation from the end of 19th century and beginning of 20th century respectively on the eastern outskirts of the town, (called SUPRA) upstreams of the river Váh and the southern outskirts (called SOLO) on the small river Revúca joining the river Váh in the town of Ružomberok. The capacity of the two Ca - bisulphite pulp mills in 1970 was 80 000 t of pulp per annum. This resulted in a disastrous pollution of the river Váh, as the spent liquors were drained without incineration. In 1979 the biological oxygen demand of the river Váh 15 km downstreams from Ružomberok (min. flow $Q = 10.2 \text{ m}^3/\text{s}$) was 24 - 25 mg/l. This situation was dramatically improved by closing the two Ca - bisulphite mills and starting up a new kraft pulp mill in 1981. (Fig.1)

The new kraft pulp mill is situated on the eastern outskirts of the town upstreams of the river Váh closed to the previous SUPRA mill. In this area the broad Liptov basin is reduced to a narrow valley, surrounded by mountains. Closed to the mill is the hill Mních (696 m above sea level). This makes dispersion of air emissions difficult.

The new kraft pulp mill was designed on a turn - key basis by SIMONS - OVERSEAS Canada. The capacity of the unbleached pulp production is 200 000 BDMT/a. The main part is bleached except about 20 000 BDMT/a of softwood pulp.

In 1991 a new, 100 000 ADMT/a writing and printing paper machine PM 8 (VOITH DUOFORMER) has been installed. The total capacity of the other, partly very old paper machines in the

two above mentioned localities is about 75 - 80 000 ADMT/a.

The kraft pulp mill is of conventional type with 8 batch digesters each of 184 m³ volume. Softwoods (mainly spruce) and hardwoods (oak, beech and a minor part other species) are debarked in dry barking drums. Chips are stored in piles. Softwoods and hardwoods are pulped separately in several days cycles. The digesters are computer - controlled.

The unbleached pulp is screened on pressurised screens and washed on a 5 - stage drum washing line using in 4 th - stage stripped condensate. The vapours from the blow tank are condensed in a spray condenser. The hot condensate is used for preparation of fresh hot water in liquid - liquid heat exchangers.

The black liquor is evaporated in two 6 body evaporator batteries of Rosenblad type (manufactured in previous USSR) without forced circulation, and further evaporated to 63% on two concentrators with raising film and forced circulation. The vapours are condensed in a surface condenser. The black liquor at a concentration of about 63% is incinerated in a BABCOCK - WILLCOX recovery boiler.

The combined vapour condensates from the blow - tank and evaporation, containing obnoxious sulphur compounds and methanol, are stripped by steam on a 24 tray stripping column. The cleaned condensates from the bottom of the column are used for pulp washing. The vapour from the stripping column is condensed in a surface condenser, the turpentine fraction is separated and incinerated in the recovery boiler. The non - condensable gases (NCGs) containing obnoxious sulphur compounds are incinerated in the wood waste boiler.

The initial bleaching sequence was

C/D - E₁ - D₁ - E₂ - D₂

with 20 - 25% chlorine dioxide substitution in the chlorination stage followed by two alkaline extraction and two chlorine dioxide stages, i.e. it was a conventional bleach plant with high elementary chlorine consumption

WASTE WATER TREATMENT

Simultaneously with the new pulp mill a biological (aerobic) activated sludge waste water treatment plant has been installed on the riverside of the river Váh about 6 km downstreams from Ružomberok. It is a joint waste water treatment plant with the town Ružomberok and other industries.

The waste waters from the CELPAP division (new pulp mill) are first mechanically cleaned with an efficiency about 78% related to suspended solids (TSS). The mechanically cleaned waste waters together with a part of waste waters from the SOLO division are discharged into the communal sewage system and pumped to the biological treatment plant.

About 70% of the total waste water treated in the plant is coming from the pulp and paper mill and this water contains about 78% of the BOD₅ entering the waste water treatment plant.

The efficiency of the biological treatment is about

- 88 - 89% related to BOD₅
- 52% related to COD_(Cr)
- 59 - 60% related to TSS

The waste waters from the paper machines are first mechanically treated with an efficiency 95 - 95% related to TSS. Afterward the waste waters are discharged to the river Váh and from the division SOLO into the river Revúca which is joining the river Váh in the town Ružomberok.

With this arrangements even biologically treated coloured pulp mill waste waters are not discharged to the river Váh upstreams of the town. The river Váh is flowing through the town without being polluted by the pulp mill.

The improved situation after shut down of the old Ca - bisulphite pulp mills and starting the new kraft pulp mill is characterized by the biological oxygen demand of the river Váh at the locality Hubová about 15 km downstreams from the town. The biological oxygen demand is significantly below the permitted limit in spite of increased pulp production (200 000 BDMT/a against previous 80 000 BDMT/a). This is a result of incineration of black liquor

and biological treatment of waste water.

Fig. 1

Ecological shortcomings of the original kraft pulp mill design

It is necessary to note, that in spite of the improvement of the situation of the river Váh the pulp mill design was not on the desired ecological standard. The main shortcoming can be listed as follows :

- The hoods of the wash filters of the brown - stock washing line and in the bleach plant were vented directly to atmosphere allowing considerable emissions of chlorine, chlorine dioxide and low concentration obnoxious, sulphur containing, non - condensable gases.

- The non - condensable concentrated obnoxious sulphur containing, gases are according the design incinerated in the wood waste boiler, which has comparatively many shut - downs resulting during this time in considerable emissions of non - incinerated obnoxious, sulphure containing gases.

- The concentration of the incinerated black liquor is comparatively low as a result of low efficiency of the evaporator battery and also low efficiency of the concentrator.

At a higher black liquor concentrations the emissions from the recovery boiler could be lower

- The bleach plant design was a conventional, outdated one with a high consumption of elementary chlorine generating a high amount of chlorinated organic compounds.

Consecutive improvements of the ecological situation

Since the mid eightieth and especially from 1990 the mill management is implementing consistently innovations aimed on improvement of the ecological situation. The main innovations can be listed as follows:

- The gases vented from the bleach plant pulp washers are scrubbed by sodium hydroxide, which is reused in bleaching. By this improvement emissions of chlorine and chlorine

dioxide have been reduced considerably (Fig. 2).

- To eliminate emissions of sulphur containing obnoxious non - condensable gases (NCGs) during shut - down or disturbances of the wood - waste boiler a stand - by incineration equipment has been installed in 1988. The MODO incinerator is actually a gas turbine using natural gas for incineration of NCGs with high efficiency. The concentration of methylmercaptane in the NCGs inlet is about 1 000 to 5000 mg.m^{-3} . After incineration the concentration is reduced to 0.02 to 0.2 mg.m^{-3} . The concentration of H_2S and other sulphur containing gases is under 0.02 mg.m^{-3} . In case of waste wood boiler disturbance the incinerator reacts in 1 - 3 minutes. By this quick action and better boiler house management the duration of NCGs emissions without incineration has been reduced to a few minutes per year.

The most important from the point of view of environmental protection as well as the most capital intensive innovations have been implemented in the bleach plant.

The conventional bleaching sequence C/D - E - D - E - D has been consecutively modified taking into consideration the possibility of high brightness pulp production including softwood pulp which is difficult to bleach.

The individual steps with the objective to reduce and finally eliminate the ecologically most harmful bleaching agent - elementary chlorine - have been thoroughly planned from the point of view of environmental protection as well as from the point of view of increasing pay - back period and implementation time of the respective steps. The modification of the bleach plant has been carried out in several phases as follows :

1. Modification of the first extraction stage to E_0 (1991)
2. Installation of dynamic, so called T - mixers (1992)
3. Implementation of oxygen delignification (1993)

The first extraction stage was modified by installing ahead of the first extraction tower a pressurized oxygen reactor. This resulted in extension of delignification in

the delignification phase of bleaching sequence by about 35-40%. Such reduction of Kappa number reduced consumption of active chlorine in case of hardwood pulp by 10 - 12 kg/t of pulp and in case of softwood pulp by 13 - 15 kg/t pulp. The organic chlorinated compounds generated in the bleaching process, expressed as adsorbable organic chlorinated compounds AOX were reduced in case of softwood pulp by 0.88 kg/t of pulp and in case of hardwood pulp by 0.65 kg/t of pulp.

The next step was installation of dynamic mixers. The result of this change of hydrodynamic conditions clearly demonstrate the importance of homogenization of bleaching chemicals with the pulp. However, in this case the positive effects of mastering and optimization of the E_0 stage have been cumulated with the positive effects of dynamic mixers. The reduction of active chlorine consumption in case of softwood pulp was 19 kg/t of pulp and in case of hardwood pulp 12 kg/t of pulp. The reduction of AOX in case of softwood pulp was 0.80 kg/t of pulp and in case of hardwood pulp 0.75 kg/t pulp. The influence of dynamic mixers on the selectivity of delignification in bleaching was not evaluated till this time, but based on analogy and theoretical considerations we can presume positive effects in this relation. A higher homogeneity ensures minimization of reaction rate and depth of reaction differential in radial direction and this consequently eliminates local extension of delignification as well as decrease of overall selectivity of the bleaching process.

The most important and most expensive action was installation of oxygen delignification ahead of the already modified bleach plant. The corresponding reduction of active chlorine is in case of softwood pulp was 32 kg/t of pulp and in case of hardwood pulp 19 kg/t of pulp. The reduction of elementary chlorine and chlorine dioxide consumption is shown on Fig. 3 and 4. The chlorinated organic compounds generated in bleaching expressed as AOX are reduced by 1.74 kg/t in case of softwood pulp and by 0.93 kg/t in case of hardwood pulp.

It is important to point out, that the waste waters from oxygen delignification are used for washing of unbleached pulp and thus recycled into the black liquor and incinerated in the recovery boiler reducing emissions from bleach plant by about 25%

This technology is currently suitable for manufacture of high brightness pulps (88- 90% ISO) without using elementary chlorine (so called ECF pulp). The organic chlorinated compounds generated in the bleaching process are reduced in this case by as much as 4.5 kg/t pulp.

Pulp bleaching will be substantially simplified by displacement cooking with extended delignification, which will be started till end of 1995. This will be a further important step in efforts aimed on harmonization of pulp production with environment. The existing digestion line will be retrofitted and converted to displacement cooking by the RDH stage 3 - process. The extended delignification will result in Kappa numbers 10 (hardwoods) to 14 (softwoods), which is substantially lower when compared with current production (softwoods Kappa no. 30, hardwoods Kappa no 20). The Kappa number of pulp will be further reduced to in the oxygen delignification stage and the pulp will be bleached with lesser amounts of bleaching chemicals and what is of utmost importance - without elementary chlorine.

Additional benefits of the displacement cooking are:

- reduced steam consumption in cooking
- increased solids amounts entering the recovery boiler resulting in higher steam generation
- increased solids content of the black liquor
- improved quality of pulp (some strength properties)
- reduced bleaching losses, which compensate and possibly exceed the lower yield in pulping
- reduced or nearly eliminated emissions of obnoxious sulphur containing gases in the cooking department

As a consequence of steam savings in cooking and increased steam generation by the recovery boiler and by the wood waste boiler (more wood will be used for pulping - more

wastes are produced) the pulp mill will be a net producer of heat.

In the framework of implementation of displacement cooking the recovery boiler will be retrofitted, as due to lower yield of pulp from wood and increased alkali consumption the amount of solids in black liquor is increased as a result of extended delignification.

The supplier of the RDH displacement cooking technology - the BELCOIN company - guarantees, that this technology will make it possible to bleach the pulp with a shortened sequence :



Chlorine will be eliminated (ECF - Elementary chlorine free) and the bleaching sequence will be shortened from 5 to 3 stages resulting in electrical energy savings of 30 - 35%.

The reduction of chlorine and chlorine dioxide consumption as a result of bleach plant modification is shown in Fig. 3 . Logically with decrease of elementary chlorine and chlorine dioxide consumption the amount of generated chlorinated organic compounds a AOX is reduced.

Fig. 4

The figures of generated AOX in ECF bleaching as expected in the Ružomberok mill after implementation of displacement cooking are very conservative, without exaggerated optimism. It should be noted, that the waste waters from the bleach plant in the Ružomberok mill are treated in the biological waste water treatment plant. This will further reduce the amount of AOX per ton of pulp to a level under 1 kg/t of softwood pulp and will be about 0.5 kg/t of hardwood pulp. This is within the limits of most stringent regulations in western countries.

Pulps prepared by the displacement cooking will be possible to bleach in the future without using chlorine or chlorine compounds (TCF - total chlorine free pulps) and later it will be most probably possible to manufacture TEF pulps (Total effluent free pulps). This will require further development and investments.

Current ecological situation of the Company

Waste Waters

We described the steps improving consecutively the ecological situation of the company. We would like to show the current level of emissions without implementation of all important measures.

The division with the largest production is the new pulp mill CELPAP. The waste waters from this division are treated in the biological treatment plant. The limits permitted by this plant (limits for entering waste waters) are shown in Fig. 5.

The figure shows, that with exemption of soluble inorganic compounds (SIC) and suspended solids (TSS) values are significantly below the limits. If taken into consideration the efficiency of the biological treatment plant then the emission per ton of pulp are :

BOD₅ about 2.5 - 3 kg/t BDMT of pulp (average bleached and unbleached)

TSS about 4 - 5 kg/t BDMT of pulp (average bleached and unbleached)

This is within the most stringent limits in western countries. A problem are apparently only the soluble inorganic compounds, generated in chlorine dioxide manufacture. This can be solved by TCF bleaching which may be introduced for at least a part of production.

The situation is favourable with waste waters from PM 8 as well (Fig. 6). The BOD₅ discharges are about 1 kg/t of paper and COD discharges about 5 kg/ t of paper and TSS about 0.5 kg/t of paper. The specific discharges from the old paper machines are considerably higher, but the production is less.

Air emissions

Air emissions from the new pulp mill including from the wood waste boiler are presented in table 7. Comparatively high are SO₂ emissions (about 6 kg/t BDMT of pulp). This is probably caused by the high amounts of heavy fuel oil fired

in the wood waste boiler, which is oversized. The heavy fuel oil has a high sulphur content. The emissions of other sulphur compounds are comparable with western and Scandinavian pulp mills, but improvement is required due to location of the pulp mill in the mountaneous area. It is presumed, that the emissions of obnoxious, sulphur containing gases, will be reduced after implementation of displacement cooking.

Air emissions are not only a problem of the pulp mill but mainly of the boiler houses. The company has three boiler houses, which are also supplying heat to the town. Some boilers are very old and unefficient, using lignite. The boilers are step by step modernized or shut down. The situation was improved especially since 1990 as shown in the following table, indicating total emissions of all divisions

Emissions	1980 t/r	1985 t/r	1990 t/r	1994 t/r
Particulates	9 035	8 232	2 782	136.3
SO ₂	8 847	8 211	5 208	3 504

This was achieved mainly by improvement of fossil fuel composition - especially by excluding lignite. By introducing the displacement cooking technology the situation will be further improved. Heat consumption in cooking will be reduced, heat generating from black liquor incinerating increased and fossil fuel consumption will be reduced (Fig.8). Consequently, SO₂ emission will decrease.

Conclusions

The North Slovakian Pulp and Paper Mills have successfully shown that the pulp and paper industry can be harmonized with environment.

The kraft pulp mill in Ružomberok is pulping besides softwoods mixed hardwoods, which have no other utilization. The quality of wood is low, but the quality of product is high. The pulp mill contributed in the eightieth to elimination of of a catastrophe in the oak forest, attacked

by graphiosis. The pulp mill used a large part of the attacked wood. This eliminated graphiosis and limited economical losses in forest.

The pulp mill design was not on an acceptable ecological standard by today's standards. The company implemented step by step innovations aimed on improvement of ecological situation. The company is a medium - scale enterprise, which can not implement technologies, which are not well tested in commercial large - scale operations. However the company applies new, proved and economically acceptable technologies. In this way the company step by step achieves a high ecological standard which is comparable with the most stringent ecological standards applied in foreign countries. The company decided to continue this cautious but effective industrial policy.

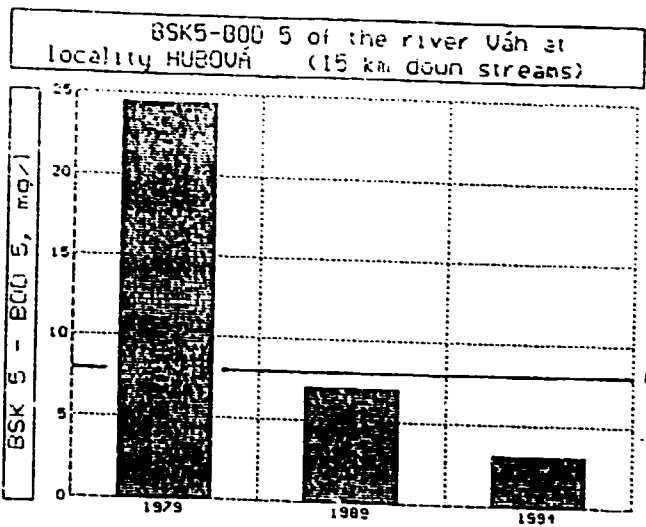


Fig. 1

LABORATÓRIUM OŽP
SCP Ružomberok

EXHALÁTY Z BIELIARNE DO ATMOSFÉRY

BLEACH PLANT AIR EMISSIONS

	ClO ₂ kg/h	Cl ₂ kg/h
1991	6,5	4,6
1992	2,7	2,9
1993	3,5	2,5
1994	1,9	0,9

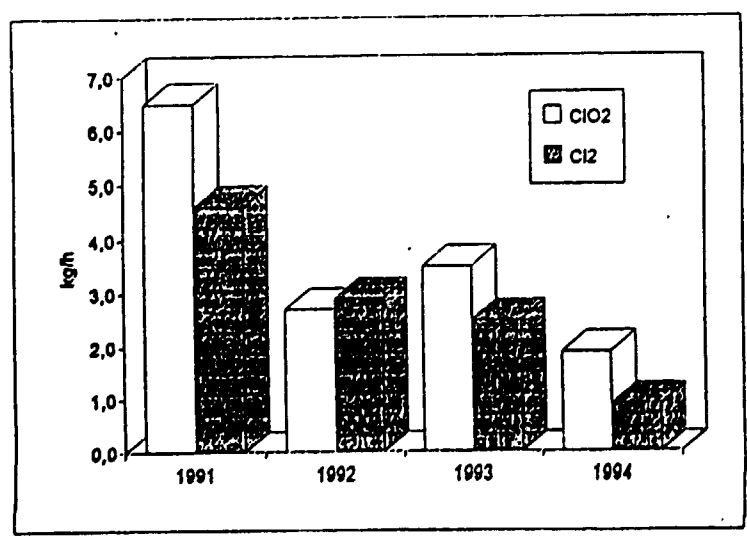


Fig. 2

Chlorine and Chlorine Dioxide Consumption

Spotreba chlóru a chlórdioxidu

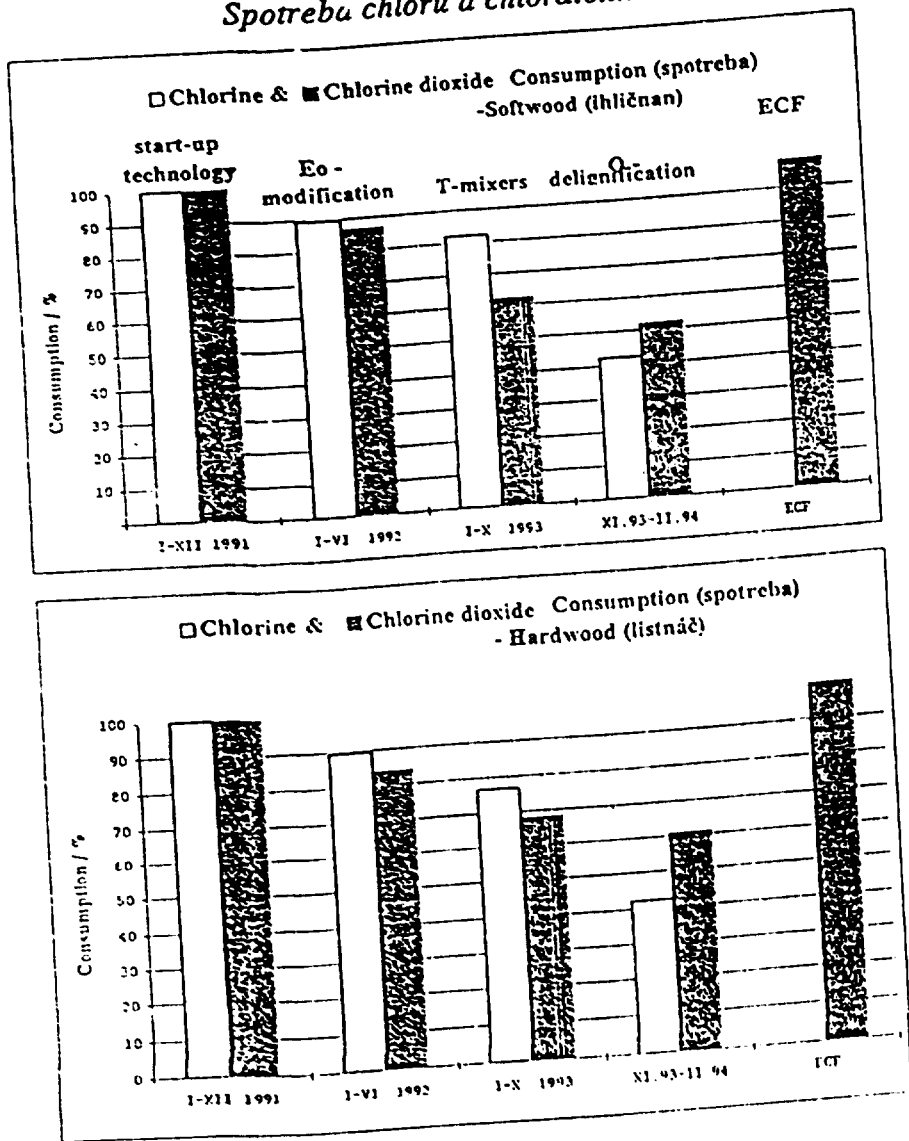


Fig. 3

Decrease of AOX level - achieved by process modifications

Pokles tvorby AOX - dosiahnutý jednotlivými modernizačnými krokmi

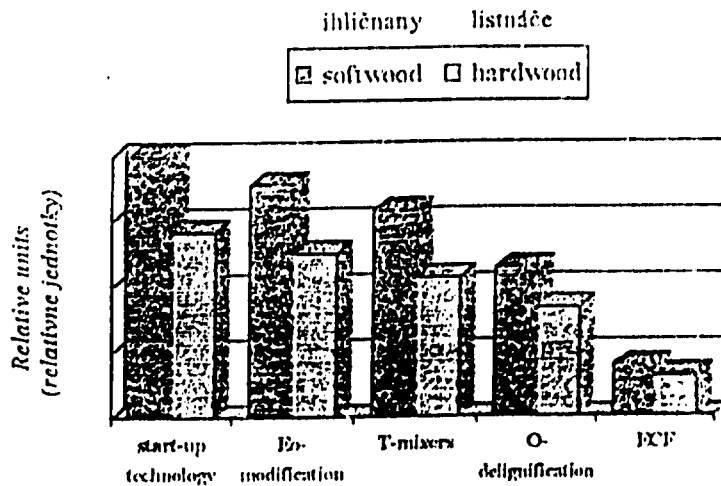


Fig. 4

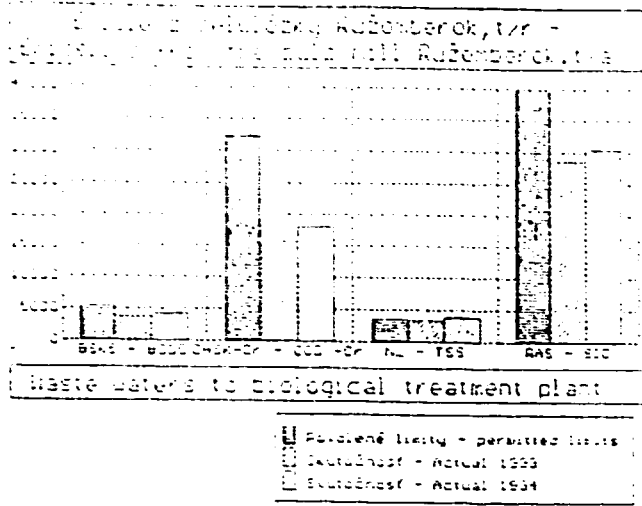


Fig. 5

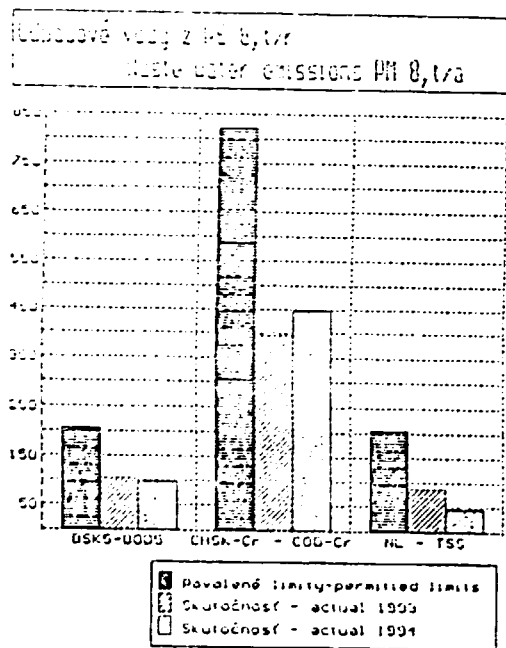


Fig. 6

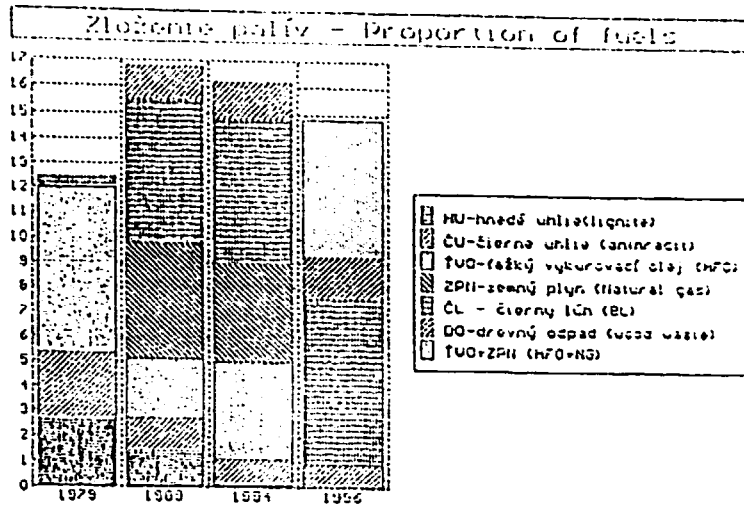


Fig. 7

AIR EMISSIONS FROM PULP MILL t/a
EMISIE Z CELULÓZKY t/r

	1990	1993
S ₂ O	2539	1269
H ₂ S	7.11	6.67
DMS (Dimetylsulfid)	0.532	0.52
DMDS (Dimetyldisulfid)	1.9	1.94
MM (metylmerkaptán)	2.82	2.71
Prach z kotla na drevný odpad (Dust from wood waste boiler)	799	221
CaO	83.2	90.9

Tab. 1 - Table 1.

The BIOCEL J.S.C. PASKOV pulp mill - Pulp production and environment

Dušan Bohdálék, Dalibor Slončík - BIOCEL J.S.C. PASKOV

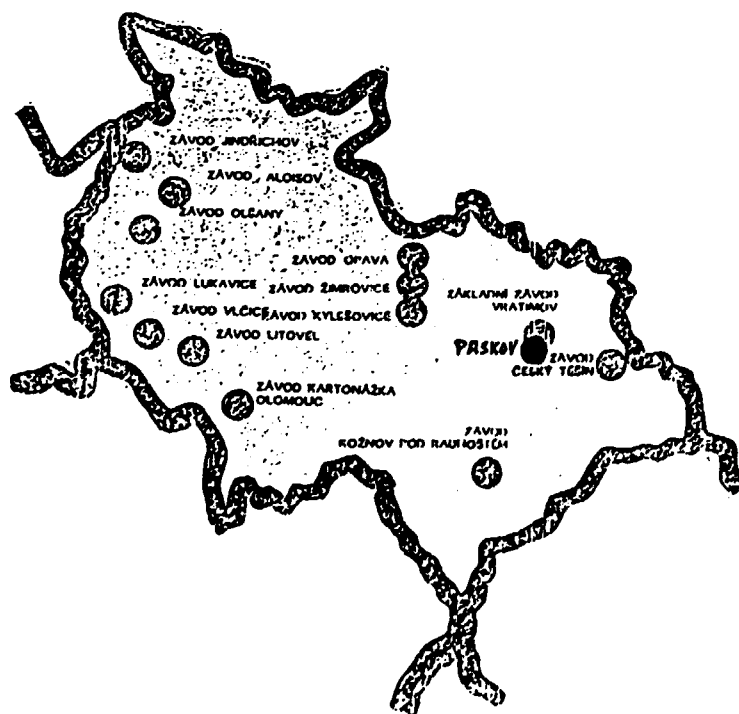
Milan Vrška - VÚPC (PPRI) Bratislava

Ján Fellegi - Fellegi Techneco Bratislava

The area of Northern Moravia, rich on wood (mostly softwoods) enables the processing of this raw material in the wood, pulp and paper industries.

As far as the pulp production is concerned there exists a more than hundred years tradition of the manufacture of pulp and paper in the Písečná, Lukavice, Jindřichov, Vratimov plants and others in the locality (Fig. 1).

Fig.1 THE LOCATION OF PULP AND PAPER MILLS OF NOTHERN MORAVIA



The raw material basis, the growing need for environmental protection and the number of persons with the professional skill to make use of the raw material initiated the idea to erect a large capacity pulp mill in Northern Moravia.

In deciding on the place where to locate the plant, the following factors were involved:

- the demand of environmental protection
- a pulping technology considering those demands
- the choice of capacity

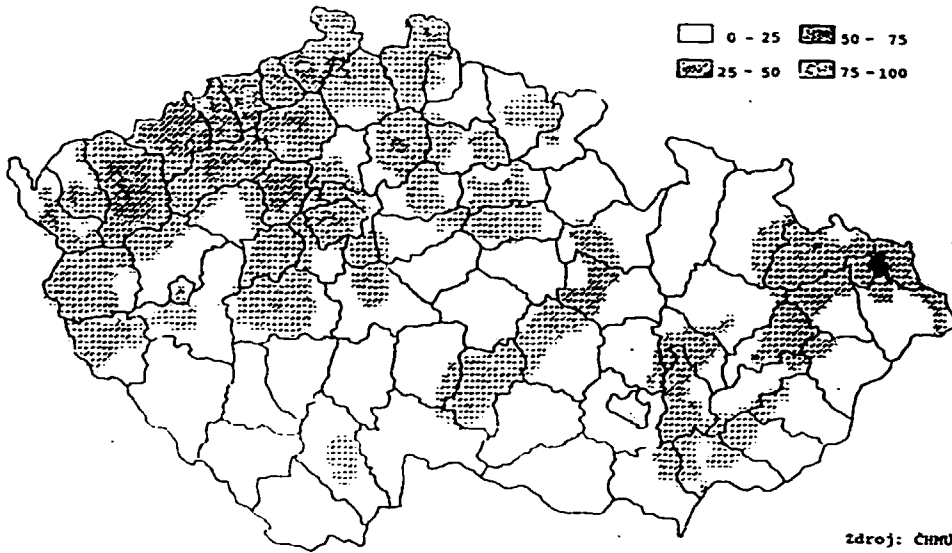
As to the demands of environmental protection, some facts have to be notified about the area where the BIOCEL J.S.C. PASKOV mill is situated.

The Air - the air of the whole area is polluted from the Vítkovice Iron Works, the Nová Huť metallurgical plant and from coal mining since more than 150 years (see Fig. 2). The average temperature during the year is about 8 °C. The average rainfall during the year is 911 mm (2/3 of it during the vegetation period). In the flow of air we cannot clearly state the prevailing wind direction, but by means of the table it can be stated that about 43 per cent are Southern winds (SE, S, SW) directed to the Ostrava area during the year (table 1).

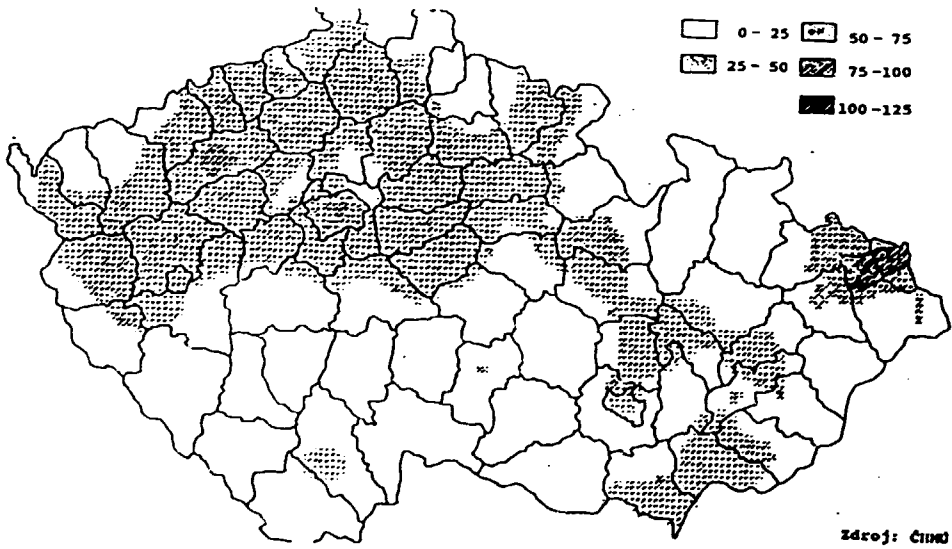
Table 1

Wind direction	N	NE	E	S	SE	SW	W	NW	Total
Relative amount, %	11.8	18.1	3.8	2.9	12.8	27.7	10.8	9.5	13.6

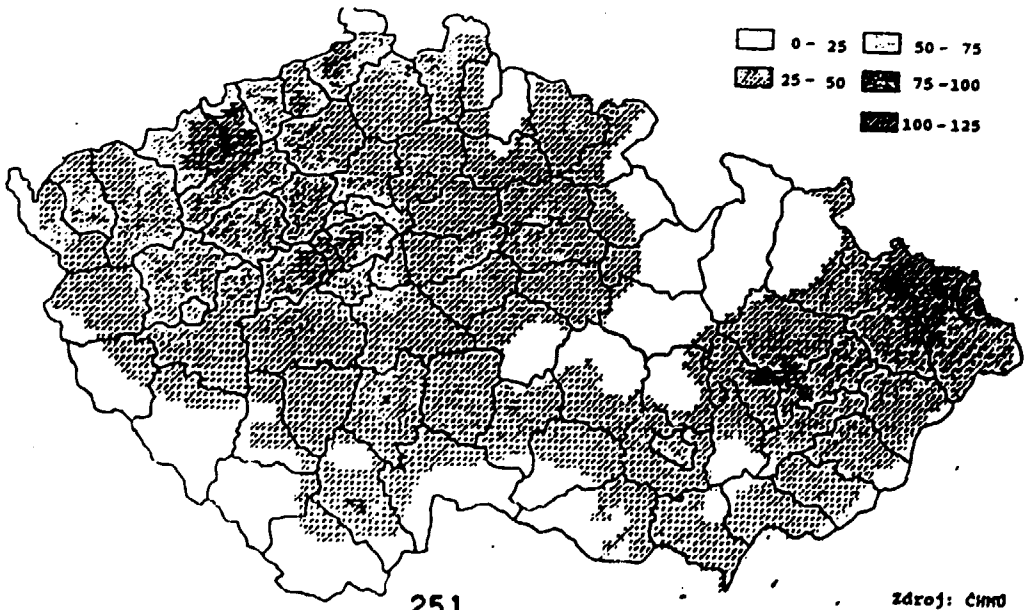
Fig.2 ANNUAL AVERAGE CONCENTRATION OF SO₂ ($\mu\text{g}/\text{m}^3$) IN CZECH REPUBLIK - year 1990



ANNUAL AVERAGE CONCENTRATION OF NO_x ($\mu\text{g}/\text{m}^3$) IN CZECH REPUBLIC - year 1990



ANNUAL AVERAGE CONCENTRATION OF FLY ASH ($\mu\text{g}/\text{m}^3$) IN CZECH REPUBLIC - year 1990



The Water - the main stream of water is the Ostravice river with the uninfluenced average throughflow of 1.53 cum/s.

For the supply of the technology the water of the Žermanice and Olešná dams are used.

Planning a pulp mill into the heavily loaded Ostrava agglomeration required a very strict check of the technologies coming into consideration. Under the aspect of those days related to the protection of the air and to the manufacturing technology, the acid magnesium sulfite process was chosen for the production of bleached spruce pulp.

After the closing of smaller wood processing pulp mills in Northern Moravia and the evaluation of the possible capacity, the output of 200 kt/year of unbleached pulp was chosen, with a possible capacity increase of 20 per cent. The mill operates as a market pulp mill. The main product is bleached paper pulp used for the manufacture of sanitary products (about 70 per cent), of writing and printing papers (about 10 per cent) and of other paper products. A sideproduct is fodder yeast, increasing the utilization of the wood substance processed.

The production is performed by the following technological units with the following simplified characteristics:

Wood preparation

- 1.1 mil cum/year of wood processed
- delivery in 2 - 14 m length with bark

The delivery contains large amounts of damaged (imission) wood.

Pulping

- capacity 600 t/day - pulping cycle of about 2 hours
- batch pulping - 9 digesters per 360 cum

Pulp washing and sorting

- Rauma Repola pressure wash filters
- centrifugal and cyclone sorters

Oxygen bleaching

- high consistency reactor (when the pulp mill was built, it belonged to the first oxygen reactors used in the sulfite technology). The implementation of the oxygen technology remarkably helped to decrease the pollution of the effluent,
- completed by the stage of pressure alkalization with the addition of hydrogen peroxide

Bleaching

- after the oxygen delignification bleaching by the (CD₀)E₀D₀ sequence (75 per cent of the output)

Screening of the bleached pulp, drying, wrapping.

Recovery of chemicals

- black liquor stripping
- thickening of the black liquor discharged from the fodder yeast manufacturing unit
- burning of the evaporated black liquor
- production of tower acid and fortification by the absorption of SO₂ from the exhaust gases of the digesters

Energy

- the main energy source is the burning of the evaporated black liquor (62 per cent of thermal energy)
- burning of wood waste (19 per cent of thermal energy)
- burning primary fuel (19 per cent of thermal energy) in the winter months using black coal in a boiler, where also natural gas can be used as fuel

- power (2 x 25 MW turbogenerator - 60 per cent of the power consumption)
- purchased power - 40 per cent of the consumption

Water treatment

- the water source are the Olešná (40 per cent of the water consumption) and the Žermanice (60 per cent of the water consumption) dams. The water is treated by filtration and clarification. The rated water consumption was about 47.9 cum/t unbleached pulp produced in 1994

Effluent treatment

- the mechanical effluent treatment plant (after thickening the sludge is incinerated)
- the biological effluent treatment plant
 - BOD₅ efficiency 98 %
 - COD efficiency 70 %

Not all of the data shown above can be considered to be design data. They were attained by the stepwise modernization of the technology, having been on top level in the period of design and erection, but unable to meet the strict limits planned for 1997.

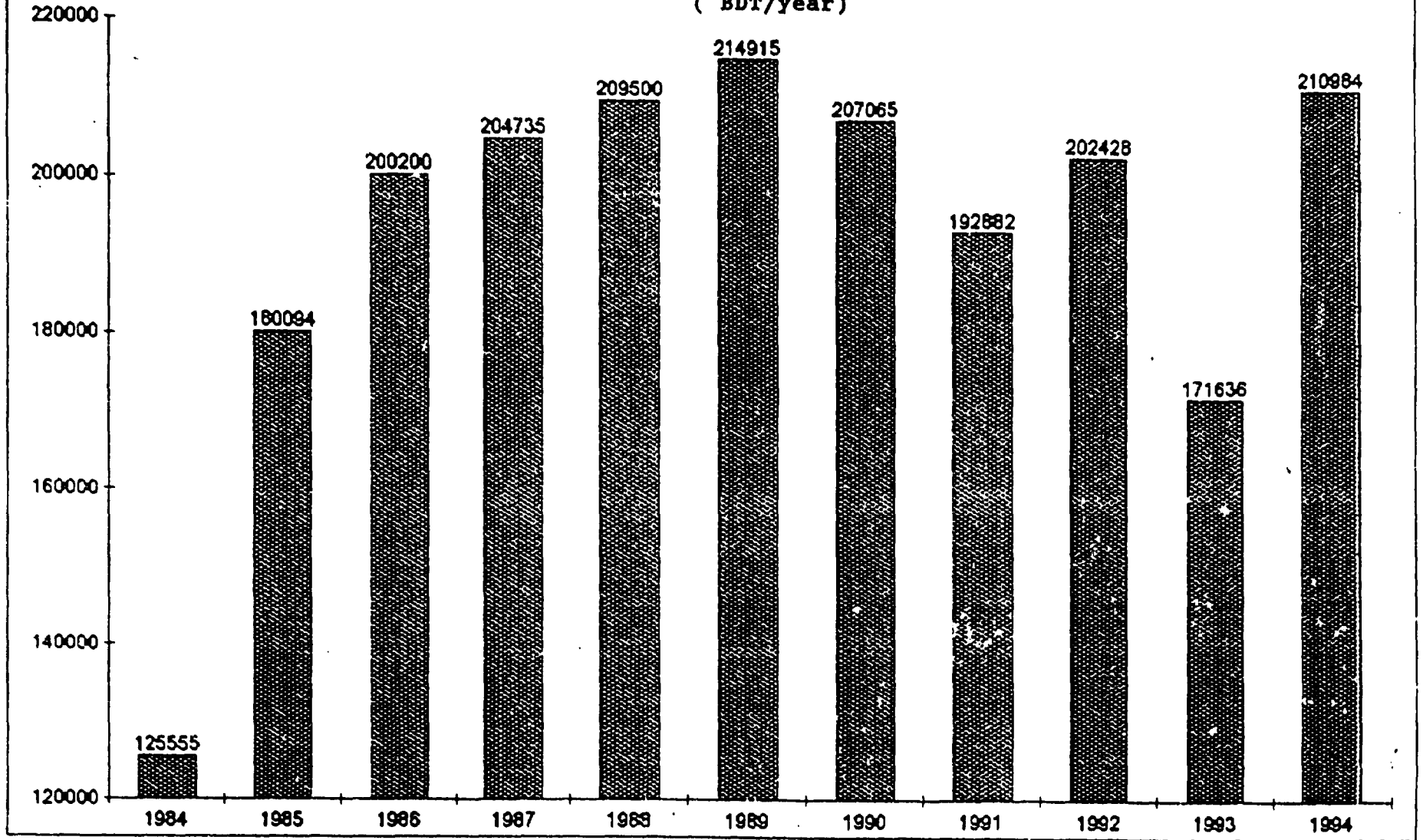
The development of the pulping technology related to modifications for less environmental pollution can be seen in the following figures.

Fig. 3 shows the development of the pulp production since 1984 (the start-up of the pulp mill was in 1983).

We can see the steady growth of the amount of pulp produced, except the years 1990 and 1993, when there was a worldwide recession in the pulp industry.

Fig.3 THE PRODUCTION OF PULP IN BIOCEL J.S.C. PASKOV
(BDT/year)

255



6.3. 95 *[Handwritten signature]*

As to the development of the effluent pollution and the SO₂ emission (Figs. 4 and 5) we see the continuous decrease of COD and SO₂ emission. It was caused by the implementation of investments and provisions in the pulp manufacture. The following steps were realized since 1988:

- there was stopped the discharging of surplus alkaline effluents from the oxygen delignification to the effluent treatment plant,
- the black liquor leakages and sewer material were pumped into a storage tank,
- the coal fired boilers were changed to natural gas firing,
- the start-up of the elementary chlorine free (ECF) and totally chlorine free (TCF) pulp production and their gradual increase in the production,
- the test run start-up of a bark fired boiler (decrease of the consumption of primary fuel and decrease of SO₂ emission),
- the reconstruction of the recovery boiler, in order to attain a higher output,
- the repumping of the effluent from the fly ash dump yard through the 2nd stage of effluent treatment, instead of discharging it behind the effluent treatment plant.

A part of those provisions was also an investment to decrease the sawdust flue (chip screening before storage).

The provisions mentioned did not only decrease the effluent pollution and the SO₂ emission, but they decreased also the values of NO_x, solids, HCL and Cl₂ (see Tab. 2).

The gradual optimization of the operation of the effluent treatment plant decreased the pollution of the effluent, too. Fig. 6 shows the increasing efficiency of the plant in the

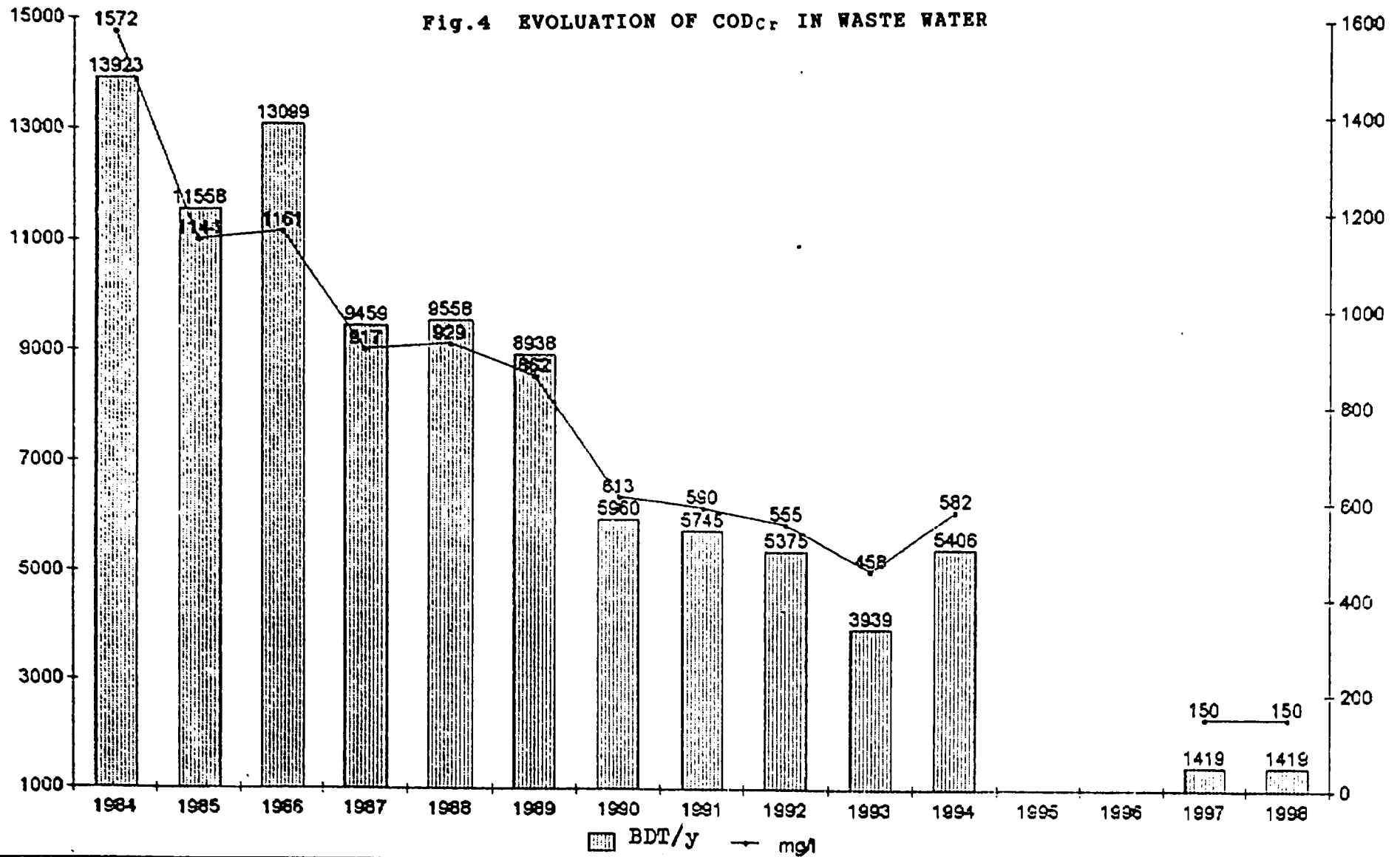
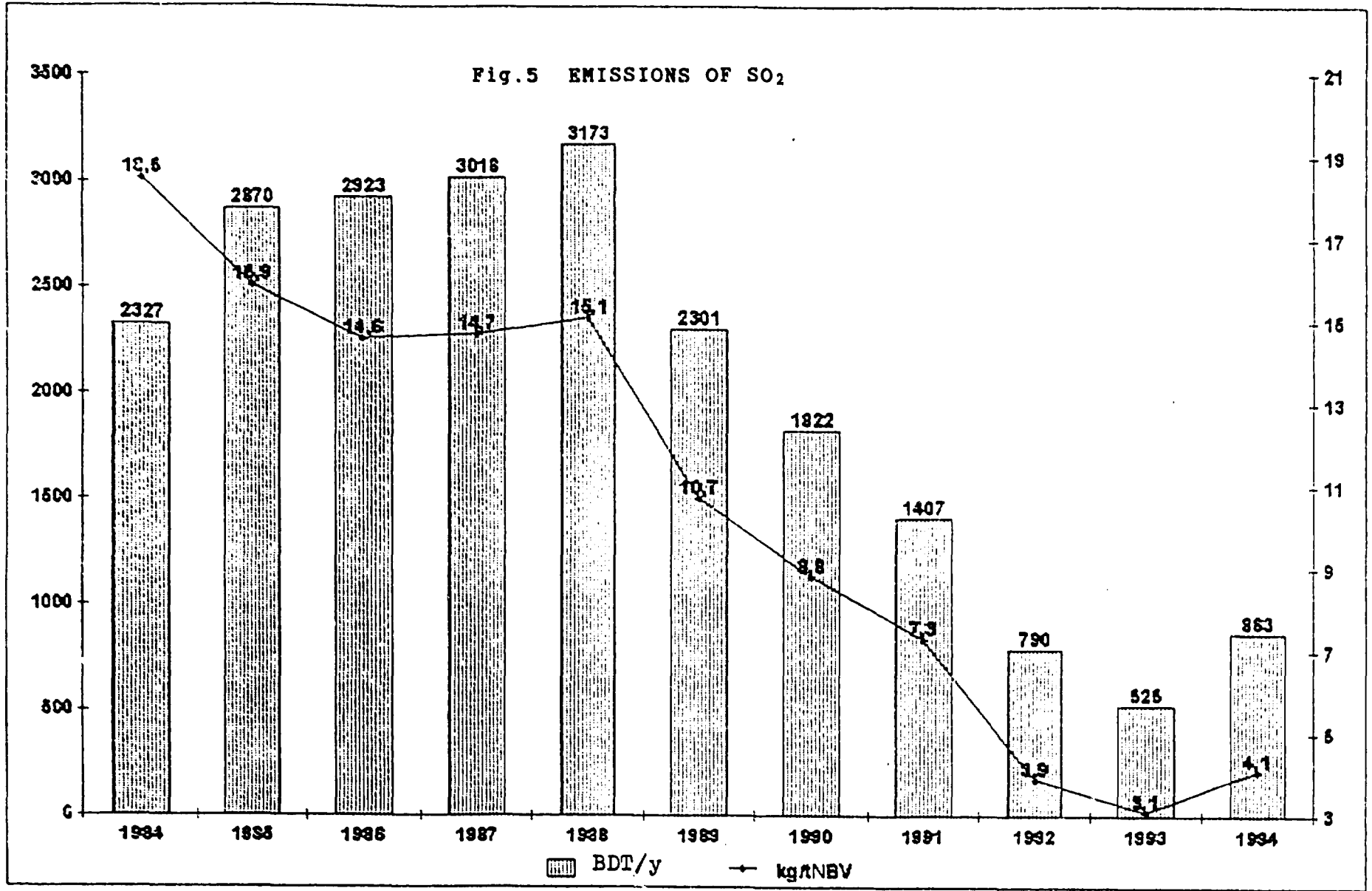
Fig.4 EVOLUTION OF COD_{Cr} IN WASTE WATER

Fig.5 EMISSIONS OF SO₂



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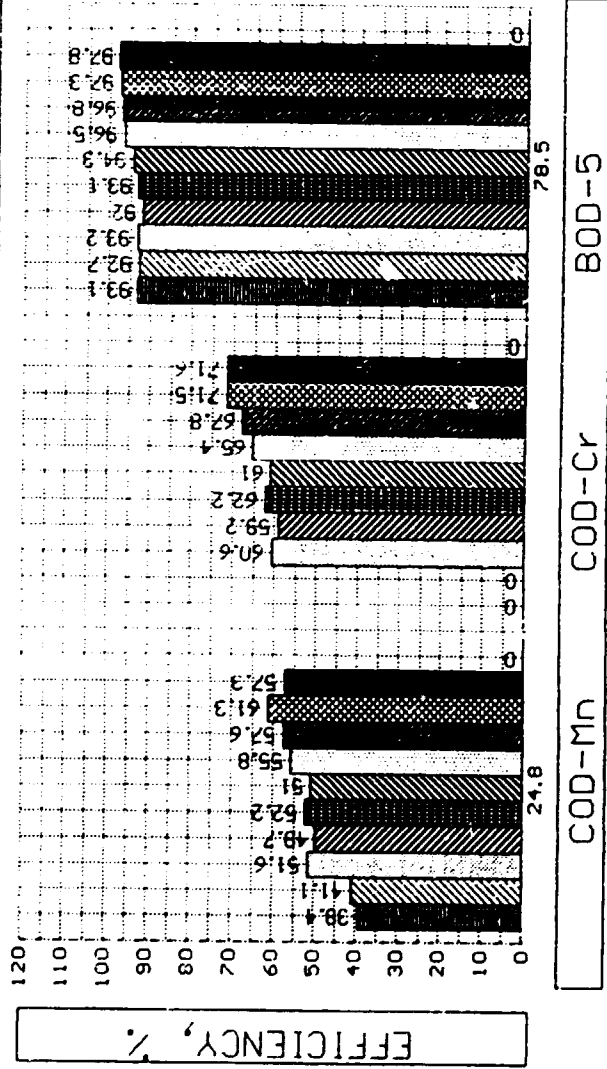
Table.2 GAS EMISSIONS OF BIOCEL J.S.C. PASKOV
(EDT/y)

YEAR	SO ₂	NO _x	FLY ASH	HCl	Cl ₂
1988	3 173	2 828	215	-	-
1989	2 301	1 407	159	-	-
1990	1 822	1 400	182	1,10	5,5
1991	1 405	1 308	156	0,86	5,3
1992	812	1 275	166	0,12	3,5
1993	525	1 035	135	0,09	3,2
1994	863	951	178	0,52	3,5

Table.3 THE LIMITS OF POLLUTION OF THE EFFLUENTS
DISCHARGED INTO THE OSTRAVICA RIVER

Parameter	Target limit since Jan. 1,1997	Attained in 1993	Attained in 1994
BOD ₅ , t/day	1.036	0.90	0.77
COD _{Cr} , t/day	3.850	11.74	14.91
Insolubles mg/l	30	51	51
Sulfates t/day	38.8	42.74	41.54
Chlorides t/day	10.3	8.06	9.42

FIG.6. - Efficiency of water treatment plant
in the years 1984 - 1994



parameters of COD_{Mn}, COD_{Cr} and BOD₅.

By the resolution No. 694/93 of the Ostrava municipality the limits of pollution of the effluents discharged into the Ostravice river were determined with the enforcement since January 1, 1997 (see Tab.3).

The table shows that the BIOCEL J.S.C. PASKOV has to treat intensively the problem of reducing the content of insolubles, sulfates and of the COD_{Cr}.

The BIOCEL J.S.C. PASKOV is aware of this task and prepares investment actions to meet the future limits prescribed, although they are already attained in some parameters. The list of investments in preparation contains:

1. Revamping and capacity increase of the recovery boiler
2. Reconstruction of the sludge management
3. Increasing the capacity of the V 009 fan behind the recovery boiler
4. Chlorine free bleaching - reconstruction of the bleach plant
5. Reconstruction of the evaporator and decreased loading of the vapour condensates.

Conclusion

The BIOCEL J.S.C. PASKOV was designed and erected based on the technical and technological knowledge of the seventies. The increasing demand on the protection of the environment requires the permanent modernization of the pulp manufacture and of the equipment used. The data of the operation and of the investment actions in preparation in the BIOCEL J.S.C. PASKOV pulp mill focused on the protection of the environment prove that the staff of the mill is seriously involved in that problem - and not only theoretically.

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