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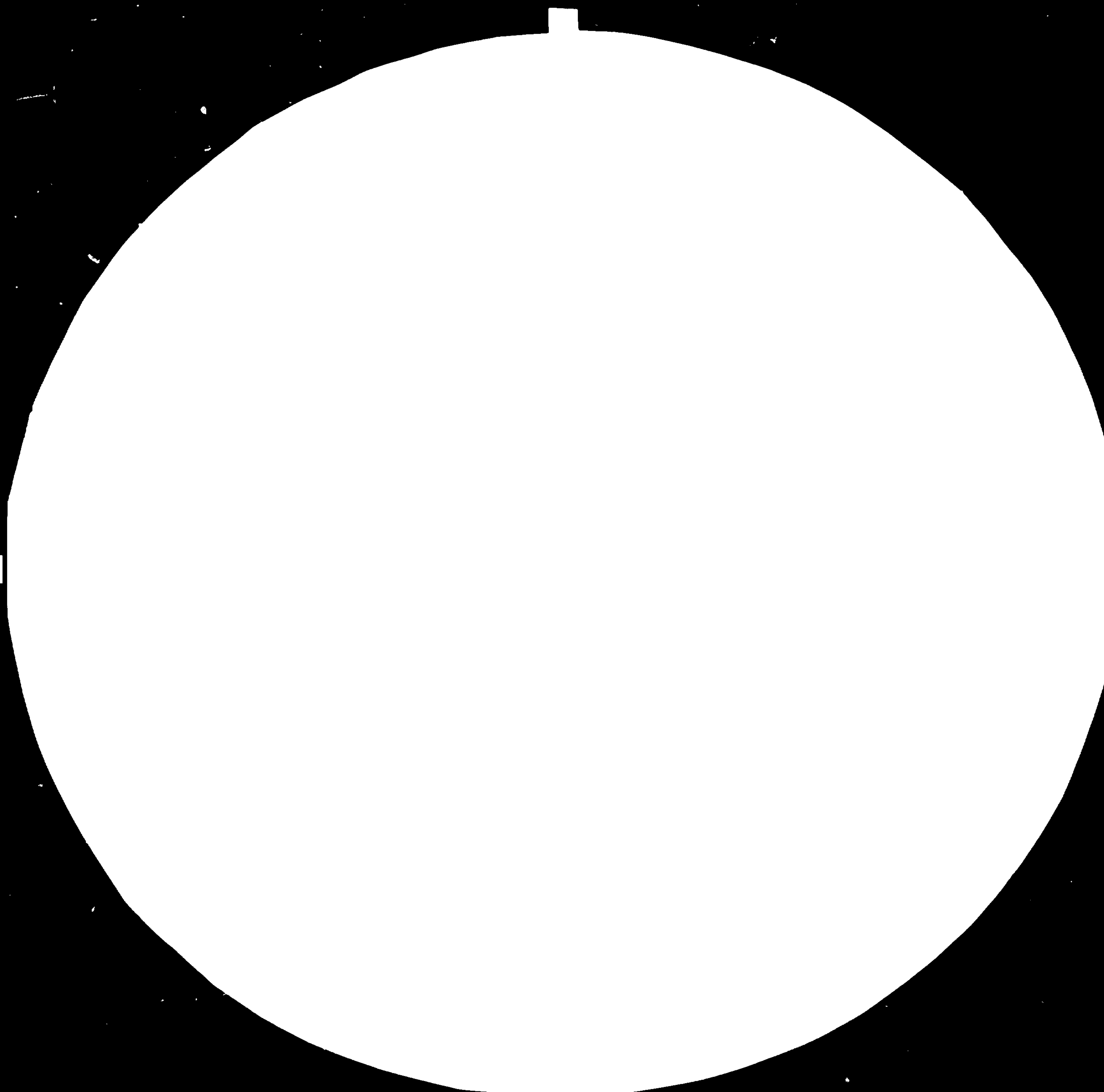

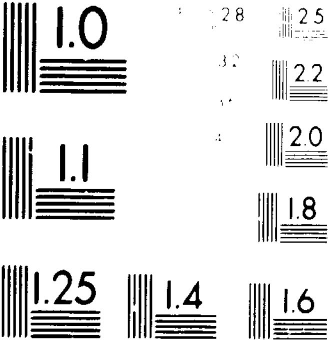

MICROCOPY RESOLUTION TEST CHART

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REPORT

ON THE EXPERT ACTIVITY IN BRAZIL.

(energy saving, chemical and petrochemical industry).

August - September 1983

P R E F A C E

During a seminar on the analysis of energy systems, given by the author of this report for the staff of CEPED and the Petrochemical Pool at Camaçari, a participant asked a short but dramatic question: What have we to do? He asked obviously for a short and general advice, suitable to overcome the difficult economic situation in Brazil.

The author borrowed the answer from Franklin D. Roosevelt, given at the beginning of the so called "new deal" to overcome the crisis in the early thirties: "You have nothing to fear except the fear itself". In fact, Brazil remains a country rich in nearly all sorts of natural resources. From its huge hydroelectric potential only a moderate part is exploited to date. The Brazilian climate frees the population from the necessity to heat their houses, while many countries of the northern hemisphere need to import per capita more oil for this purpose than for the industrial and automotive demand. Last but not least, Brazil is able to produce many goods for export at competitive prices. So, an answer to the quoted question could be: use hydroelectricity wherever possible (e.g. development of a transport system driven by electricity). The answer to the petrochemical industry will be: hard detail work. This report contains some suggestions thereto.

Some steps towards a Brazilian "new deal" have already been initiated. The author of this report hopes that his advice given in Brazil and completed in the following text will contribute to this objective.

DR. L. SILBERRING
Zürich, November 1983

A C K N O W L E D G E M E N T S

The autor presents his acknowledgements to the UNIDO and its staff in Vienna and Brazil for organizing and sponsoring the action which has led to the present report. The staff at the Centro de Pesquisas e Desenvolvimento (CEPED) at Camaçari, Bahia, as well as the staff of the Instituto de Pesquisas Tecnologicas do Estado de São Paulo (IPT) have been of great assistance during the activity in Brazil. They took all efforts to organize a comprehensive program and, moreover, have provided useful information, related to the subject of this report.

T A B L E   O F   C O N T E N T S

ANNEXES

S U M M A R Y

Brazil is a wealthy country in terms of many natural resources. It has considerable land reserves, numerous mineral resources a favourable climate and additionally, it possesses a significant hydroelectric potential. But it has not enough assured oil deposits and therefore it will be difficult to acquire self-sufficiency of oil supply for prolonged periods.

The sharp rise of oil prices in the seventies has hit the Brazilian economy stronger than it was the case in many other countries. In fact, the stroke came in a period when the industry went through a rapid development. This development must continue in order to provide the necessary contribution to the solution for a number of social problems.

Oil can be economized almost everywhere and a number of actions have been taken in Brazil towards this objective. The present report recommends some essential priorities in this respect and describes some actions able to provide appropriate results within a reasonable period of time and at an acceptable cost. According to the Terms of Reference prepared by UNIDO, the recommendations are centered on the energy economy in the chemical and petrochemical industries. They are also restricted to the particular problems presented by the staff of the Centro de Pesquisas e Desenvolvimento (CEPED) in Camaçari ,and by the staff of the Instituto de Pesquisas Tecnologicas do Estado de São Paulo (IPT) in São Paulo. On the other hand, some of those problems have been treated, although they do not belong to the chemical and petrochemical industry.

Oil and oil derivatives should be assigned with the highest priority to those requirements which are usually designated as petrochemical feedstock. Replacement of oil in this area would be very costly and time consuming. On the other hand, oil can be replaced most easily for most of those requirements in which it is used as fuel, i.e. for heating purposes. Especially favourable oil replacement is possible wherever heating is required at a low or moderate temperature level.

According to the received information, the hydroelectric power presently available in Brazil is not fully used. The excess power between 2 and 3 GW is dissipated by overflows of dams. As long as this situation lasts, it is strongly recommended to stop any electric power generation (even the so called cogeneration at Camaçari or elsewhere) using oil firing, provided that the excess hydroelectric power can be supplied to the potential users by existing electric transmission lines. Subject to the same condition, heating by oil should be replaced by electrically driven heat pumps for low or moderate temperature levels or even by electric resistance heating for any temperature level. The above actions can be completed within a few months at very moderate cost and can bring an economy on oil imports between 300 and 800 million dollars per year, which depends on particulars of the energy transformation systems.

In the future, the available hydroelectric energy will continue to rise according to the national program but will simultaneously almost certainly find a better use than large scale electric resistance heating. Hence, high temperature heating power requirements must be satisfied by other means.

The petrochemical pool at Camaçari belongs to the most important consumers of oil in Brazil. The consumption of oil as chemical feedstock will continue to rise at this site along with the expansion of the pool's capacity, unless some of the requirements can be replaced by domestic natural gaz. But a significant part of the present oil consumption, namely about half a million tons per year, is used just for heat (steam) supply. An additional eighty thousand tons of oil per year are burned for electric energy cogeneration, which should be stopped, provided that the excess hydroelectric energy can be brought to Camaçari.

Attempts have been made towards the replacement of oil which is presently used for heating purposes at Camaçari by biomass which should be used in the far future. The author of this report did not see any feasibility study about the subject, and he cannot avoid to express his scepticism about the said attempts. The required heating power at Camaçari is simply too great and the distances for the overland transport of biomass from its potential sources too long in order to solve the problem competitively. At this point it should be mentioned that the Camaçari pool is producing basic chemicals, which should be delivered at competitive prices to other industries and that the influence of the heat (steam) price on the product price is high for this kind of products.

In the opinion of the author of this report, the best solution for the problem of heat supply at the Camaçari pool is a nuclear steam supply system. Such a system can be constructed within a few years at a competitive cost provied that a strong and effective project management is set up. It should be noted, that the technology and the objectives will be in this case quite different from those associated with the construction of the nuclear plants for electric power generation.

A new coal or peat fired boiler plant could also be considered in order to replace oil actually used for heat supply at Camaçari. However, it would be necessary to examine prior to any further consideration of these variants the feasibility and economics of coal supply from the South as well as the availability of peat together with the feasibility and economics of its supply from the bogs. In any case, the new boiler plant should be preferably located at the seashore near Camaçari and the steam should be transfered by pipelines to the users. In contrast to this, a nuclear steam supply system can be located as near as possible at the existing boiler plant of COPENE UTIL.

Ammonia production belongs to petrochemical industries needing many oil derivatives as feedstock and fuel. The actual ammonia production capacity in Brazil is moderate, but its rise can be expected together with an intensification of agriculture. The highly competitive world ammonia market does not allow to produce it economically in Brazil because the country is forced to use imported feedstock and fuel. Plants using domestic low grade feestocks and fuels, e.g. coal, can be constructed (one plant using asphalt residue of oil is already in operation) but the capital investment is, in this case, roughly twice as high as for natural gas based plants, which again compromises the economics. But it can hardly be recommended to Brazil to rely entirely on imports of such an important basic product like ammonia. A process called electroreforming, developped a few years ago but not yet implemented, can probably help to solve this dilemma. Negociations about this have been initiated at IPT.

The industry, set up a few years ago in Brazil for producing alcohol from sugar cane, can look at remarkable achievements in spite of controversies due to the high specific investments and the competition created in respect to the assignment of land. Improvements recommended by the author of the present report are centered on a better use of bagasse, a significant part of which is actually burned to supply low grade heat to the reboilers of the alcohol distillation columns. This duty can be preferably replaced by vapour compression using electrically driven compressors, whereas bagasse can be used to extract paper pulp and as fuel for heat supply at a high temperature. Furthermore, it is recommended to start feasibility studies of alcohol production using domestic coal or peat in order to explore a second way for the production of this product, which is important for transportation requirements.

Vapour compression can be applied not only to the alcohol distillation but also to any distillation process in which the ratio between the absolute temperatures at the column top and the bottom is not too low. In some cases an indirect heat pump might be preferable to direct compression of the product vapour, in particular if the density of the latter is low. In any case, oil can be efficiently replaced by a fraction of electric energy.

Drying processes represent another area in which fuels can be replaced by electric energy using heat pumps. The latter can recover most of the sensible and latent heat of the effluent drying gas and rise its temperature to a level necessary to heat the affluent drying gas. Hence, only a more or less small fraction must be added in form of electric energy.

The pulp and paper industry should be optimized differently in Brazil compared to other countries. In particular, the availability of cheap hydroelectric energy should be taken into account and again a large scale application of heat pumps should be considered.

Future ceramic furnaces in Brazil should be preferably electrically heated.

Some particular problems have been presented by CEPED and IPT and, subsequently, examined more in depth. The corresponding descriptions and recommendations are included in the text of the report and in its annexes.

A lot of engineering work remains to be done in order to improve the energy economy in Brazil. During the mission, CEPED and IPT have expressed their interest to continue at least some actions with the author of the present report, who is also interested to do so.

Future visits to Brazil, if any, should preferably include meetings at an energy managment level, e.g. with the Brazilian National Energy Commission.

1. Objectives of the mission and a brief description of actions in Brazil

The objectives of the mission are descriped in the terms of reference which served as a basis of the contract between UNIDO and the author of the present report (Annex 1). A more detailed program has been prepared by CEPED (Annex 2) for the actions in Camaçari and by IPT (Annex 3) for the actions in São Paulo. The seminar given in Camaçari on August 25 and 26 was attended by representatives of a number of companies, belonging to the Petrochemical Pool in Camaçari. An additional seminar, not mentioned in the Annex 2, was given on August 29 at COELBA, a state company in charge of electric energy production and distribution in Bahia. The actions in Bahia have been summarized in a publication in the local press, Annex 5.

Following a suggestion of the author, a list of specific projects and specific themes has been prepared by CEPED (Annex 6). Some suggestions on the subjects specified therein were given during various conferences with the personnel of CEPED.

The activities were not limited to the chemical and petrochemical industry. Some suggestions were also given on topics related to the pulp and paper industry, to the ceramic industry and as far as possible to other industries.

Most members of the staff of CEPED and IPT deal with some kind of particular subjects as research engineers usually do. These subjects are not necessarily the most important or the most urgent ones what the present energy situation in Brazil concernes. The author of this report tried to encourage the people to attack those energy problems which are of the highest national importance for Brazil. Studies and decisions on such problems have often been performed hitherto by multinational companies; and the staff of such research institutions as CEPED and IPT need still to get more courage and more industrial experience in order to provide significant contributions in the areas under consideration.

The author of the present report informed the UNIDO representative in Brazil about the situation and asked for meetings at a level at which key issues are discussed. The Brazilian National Energy Commission, of which one member was encountered at IPT, would probably represent the best address for the purpose under consideration. Unfortunately, it was not possible to organize meetings on this level during the limited time of the mission. However, the staff of CEPED and IPT have been informed about the author's opinions, related to some of the key issues. These opinions are repeated in the subsequent paragraphs of this report and it is also expected that they will reach the right addresses. Needless to say that the author is ready to give any further suggestions and/or take any further actions which might be necessary on the suggested lines.

2. Some basic information about the key chemical and petrochemical industry in Brazil

2.1. Petrochemical Pool in Camaçari, Bahia

The biggest production center for basic chemicals in Brazil is situated in Camaçari near Salvador. Essential information about the companies belonging to this center is summarized in Reference 1. According to the References 2 and 3, this center consumes nearly 1 million tonnes of oil products and about 0,4 million tonnes of natural gas per year. Additional information received on the site leads to the conclusion that at least one half of the above consumption is used for heat (mainly steam) and electric energy generation, whereas less than one half is used as chemical feedstock. Thus the Camaçari complex participates significantly in the high Brazilian oil import bill.

The supply of utilities (steam and electric energy) for the Camaçari complex is centralized at a company called COPENE UTIL. This company was visited during the mission. It consists mainly of five boilers, each of them having a steam rising capacity of 400 t per hour at a pressure of 120 bar and a temperature of 550 oC. This high pressure steam is expanded in five steam turbines, each of them constructed for an extraction pressure of 42 bar and a back pressure of 15 bar. Steam at the two last mentioned pressure levels as well as electric energy are distributed from the COPENE UTIL plant among all participants of the Camaçari Pool. The COPENE UTIL plant is therefore a so called cogeneration plant but the ratio between electric power and heat generation is quite low due to the relatively high extraction and back pressure.

The fate of the steam delivered to different companies is unknown (!) to the staff of COPENE UTIL. However, it might be expected that at least some of the delivered steam is expanded at various sites in condensing turbines for different drives. Even at COPENE UTIL a number of condensing steam turbines are used for the drive of auxiliary equipment. Hence, a significant part of oil is burned in order to provide driving power by condensing steam turbines.

Several particulars of the engineering design of the COPENE UTIL plant are questionable as well as overall economics, accessibility for maintenance and expected lifetime of the equipment.

2.2. Ammonia plants in São Paulo and elsewhere

Nearly one half of the ammonia production capacity in Brazil is concentrated in São Paulo where three plants belonging to ULTRAFERTIL S.A. are in operation, in particular:

- Cubatão plant. Design capacity 100 t per day. The plant is operating since 1945 using Texaco partial oxidation process of refinery off gas.

- Piaçaquera plant. Design capacity 454 t per day. The plant has been operating since 1970 using Forster Wheeler steam reforming of nafta. Actually, the plant is in course of adaptation for changing the feedstock to refinery off gas.

- Araucaria. Design capacity 1200 t per day. The plant is in operation since 1982 at a capacity factor of about 70 % using Shell partial oxidation process of asphalt residue.

Besides these three plants for which the head office is located in São Paulo there are additional following plants in Brazil:

- Two plants at Camaçari, one of them having design capacity of 250 short tons per day, using Foster Wheeler synthesis gas preparation and Ammonia Casale synthesis process and the second having a design capacity of 1000 short tons per day, constructed by M.W. Kellogg.

- Laranjeiras plant in Sergipe having a design capacity of 1000 short tons per day constructed by M.W. Kellogg.

Thus the total design ammonia production capacity is about 3800 metric tons per day. The total supply of nitrogen fertilizers in 1982 was slightly above 1 million tons of nitrogen of which 70 % was used to satisfy the domestic demand, whereas the remaining nitrogen fertilizers have been exported. It is expected that the domestic demand will balance the production capacity in about three years from now.

All above information was given by the representatives of ULTRAFERTIL S.A. during a meeting held at IPT on September 5 1983.

2.3. Alcohol from sugar cane

The results of the alcohol program in Brazil must be considered as a success, in spite of all controversies about the "gasoline gardens". According to the Reference 4, this program succeeded to replace as much as 17 % of gasoline used for the transport on roads in 1981 (five years earlier, the ratio between the alcohol and gasoline used for the road transport was negligible small, namely 1.2 % only).

The heating value of the alcohol produced from sugar cane is only about 1/5 of the heating value of the feedstock. A significant amount of bagasse is produced as a byproduct of the process. The fate of this byproduct cannot be followed in detail from the general data in the published statistics. However, according to the information received during the mission, a significant part of this bagasse is used to heat the reboilers of the alcohol distillation columns.

Investments for the alcohol production are twice as high as the investments necessary for the increase of the domestic crude oil production, according to the reference 5, which also indicates that each barrel of oil extracted from the Campus basin costs $ 17.1, which is one of the highest cost levels in the world. However, the same reference advocates higher investments in alcohol production instead of investing it in oil reserves that will be exhausted in the foreseeable future.

3. Basic information about energy in Brazil

The already mentioned Reference 4 includes almost all relevant information about the energy fluxes in Brazil. The presentation is excellent and allows a quick reference to almost all relevant data. A similar balance for the state of Bahia (Reference 6) includes some additional information about the methodology of these statistics adopted in Brazil which, according to this reference, has been developed by the Latin American Energy Organization (OLADE).

As in all other known statistical summaries, there is still a controversy about the factors to be used in calculating the so called equivalent amounts of different forms of energy. The recommendation of the author of this report to solve this dilemma is quite simple: Different formes of energy are not equivalent. Therefore, in the author's opinion, the highest value of statistical information can be attained if the data about each form of energy are specified using any well defined unit. Energy balances can be still computed using first law of thermodynamics together with some well defined basic levels of each form of energy and any common unit for all forms of energy. However, it is not very useful to make such assumptions as for example about the transformation of fuels into electric energy in condensing power plants. These assumptions can be often quite far from reality as it has been concluded in Annex 1 to the Reference 6.

Valuable statistical information about oil, its derivatives, coal, alcohol and petrochemistry is included in the Reference 7.

Some selected key data about the primary energy inputs in 1981 are summarized on table 3.1. It can be seen therefrom that slightly more than one half of the fossil fuel requirements have been provided by crude oil of which more than 80 % has been imported at the cost of about 8 billion dollars. According to the Annex 7, this important bill shall be reduced by nearly 60 % by 1985. However, as it follows from the Reference 5, very high investments are necessary to reach this objective.

The hydroelectric potential represents probably the most valuable resource of primary energy in Brazil. In 1981, the installed capacity was 31.1 GW. Another 26 GW are in construction and will be added to the present potential by 1991. By the year 2000, the firm potential (in critical hydraulic periods) shall reach 56.4 GW. In 1982, the average cost of electric energy from hydroelectric plants was equivalent to 2.4 US cents per kWh, including the cost of transmission over average distances.

Comparing the delivery of hydroelectric energy, specified on Table 3.1, with the above mentioned installed capacity, one can conclude that this capacity has been used in less than half the time. This quite limited use cannot be fully explained by limited hydrological availabilities. In fact, the author of the present report has been informed that the actually not exploited capacity is between 2 and 3 GW. Most of this excessive capacity is available in the Southern States of Brazil, namely Parana and São Paulo. However, it should be mentioned that according to the Reference 6, page 56, only 63 % of the transmission capacity to Bahia have been exploited in 1982.

The excess of the capacity of the hydroelectric plants has acctually simply not been delivered and the overflows of the dams are at least partially open. The conclusion is, that hydroelectric energy is presently available in Brazil at zero cost. In fact, the COPENE UTIL plant purchases actually electric energy at 6 cruseiros per kWh, which is equivalent to less than one US cent per kWh, that is at a price which is significantly below the cost of the higher heating value of imported oil.

Coming back to the fossil fuel, it can be concluded that the known deposits of oil and natural gas as spezified in the Reference 2, page 13 are inadequate to increase significantly the domestic production for a prolonged period. Coal reserves in the southern states are large and allow a significant increase of production even if one takes into consideration the fact, that the quality of this coal is not very high. On the other hand, most coal can be exploited using open mines and most deposits are located not very far from the Ocean. That means that this coal can be transported at moderate cost to any place on the Brazilian ocean coast. Peat may represent another significant source of fossil fuel. However, peat deposits are not yet adequately explored. Consequently, the future of peat as a large scale energy source in Brazil cannot be predicted for the time being. In any case, peat cannot be transported over any significant distances at acceptable cost. Only transport by barges can be perhaps economically acceptable. Consequently, the rules valid for coal are still more significant for any peat uses. In short terms, both these fuels can be used either near their deposits or at sites accessible by water.

The author of this report did not collect any information about the deposits of nuclear fuels in Brazil. It seems, however, that the supply of nuclear fuels would not represent any significant problem for nuclear energy program. At present, the capital cost of nuclear power plants is, however, several times higher than the capital cost for additional hydroelectric power.

Table 3.1.

Selected key data from the Brasilian energy balance 1981

Primary energy inputs (oferta interna bruta)

Higher heating values of fuels, MTOE (1)

Crude oil (2)	52.2	
Natural gas	1.1	
Coal	5.8	
Wood	27.6	
Sugar cane	13.5	
Other fossil fuels (3)	0.4	
TOTAL	100.6	MTOE
Electric energy from hydroelectric origin (4)	128.8	TWh

(1) Expressed in MTOE (millions of tons of oil equivalent); 1 TOE = 10.8 Gcal = 45.2 GJ
(2) Of the specified amount 42.4 MTOE have been imported
(3) Combustion of nuclear fuel started in the first Brazilian nuclear power plant (Angra dos Reis 1) in 1982.
(4) In Brazilian energy balances this value is converted to 37.4 MTOE using a "factor of equivalence" equal to 0.29 TOE/MWh. As mentioned elsewhere in this report, its author does not consider it as necessary and/or as useful to make such conversions.

4. Initiated and planned actions towards the reduction of oil imports

Like in many other countries, the necessity to reduce the oil import bill is recognized by almost everybody in Brazil. There are several organizations trying to provide some contributions to this objective.

Thanks to the favorable climate, it is not necessary to heat the houses in Brazil. Contrary to the situation in many countries of the northern hemisphere, which have to import a lot of oil for heating purposes, in Brazil most oil is necessary for industry and transportation purposes.

A national program of the energy conservation in the industrial sector has been prepared by the Ministery of Industry and Commerce (Reference 8). This programm sets general objectives for all industries and specific objectives for the cement, iron and steel industry as well as for the pulp and paper industry. It is essentially recommended to replace oil in the last mentioned industries by coal and, in the pulp and paper industry, by process waste materials and wood. No specific recommendations are formulated for the chemical and petrochemical industry.

The research institutions, namely CEPED and IPT, are basically in charge to help all industries to economize energy. The staff of these organizations analyzes a number of processes and prepares recommendations for the energy economy and last but not least provides basic general information for the personal in all sorts of industries.

The staff of the research organizations is also working on some research programs, which are expected to replace oil and oil products or to reduce their consumption.

5. Suggestions from the author of the present report

5.1. General observations

Most suggestions given in this chapter were already discussed during the mission. Some additional suggestions have been worked out afterwards using the information received during the mission as well as the information available from the home office.

The suggestions are limited to the subjects on which adequate information were available. Their validity is conditioned by the validity of the basic information, which has led to the conclusions and suggestions described in the following sections of this chapter.

As an independent consultant, the author of this report stresses that his suggestions are governed solely by the Terms of Reference of the UNIDO contract and by the interests of the Federation of Brazil in as much as they have been understood by the consultant.

5.2 Heat supply for the utilities in Camaçari

As descriped in the previous chapters, the Camaçari petrochemical complex needs significant amounts of oil and oil derivatives for three principal purposes:

- Chemical feedstock
- Process heat supply
- Electric energy generation

Among the above purposes, the replacement of oil as chemical feedstock, for example by coal, would not only be most difficult but would also need most time and capital. Therefore, attempts to replace oil used for this purpose should be considered at last if at all among actions centered on economy of hydrocarbons. Nevertheless, in many cases liquid hydrocarbon feedstock can be replaced by natural gas or by refinery off gas. Such actions are recommended wherever gas can be supplied over a moderate distance. An economically acceptable distance depends on the size of the gas source; the higher the transport capacity the longer the acceptable distance. The Reference 9 gives some indications about this.

On the other hand, electric energy generation using oil as fuel should be replaced in the highest priority. As already mentioned, the COPENE UTIL plant is producing electric energy by a so called cogeneration process which is more economical than the production of electric energy using oil fired condensing power plants. However, even a cogeneration process cannot be considered as economical in the present Brazilian situation. Each kWh of electric energy produced by cogeneration needs about 110 g of oil, which is actually imported at the cost of about 2 U.S. cents. Simultaneously, the possibilities to obtain the same electric energy from hydroelectric plants are not fully used. As long as this situation exists, a very simple and quick action is recommended, namely to stop cogeneration and to produce only as much steam as necessary for the chemical processes. According to the received information, the COPENE UTIL plant has delivered 344 GWh of electric energy during the first six months of 1983. Consequently, about 14 million dollars per year can be economized on the actual oil import if cogeneration is stopped. No investments are necessary to achieve this economy provided that the capacity of the electric transmission lines to Camaçari is adequate and enough safe to replace the electric power which originates actually from cogeneration by electric power originating from Brazilian hydroelectric plants, the latter being presently not fully used, as already mentioned.

Provided that the above described condition related to the electric transmission lines is met, still more oil could be economized if all condensing steam turbines in Camaçari were replaced by electric motors. A corresponding action needs a careful examination of each case and some investments must be made to implement this recommendation. However, in general, the repayment of such investments can be achieved within a few months.

If the above described condition related to the electric transmission lines is met to an adequate extent, still a more significant action is recommended in order to stop wasting the hydroelectric potential. In particular, the author of the present report recommends to construct electric boilers at the COPENE UTIL plant in Camaçari. The capacity of these boilers should depend on the maximum possible electric power input. If all steam which is necessary for the Camaçari complex and which is actually produced by the combustion of oil were replaced by electric steam generation nearly half a million ton of oil, burned acutally for this purpose, could be economized. This would reduce the oil import bill by nearly one hundred million dollars per year. The available excess hydroelectric power is obviously not constant during the time. As a consequence, the electric power, which can be used for steam generation depends also on the time. However, any shortage of electric power for steam generation can be easily compensated by existing oil fired boilers, which can be always kept hot by using very moderate amounts of oil for this purpose. Hence, a very economic cooperation between the existing oil fired boiler plant and the electric boilers suggested by this report can be easily organized. The investment, necessary for electric boilers is non negligible. However, its repayment can be achieved within a period of less than one month. Most of the necessary equipment can be fabricated in Brazil.

In the more or less far future, one must assume that in Brazil the whole available hydroelectric potential will be necessary for more sophisticated purposes than for steam generation. Electric boilers would therefore probably have a lifetime of no more than a few years and other solutions must be considered for the period afterwards. A number of actions have already been started at the COPENE UTIL plant in order to reduce the oil consumption. An obvious possibility, namely the combustion of residual gases (mainly from pyrolysis) has already been implemented with success. Also about 20 % of the fuel requirements of the COPENE UTIL plant is already covered by natural gas. In spite of all these actions, the problem of nearly half a million tons of oil per year used just for heat generation remains pending. Some attempts are started to replace some of this oil by charcoal and wood and it has been mentioned that in 15 years from now one of the five existing boilers will use only wood as fuel. It is difficult to see technical and economic prospects for this action, which in any case would yield too little and too late. The author of this report does not recommend to continue the attempt to replace oil by biomass in Camaçari but recommends instead another action which has all chances to solve the problem radically and that not only in the present situation but also in the future, assuming that the petrochemical pool in Camaçari will continue to expand.

In the author's opinion, there are only three possibilities to replace oil actually used in Camaçari for heat generation by domestic fuels.

The first possibility is the coal from the South. If this coal can be brought at a sufficient rate and at an acceptable price to the coast, the transport over the ocean will not represent an economic obstacle even if the distance is significant. However, Camaçari is not situated on the shore. The shortest distance to the Bay of All Saints is about 15 km. Coal transport by railway, even over this limited distance, could comprise the economics of the project. A better solution would be to construct a new boiler plant near the coast with an adequate coal storage area directly accessible for ships unloading equipment. Steam from this new plant could be economically transported by a pipeline over the distance under consideration. It should be noted that a new boiler plant would be, in any case, necessary if oil had to be replaced by solid fuels. It is seldom possible to adopt boilers constructed for oil firing to fossil fuels without major changes and without significant sacrifices to the capacity. A new boiler plant near the coast is therefore a better solution.

Domestic peat may represent another valid solution provided that there is enough of it and that it can also be brought over the ocean to a place near Camaçari. In any case, a new boiler plant should be constructed near the coast. But it should be stressed that the coast of a peat fired boiler plant would be significantly higher than the cost of a coal fired plant.

In the author's opinion, the technically and economically best solution for the steam supply to the petrochemical pool in Camaçari is the construction of a nuclear steam supply system. The site of such a system may be selected diregarding any problems of fuel transport. Therefore, it can be constructed as near as possible to the present COPENE UTIL plant. The fact that the steam supply for the whole pool was centralized already years ago represents a very favorable condition for the delivery of the steam to the whole pool by a nuclear steam supply system since it would be more difficult and less economic to construct a multitude of such systems for every particular plant. On the other hand, the sum of the present steam requirements of all plants belonging to the pool is adequate to be supplied by a system under consideration, which can be easily extended in the future as far as necessary. For the present needs, just one nuclear reactor could supply the basic load whereas the existing oil fired boiler plant can supply the peak steam requirements and serve as a reserve for periods during which the nuclear reactor is out of service.

The construction of nuclear reactors started in Brazil in 1971 and the first nuclear power plant (Angra dos Reis 1) was put into operation one year ago. In the meantime, the Brazilian nuclear power plant program has become controversial mainly due to the doubts about its economics as compared to the hydroelectric possibilities. In this context it must be stressed that the petrochemical pool at Camaçari does not need a nuclear power plant but that it needs only a nuclear steam supply system. The investment cost for such a system is only a fraction of the investments necessary for a nuclear power plant for power generation using the same reactor size. As it has already been described, it is not easy to generate the steam in Camaçari by any other means except perhaps by electric boilers which, however, cannot be considered as a permanent solution. Given the fact that nuclear reactors for electric energy generation are already constructed in Brazil, it would be quite wasteful to generate electric energy using nuclear heat in order to use this electric energy in a backward process to generate again heat for Camaçari. Bypassing this two opposite process steps allows to economize about 2/3 of the nuclear fuel and roughly the same proportion of the total investment.

However, advocating a nuclear steam supply system in Camaçari should be accompanied by some recommendations of caution. The nuclear industry succeeded to construct quite safe nuclear reactors enclosed by efficient containments preventing the release of radioactivity in almost all cases. As a consequence, an explosion of a nuclear reactor has become an extremely unlike event but simultaneously, the nuclear industry has allowed to explode something else, namely the investment cost and the time schedules of the construction of nuclear reactors. It is the author's opinion that an acceleration of the nuclear programs, which are badly needed for many developing countries, must be accompanied by an invention of an efficient containment against this explosion of the investment cost and constructing time schedules. The problem is obviously not a technical one but a problem of management. The author believes that it can be solved and that the steam supply for the petrochemical pool in Camaçari may be a good example for this exercice. It should be possible to perform a feasibility study on the subject within about 6 months and in the case of positive results of such a study to construct a nuclear steam supply system in Camaçari within 4 to 6 years from the moment of a committing decision. Return of the necesseray investment can be achieved within a few years, given the fact that one hundred million dollars per year are presently necessary to purchase oil for process heat generation in Camaçari. This amount can be still higher in the future due to the necessary expansion of the petrochemical pool as well as due to the possible increases of the oil prices.

5.3. Ammonia production

Since many years, the world ammonia market has been dominated by suppliers who use cheap feedstock and fuel (mainly natural gas) to produce ammonia. As a consequence, the ammonia prices in the international trade are lower than the prices of liquid feedstock and fuel necessary to produce it. One Brazilian plant, namely Piaçaquera, is actually producing ammonia using naphta as feedstock and as fuel. Since this plant is not very efficient, it needs about 7 barrels of naphta (extracted from imported oil) at a cost of at least 200 dollars to produce each ton of ammonia which is exported at a price of 110 dollars. The detrimental economics of this business has been apparently already detected because the plant under consideration is actually changing the feedstock to refinery off gas. The question still remains whether it is opportune to use this gas (which still represents a valuable product and which is able to replace the oil elsewhere) as feedstock and fuel for ammonia which is produced for export. In the opinion of the author of this report, ammonia production for export from Brazil cannot be presently economical.

Of all Brazilian ammonia plants only the Araucaria plant is using a feedstock for which it would be difficult to find a better application, namely asphalt residiue. As for the remaining plants, it would be presently favorable to deviate as far as possible the feedstock and fuel used by them towards the replacement of oil and to replace the ammonia production by imported ammonia. But such an action cannot be recommended since Brazil will certainly need more ammonia in the future and it would not be wise to rely too heavily on imports of this important product. As a consequence, the decision to change the feedstock from naphta to refinery off gas is considered by the author of the present report as correct. However, in the future the expansion of the ammonia industry can hardly use the same basis since the available quantities of the refinery off gases are certainly limited and as already mentioned could probably find a better use elsewhere in order to replace the imported oil.

A new process developed three years ago by the author of the present report called electroreforming (Reference 10) might be favorable for Brazil. It allows to reduce the hydrocarbon feedstock and fuel requirements to about one half of the requirements of usual plants and to replace the remaining half by about 20 % of electric energy (in relation to the heating value of the usual hydrocarbon requirements). The investments necessary for the construction of a plant using electroreforming processes will also be significantly below the investments necessary for usual plants based on steam reforming. The new process has not been implemented to date, but negociations about the construction of a pilot plant are running in Switzerland and abroad.

Of the existing plants only the Piacaquera plant has been examined more in detail on the basis of IPT report number 18.325 (Reference 11). As already mentioned, the energy efficiency of this plant is poor. The heating value of the feedstock and fuel used actually to produce one ton of ammonia is 11.5 Gcal compared to about 8 Gcal for modern energy efficient plants. The plant design consumption in steady state operation is about 10 Gcal. The difference to actual consumption originate mainly from too frequent stops. The staff of ULTRAFERTIL attempts actually to rectify the situation.

IPT analysed extensively the Piacequera plant and made in the report number 18.325 a number of valuable suggestions to improve the energy economy of this plant. All these suggestions were discussed during the mission and nearly all of them have been supported by the author of the present report.

The possibility to construct a pilot plant for the electroreforming process in the São Paulo area was also discussed with IPT, which will inform about any decision taken on this subject.

5.4. Feedstocks and utilities for alcohol production

Alcohol production from biomass has been treated in many recent publications. The overall energy balance must be carefully observed, as mentioned e.g. in the Reference 12. In Brazil, the process could be significantly improved if a better use is found for the bagasse. Actually, important amounts of it are used as fuel for reboilers of the alcohol distillation columns. This is not a mandatory application. Distillation can be accomplished by thermocompression. In doing so, a lot of bagasse can be replaced by a certain quantity of hydroelectric energy necessary to drive the compressors. On the other hand, the bagasse can still be used as a valuable feedstock for the paper pulp production even if not all qualities of paper can be produced in this way. In any case, bagasse can be used directly after extraction of cellulose as a valuable solid fuel which can be used anywhere at proximity of its source to produce high grade heat rather than low grade heat necessary for alcohol distillation.

Biomass is not the only possibility to produce alcohol in Brazil. Brazilian coal deposits are adequate to provide the liquid fuel supply for long periods ahead. It is strongly recommended to start to consider coal gasification plants followed by alcohol synthesis plants as a second leg of the alcohol production industry.

5.5. Other processes and industries

5.5.1 Distillation

Many distillation processes require significant heating power at a moderate temperature level for the heating of reboilers. On the other hand, almost the same heating power is available from the top condensers at a lower temperature level. If cheap electric power is available, as it is the case in Brazil, the energy cost can be often significantly reduced if conventional heating of reboilers by steam or by direct firing is replaced by thermocompression. In the present situation in Brazil, even a direct electric resistance heating is more economic than oil firing for heating purposes. But thermocompression can significantly reduce the electric power requirements provided that the temperature of the heat source is not too low compared to the temperature level required for the heating. As a general rule, the feasibility and economics of thermocompression should be always examined if the ratio of the said (absolute) temperatures is not lower than 0.8. In such cases, as compared with direct electric resistance heating, additional investment necessary for thermocompression can be generally returned during quite a short period.

The process recommended above is known but was often forgotten during the cheap oil era. In its simplest implementation the top condenser of a distillation column is replaced by a compressor in which the top vapour is compressed to a pressure level necessary to condense it at an adequate temperature level in order to use the latent heat of the condensation for the evaporation of the bottom reflux at the bottom of the column. This reboiler must be, however, often reoptimized in order to be able to exchange the necessary heat flux at a smaller temperature difference than in the case of heating by steam or by direct firing.

As already mentioned above, alcohol distillation represents a good possibility for the application of thermocopression.

In some cases, it may be unpractical to compress the vapour from the top of the column, e.g. if the density of the vapour is too low. In such a case, indirect thermocompression can be still successfully applied and the top vapour is condensed in a recuperator which serves simultaneously as a heat source for thermocompression. The thermocompression process can use in this case any fluid as working medium. Its evaporation takes place in the top condenser and its condensation in the bottom reboiler. The indirect thermocompression needs additional temperature differences accross the top condenser but on the other hand, leaves freedom in the selection of the working fluid and consequently of the type of the compressor.

5.5.2. Drying

Most drying processes need heat at a moderate temperature level to preheat the drying gas (usually air) to a moderate temperature level. In drying processes using closed gas cycles, moisture must be withdrawn by refrigerating. The temperature level of refrigeration remains usually moderate too. Hence, drying processes using either open or closed drying gas cyles are predestinated for the application of heat pumps. Whereas the gaseous drying effluent serves as a heat source and the drying gas heater as a heat sink. A proper selection of process parameters allows usually to close the energy balance. Excess energy, if any, can be evacuated by cooling water.

The temperature levels in drying processes fulfil usually a condition described in the previous section. Therefore, a heat pump is usually a very economic device in drying processes compared to direct electric heating which in turn would be presently more economical in Brazil than heating by oil firing.

5.5.3. Pulp and paper industry

Paper mills need much heat at a temperature level slightly above 100 oC and some heat at higher temperature levels. Most European and Nord American paper mills use medium or high pressure steam boilers and back-pressure steam turbines for electric energy cogeneration. As already described in the section related to Camaçari, cogeneration is not economical in Brazil if boilers are fired by imported oil. Therefore, unless the fuel requirements can be entirely satisfied by process wastes, the energy systems of Brazilian paper mills must be optimized in a different way as compared to paper mills in Europe or in North America. As in the cases of other industries more advanced heat recovery systems must be engineered and the available cheap electric energy must be applied on a larger scale as compared to elsewhere.

Most heat applied for the drying process of a paper mill appears eventually in the enthalpy of the effluent air and can be recovered therefrom at a themperature level between about 50 oC and 90 oC. This heat can be directly applied for at least two purposes: Firstly for preheating the fresh air input to the drying process and secondly for preheating the process water. Besides the energy economy effect, both these applications of waste heat allow also to increase the capacity of existing paper machines.

Sensible heat of the drying air effluent together with the latent heat of its vapour can be also used as a heat source for a heat pump, supplying steam for the heating of the cylinders. In this case, no external steam supply would be necessary for this purpose.

Careful engineering studies and a good design are necessary in order to implement new energy systems of paper mills optimized for Brazilian conditions.

5.5.4. Ceramic industry

The Brazilian ceramic industry is confronted not only with high prices of imported oil but also with official restrictions in supplying light oil for furnaces. On the other hand, replacing light oil by heavy fuel oil may be detrimental to the quality of products.

The fraction of the heat, necessary to dry and to heat up a product of the ceramic industry, is generally small as compared to the losses of ceramic furnaces. New furnaces should be preferably electrically heated. The energy consumption of such furnaces can be significantly reduced as compared to the oil fired furnaces, provided that the new electric furnaces are appropriately designed and constructed.

Retrofitting of existing light oil fired furnaces might be difficult if at all possible. Therefore, it is recommended not to cut the light oil supply too quickly. A leading time of at least a few years is necessary for every industry in order to adapt to new conditions without significant perturbations.

5.5.5. Miscelaneous particular processes

During the mission, the author of the present report asked both CEPED and IPT to formulate at least some particular problems more in depth in order to initiate at least some actions as quickly as possible. As a result, both host organizations presented a number of such particular problems. They were treated during the discussions with the staff of CEPED and IPT. The suggestions given on these subjects are summarized and completed in the Annexes 8 to 15.

It should be mentioned that neither the suggestions given during the mission nor the Annexes to the present report represent any kind of a complete solution of the problems. These suggestions represent recommendations on which an engineering design of each particular case can start. The author of the present report remains at disposal of UNIDO and Brazilian organizations to continue the work on this and other problems as far as necessary and parcticable taking into consideration the distance between Europe and Brazil.

A number of additional problems and questions were discussed during the mission, however not enough in depth as to be included in the present report. The author remains at disposal to continue the examination of all these problems as far as possible and practical. However, it would be necessary to set some priorities for any further actions which may continue on behalf of UNIDO and/or Brazilian organizations.

6. Recommended actio. s

CEPED and IPT belong to the most important research organisations which work on energy problems in Brazil. They have certainly made hitherto many significant contributions to the energy economy. However, the tasks for the immediate future have raised tremendously as compared to the previous situation. In particular, it is necessary to translate the national programs of the energy conservation into a set of concrete actions, which can be implemented in the necessary period. The objective is high, namely the escape from the financial squeeze.

Energy can be economized almost everywhere but not every action leads to the same magnitude of results. It is therefore mandatory to set proper priorities and to assign for the corresponding activities the best human and material resources.

On the basis of the information collected during his mission the author of this report summarizes below the most important recommended actions.

a) As long as hydroelectric energy is wasted and as long as it can be distributed by the existing network to the users, it is recommended, to stop burning oil for heating purposes and to replace oil heating by electric resistance heating.
b) Provided that the condition a) is fulfilled for the Camaçari petrochemical pool, it is recommended to stop the cogeneration of electric energy and to replace the electric energy from the COPENE UTIL cogeneration plant by electric energy from hydroelectric sources. The existing boiler plant can still continue to deliver steam at necessary pressure levels using pressure reducing valves.
c) Provided that the condition a) is fulfilled for the petrochemical pool at Camaçari, it is recommended to start a feasibility study about the installation of electric boilers for delivery of process steam in order to replace steam originating from oil fired boilers at least for the periods during which excessive hydroelectric energy is available.
d) Start a feasibility study about the construction of a nuclear steam supply system for the petrochemical pool at Camaçari.
e) Start actions towards the development of ammonia productions in Brazil using electroreforming of hydrocarbons.
f) Start feasibility studies about the coal gasification for alcohol synthesis.
g) Apply steam compression for all distillation processes wherever the ratio of absolute temperatures between the heat source and the heat user is not too low, in particular for alcohol distillation processes.
h) Apply heat pumps to all processes wherever heat is required at a moderate temperature level, in particular for most drying processes.
i) Select electric resistance heating for new furnaces in the ceramic industry.

As already mentioned, the actions recommended above are based on the information collected during the mission. It is quite likely that other actions of similar if not of greater importance could also be recommended as soon as the knowledge about other energy transformation processes is aquired. It has already been mentioned that the author of this report is interested to continue the initiated actions and to contribute as quickly as possible to the energy conservation program in Brazil.

The efficiency of future visits to Brazil (if any) can be significantly increased if meetings are scheduled in advance at an adequately high level of management of the Brazilian national energy programs. In particular, it would be very useful to discuss some key issues with the president or members of the Brazilian National Energy Commission.

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Annex 1 to R. 526'7'1

DP/BRA/82/003/11-57/32.4.B

Terms of Reference for

Mr. Ludwig Silberring

The expert will be expected to give advice on:

1) energy studies in chemical/ petrochemical industries;

2) fuel conversion from oil to coal or other domestic fuels;

3) waste heat recovery and use of waste heat;

4) technological advances in reduction of energy consumption;

5) identification of projects where energy savings potential exists within industry;

6) methodologies applied to study of data and energy conservation;

7) utilization sensible heat of hot and cold flows;

8) evaluation of energy capacities of various equipment consuming energy from chemical/petrochemical industries;

9) presentation of topics 6, 11, 12, 13, 15, 17, 28, 31, 33, 35, 38, 40, 41, 42, 45 and 48 according expert's list of publications;

10) prepare final report setting out the findings of the mission and recommendations to the Government on further action which might be taken.

CEPED

ENCONTRO TÉCNICO SOBRE CONSERVAÇÃO DE ENERGIA NAS INDÚSTRIAS PETROQUÍMICAS

EXPOSITOR: Dr. LUDWIG SILBERRING

EXPOSIÇÕES	Datas
1. O poder calorífico e exergético dos hidrocarbonetos.	19/08
. Os sistemas de tratamento de energia.	19/08
2. Otimização do aquecimento de ar em geradores de vapor.	19/08
. Otimização da temperatura de saída dos gases.	19/08
3. Fluídos alternativos para geração.	22/08
. A caldeira de vapor sobre-alimentada.	22/08
4. Bombas de calor. Economia nas bambas de calor. Contribuição na economia energética. Tecnologias e possibilidades de aplicação.	22/08
5. Recuperação de calor em plantas de amônia.	23/08
. Trocadores de calor para plantas de amônia.	23/08
6. Processo de separação de gases inertes em plantas de amônia (Synthesis Loop).	24/08
PAINEL	
7. Rejeitos petroquímicos e seu aproveitamento.	29/08
8. Otimização energética em sistemas complexos de trocadores de calor.	29/08
9. Recuperação de calor em fluídos de baixas temperaturas.	29/08
10. Sistemas de vácuo: ejetores versus bombas de vácuo. Sistemas mixtos.	29/08

Participantes: Pessoal do CEPED.

SEMINÁRIO

. Metodologias e evolução do uso de energia em plantas petroquímicas.	25/08
. Metodologias de otimização em sistemas de vapor.	26/08

Participantes: Pessoal do CEPED e Polo Petroquímico

Sugestões para futuros Programas e Reserva de Tempo	30/08

Participantes: Pessoal do CEPED

X CIRCULAR

DE : Comissão Treinamento AET 01 9 83

PARA: Equipes dos Projetos: Manual de Fertilizantes/Manual de Celulose Papel/CNP 90

CÓPIAS PARA: Fausto Furnari - AET
Marco Giulietti - Grupo Eletrotermia IPT
Walter Link - DEM

REFERÊNCIA

ASSUNTO: Visita do Consultor da UNIDO: L. SILBERRING

Anexo, o programa de atividades do que o referido consultor deverá cumprir no IPT durante a sua estadia até o dia 09/09/83.

Solicita-se a colaboração dos técnicos envolvidos para os horários indicados. Qualquer modificação que se faça necessária pode ser feita diretamente com a Comissão ou com o colega Márcio de Souza Santos.

O Seminário previsto para o dia 08/09/83 está sujeito à confirmação e, em caso positivo, será divulgado amplamente por nova comunicação.

COMISSÃO TREINAMENTO AET

Maria Aparecida Salles/Sílvio Oliveira Jr./Marcos Bruno

Annex 3 to R. 526'7'1

	PARA USO DO DESTINATÁRIO				RECEBEDOR	
	DE	DATA	PARA	PROVIDÊNCIA	RUBRICA	DATA
A - ARQUIVAR						
C - CONHECER						
D - DEVOLVER						
O - OPINAR						
P - PROVIDENCIAR						
V - VIDE VERSO						

PROGRAMA TENTATIVO

Visita do Consultor da UNIDO: L. SILBERRING

Período: 31/08/83 a 9/9/83

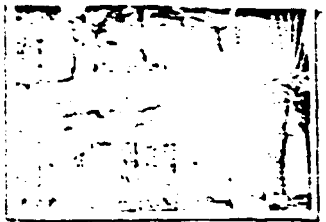
31/08	01/09	02/09	03/09	04/09
. Recepção/Apresentação do AET . Discussão e fechamento do programa . Visita ao AET/IPT FAUSTO/MÁRCIO/BRUNO	. Leitura relatório Ultrafértil/Preparo reunião BRUNO	. Conservação de Energia - NH_3 1. discussão das potencialidades do relatório Ultrafértil 2. preparação da reunião técnica com Ultrafértil (Paiva/Bing/Eugênia/Equip.Manual de Fertilizantes/Marco) LOCAL: sala aula CEFER DURAÇÃO: manhã/tarde	SÁBADO	DOMINGO
05/09	**06/09**	**07/09**	**08/09**	**09/09**
. Reunião com Ultrafértil IPT (Equipe Manual Fertilizantes/Paiva/Bing/Eugênia/Marco) Ultrafértil (Eng? Socolowski/Eng? Clovis/Eng? Obdulio) LOCAL: sala aula CEFER DURAÇÃO: manhã	. Emprego de bombas de calor(manhã) (Sílvio/Marco) . Conservação de Energia na Indústria de Celulose e Papel (tarde) (Adriano/Zé Hélio/Ronaldo/CNP 90/CTCP)	FERIADO	. Seminário "Sistemas de Tratamento de Energia" LOCAL: sala aula CEFER HORÁRIO: 9:00 às 12:00 h AET/OUTRAS DIVISÕES IPT	. Entrevista com a Diretoria do IPT . Avaliação da visita FAUSTO/COM.TREINAM.AET

RELAÇÃO DOS PARTICIPANTES EXTERNOS

N O M E	EMPRESA / ENDEREÇO
LUIZ ANGELO SANTOS	OXITENO DO NORDESTE S/A Rua Eteno s/n - Camaçari-Ba
ANTONIO FERNANDO A.P. COELHO/ /JOSÉ ANTONIO DE C. CUNHA/ E WILTON AROLDO WEBER	COPENE - PETROQUÍMICA DO NORDESTE Rua Eteno s/n - Complexo Básico Pólo Petroquímico
MANUEL JORGE AMBROSINE	FISIBA - FIBRAS SINTÉTICAS DA BAHIA S/A Rua Nafta s/n - P. Petroquímico
JORCELINO TAVARES BASTOS	POLIALDEN - PETROQUÍMICA S/A Rua Hidrogênio s/n - P. Petroquímico
MANUEL VELOSO/ EDUARDO MENDONÇA	METACRIL - COMPANHIA QUÍMICA Fazenda Caroba s/n - CIA - Candeias - Bahia
MÁRCIO TAVARES BARREIROS/ROBERTO DE CARVALHO..................	NATRON - CONSULTORIA E PROJETOS S/A - Av. Pres. C. Branco, 750
ARNALDO LIMA BARBOSA/SILVIO MOURA FRANCO/JOSAFÁ NASCIMENTO MOURA/AIRTON BARBOSA BONFIM.......	PETROBRÁS - PETRÓLEO BRASILEIRO S/A Av. Luiz Viana Filho s/n - Acesso Stiep - Salvador - Bahia
ANTONIO CARLOS BROCANELLO/NELSON TIETROBON DE S. GOMES......	NITROCARBONO S/A Rua Hidrogênio s/n - Pólo Petroquímico
EDILSON PINHEIRO DE MOURA......	POLIPROPILENO Rua Alto Cacinba, 21

Continuação...

N O M E	EMPRESA / ENDEREÇO
J. OKAMOTO	ACRINOR - ACRILONITRILA DO NORDESTE S/A Rua Hidrogênio s/n - Pólo Petroquímico
ANA VIRGINIA F. ROCHA/JOSÉ ROBERTO ARAGÃO ARAÚJO............	PRONOR - Rua Hidrogênio s/n - Pólo Petroquímico



Por falta de local, os ambulantes guardam seu material nos abrigos.

apareceu um caminhão e saiu cheio de tabuleiros", contou Francelina de Jesus, há dois anos desempregada e por isso optou pela barraca, informando que o pessoal guarda o material durante a noite, daí não ver necessidade em retirar as coisas de onde estão. Para ela, se fosse dado um lugar especial para guardar os seus tabuleiros, não havia necessidade de ser utilizado o teto dos abrigos.

...bancos estão ... as empresas

pelos bancos estabelece uma concorrência desigual que não beneficia o setor nem o país. "Pelo contrário, a expansão dos bancos no turismo não tem contribuído para o crescimento do mercado, fazendo-se muito mais pelo deslocamento de ... existentes, o que resulta em perda de ... humanos especializados".

Alf Domingos disse que o esmagamento das empresas menores, neste como em outros setores, afeta a oferta de emprego e leva o Estado a procurar suprir, por meio de atuação direta, a criação de empregos, levando a uma maior estatização da economia. "Defendo que os próprios bancos deveriam se conscientizar disso e procurar restringir sua atuação às atividades financeiras, apoiando as pequenas e médias empresas dos diversos setores, com o que estariam contribuindo para fortalecer o setor privado e, consequentemente, a sua própria posição em relação a ele", afirmou.

— Caso contrário — salientou — cabe às autoridades monetárias, cuja política até agora tem levado à concentração e à verticalização do setor financeiro, adotarem medidas que não apenas contenham os bancos nas atividades que lhes são próprias, como ainda facultar o surgimento de novas instituições financeiras, produzindo maior concorrência no setor. Se não, corremos o risco de vermos confirmadas no Brasil as previsões de Marx, com o desaparecimento das pequenas e médias empresas.

MESA-REDONDA

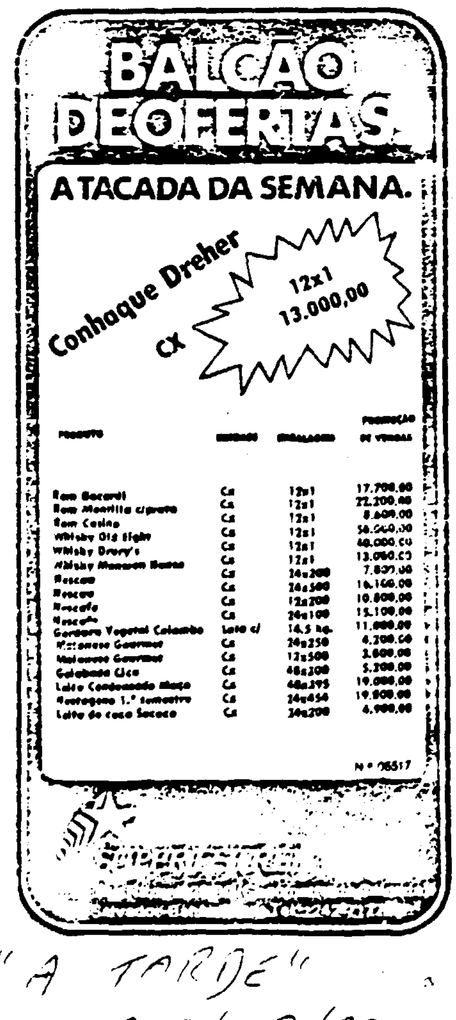
Durante a mesa-redonda que se realizará no sábado, dia 3 de setembro, serão revistos os principais acometimentos dos reumatismos fora das articulações, destacadamente o envolvimento do coração, dos rins, da pele e dos pulmões. O curso vai possibilitar aos médicos não-especialistas uma reciclagem dos seus conhecimentos com atualização dos novos avanços na área reumatológica e, aos estudantes, uma avaliação panorâmica, sob o aspecto clínico, diagnóstico e terapêutico.

As inscrições já se encontram abertas na Secretaria da Escola de Medicina e Saúde Pública da Bahia (Sra. Maria Leal) e Hospital das Clínicas (Sr. Raimundo, no stand da Guanabara). Serão conferidos certificados a todos os participantes.

O PROGRAMA

No dia 2 de setembro o simpósio versará sobre "Abordagem do paciente reumático", tendo como coordenador o professor Lipe Goldenstein. Às 20h30min, será efetuada a "Abordagem Clínica", pelo professor Aecio Soares de Brito; às 20h45min, "Abordagem Psicológica", pelo professor Arthur Kaufman; às 21 horas, "Abordagem Endocrinológica", pelo professor Marcelo Bromstein; às 21h15min, "Abordagem Terapêutica", pelo professor José Knoplich. Às 21h30min haverá debates sobre as exposições, com perguntas da assembléia e dos componentes da mesa.

No dia 3, sábado, haverá mesa-redonda sobre o tema "Dia-a-dia na prática", ainda coordenada pelo professor Lipe Goldenstein. Às 8h30min, "Erros comuns no manuseio das reumatopatias", pelo professor Aecio de Brito; às 8h45min, "Conduta Psicoterapêutica nos Reumáticos", pelo professor Arthur Kaufman; às 9 horas, "Tratamento das manifestações reumatológicas das endocrinopatias", pelo professor Marcelo Bromstein; às 9h15min, "Conduta nas Lombalgias", pelo professor José Knoplich; às 9h30min, debates com perguntas e respostas. Em seguida, haverá nova mesa-redonda com o tema "Manifestações extra-articulares das doenças reumáticas", tendo como coordenador o Dr. Nivaldo Souza Cardoso. Às 10 horas, a Dra. Eugênia Araújo abordará as "Principais manifestações cutâneas"; às 10h15min, o Dr. Albino Novais falará sobre as "Principais manifestações renais"; às 10h30min, "Principais manifestações cardiovasculares", pelo Dr. Edgar Marcelino; às 10h45min, "Principais manifestações pulmonares", pelo Dr. Argemiro D'Oliveira.



pongrével de esforços e responsabilidades", finalizou Pinho Coutinho.

Centec vai melhorar o ensino de mecânica

O diretor geral do Centro de Educação e Tecnologia da Bahia — Centec, professor Jeferson Bacelar, esteve recentemente em Brasília, onde manteve contatos com diretores da Secretaria Geral e da Secretaria de Ensino Superior do Ministério da Educação e Cultura. Na oportunidade, definiu a liberação de recursos para complementação da área de mecânica.

A área de mecânica do Centec, com os recursos conseguidos pelo diretor geral, terá a implantação do laboratório de termodinâmica e instrumentação, o que vai possibilitar maiores facilidades aos alunos destes cursos naquele estabelecimento de ensino.

Todos estes equipamentos serão destinados à área de ensino, bem como a implementação do programa de nacionalização de peças e prestação de serviços à comunidade".

Jeferson Bacelar definiu ainda em Brasília, a data de realização do curso sobre "Princípios para planejamento de estruturas de cargas e salários das Universidades", que será realizado no Centec de 12 a 23 de setembro próximo. Este evento contará com a participação de dirigentes de pessoal das universidades do Norte e Nordeste, inclusive a participação do diretor de Pessoal do Ministério da Educação e Cultura (MEC).

Ceped tem consultor: assuntos de energia

Dentro do convênio existente entre a UNIDO/PNDU através da STI/MIC, foi convidado para assessorar o programa de energia do Centro de Pesquisa e Desenvolvimento-Ceped, o engenheiro Químico, Ludwig Silberring, com mestrado em Energia, no Instituto Politécnico de Wroclaw, na Polônia, e doutorado em Termodinâmica, pelo Instituto Politécnico de Zurique, Suíça. O convênio visa a substituição e conservação de energia.

Segundo declarações de técnicos do Ceped, o engenheiro Silberring trabalhou em mais de 30 grandes projetos de geração de energia térmica na Suíça, França, Suécia, Itália, Peru, Venezuela, abrangendo até usinas de 350MWt. Estão incluídas ainda na experiência do consultor que na sexta-feira última visitou e proferiu uma palestra no Ceped, conhecimentos da indústria petroquímica, fertilizantes nitrogenados e de papel em vários países.

O engenheiro suíço proferirá, hoje, uma palestra no auditório da Coelba, em Salvador quando abordará o tema "possibilidades de substituição de diferentes formas de energia".

Quanto ao programa de consultoria no Ceped, abrange treinamento e assessoramento em: energia nas indústrias químicas e petroquímicas, uso alternativo de fontes de energia, conversão de óleo para carvão ou outro combustível produzido localmente, recuperação de calor, e identificação de projetos onde existe potencialidade de economia de combustível nas indústrias.

PROGRAMA DO CEPED

Afirmam os técnicos que o Ceped está desenvolvendo um programa junto às indústrias da Bahia buscando não só reduzir o consumo de derivados de petróleo na área de energia industrial como também objetivando a substituição de derivados de petróleo por combustíveis encontrados localmente. Projetos relacionados com o aproveitamento da turfa, de resíduos vegetais, gaseificação de madeira que interessam à Copene, às indústrias de cerâmicas, de cimento metalurgia e outras que estão em curso. "Estes projetos têm participação do SME-Ba, da STI/MIC, da Finep, da Copener e de algumas empresas locais. Quanto aos resultados das pesquisas em andamento terão significativa contribuição ao esforço do governo no sentido de reduzir as importações de petróleo".

Disseram, ainda, que um manancial de mais de 50 publicações importadas na área de energia atesta o alto nível do consultor escolhido pela UNIDO. Esta intimidade com a energia Petroquímica o Ceped colocou à disposição de um público oriundo de 11 empresas locais como: Copene, Natron, Petrobras, Oxiteno, Fisiba, Polialden, Metracril, Nitrocarbono, Polipropileno, Pronor e Acrinor, através da realização de um seminário com o engenheiro Ludwig Silberring, nos dias 25 e 26 em seu auditório, do qual participaram mais de 60 técnicos das empresas.

"A TARDE"
29/08/83

SPECIFIC PROJECTS

1 - Heat pump utilization for cacao-bean drying

2 - Gas generation from biomass and purification for stationary engine up to 2 MW for eletric pawer generation.

THEMES

1 - Waste heat recovery projects.

2 - Heat pump application in chemical plants.

3 - Exotermic reactions heat recovery

4 - Chemical processes modifications with respect to energy economie.

5 - Thermic integration of systems: distillation columms, heat exchangers, etc, otimization.

6 - Feasibility studies.

SUBSTITUTION OF PETROLEUM DERIVATIVES (1000 b e p d)(*)

	1979	1980	1981	1982	1983	1984	1985
Substitutes							
1. Biomass(1)	0	9	4	29	57	87	117
2. Coal	0	9	17	25	46	56	60
3. Natural Gas	0	2	2	11	23	40	42
4. Eletricity	0	0	0	0	13	33	49
5. Total substitute	0	20	23	65	139	216	268
6. Domestic oil	171	187	220	266	324	429	500
Consumption							
7. Teoretic	1.122	1.118	1.039	1.083	1.083	1.083	1.083
8. Actual	1.122	1.098	1.016	1.018	944	867	815
9. Imported	951	911	796	752	620	438	315

(*) barrels equivalent of petroleum per day

(1) includes: wood, charcool, tar oils, alcohol, sugar cane bagasse, agricultural and forest residues.

Received from ITT

Annex 7 to R. 526'7'1

VACUUM SYSTEM OF A SODIUM CYANIDE CRYSTALLIZER FOR METACRIL, CENTRO INDUSTRIAL DE ARATU

Problem presented by Mr Rodolfo Mattos of CEPED

In the plant under consideration a sodium cyanide solution is concentrated in a vacuum evaporator located upstream a crystallizer. According to the enclosed scheme designated "System 1", vacuum is maintained by a three stage ejector with two intermediate condensers, the first of them being feed by cooling water and the second by brine. It is not clear how the ice formation is prevented in the second condenser since the temperature of the brine is -15 oC at the inlet and -6 oC at the outlet.

The ejectors are driven by saturated steam at an effective pressure of 7 kg/cm2. The evaporator is also heated by steam at an effective pressure of .35 kg/cm2. In addition, a small amount of steam at an effective pressure of 3 kg/cm2 is used to heat the connection pipe between the evaporator and a crystallizer. Altogether, the system needs 3.25 t/h of steam. Most of it is necessary for the first stage ejector and for the heating of the evaporator. A simple calculation shows that the production of this steam needs about 2000 t of fuel oil per year at the cost of about 220 million cruseiros.

The key question asked was how to economize steam. Mecanical steam compression could be used at least instead of the first stage ejector in order to replace its high steam consumption by some electric power for compressor drive. In addition, compressed steam could be used to heat the evaporator and to replace also the significant amount of steam actually used for this purpose. A closer examination of the problem leads to the conclusion that the steam compressor, necessary in this case, would be quite big and expensive. As a consequence, another system is suggested. It is shown on drawing nr. 526/7/2.

The essential elements of the suggested modifications are as follows:
A refrigerated condenser should be incorporated in the steam line between the evaporator and the first stage ejector. A moderate level of refrigeration, namely an evaporating temperature of 10 oC and a condensing temperature of 60 oC, is adequate to condense nearly all the steam originating from the evaporator. The evaporator heating coil may serve as a condenser of the refrigerating equipment. Consequently, the added equipment would mainly consist of a heat pump of which the hot end will be used to evaporate the water from the solution and the cold end to condense the vapour exctracted from the solution. Refrigerant 12 may be used as working medium of this heat pump. In this case, a set of piston compressors or preferably one or two screw compressors may be used for the heat pump. Superheated refrigerant vapour may be preferably used to heat the downcomer between the solution evaporator and sodium cyanide crystallizer.

The existing heating coil of the solution evaporator must be replaced by a bigger one securing adequate heat flux at a lower temperature difference and constructed for the maximum pressure at the delivery side of the compressor. The refrigerated vapour condenser will be an apparatus of significant size and must be well egineered in order to secure safe operation and an optimum ratio between the investment and operating cost.

The feasibility of the modified system depends largely on the vacuum tightness of the equipment. It is mandatory to secure that the air leakage into the system is not higher than specified, namely 6 kg/h.

The existing ejectors will be replaced by very small ones, sized to compress the mentioned air flow together with residual vapour, saturating this air at the temperature downstream the said refrigerated condenser.

When the system is implemented the whole present steam consumption will be reduced to a negligible fraction and electric power for the driving of a heat pump compressor will be used instead. The necessary power is estimated to be 280 kW, which will lead, even at 14 cruseiros per kWh, to an annual energy cost of 30 million cruseiros compared to the present 220 millions cruseiros. In addition, it should be mentioned that oil for steam production must be imported whereas the electric energy necessary for the modified system originates from domestic sources.

As a consequence, it is strongly recommended to continue the action on these lines. As a first step, it is recommended to verify the actual air leakage into the system. Afterwards, a rough estimation of the necessary investments has to be made. At the present stage of the investigation, the return of the necessary investment can be expected in less than two years.

Enclosures

System 1: sheet 1 to 3
Drawing nr 526/7/2

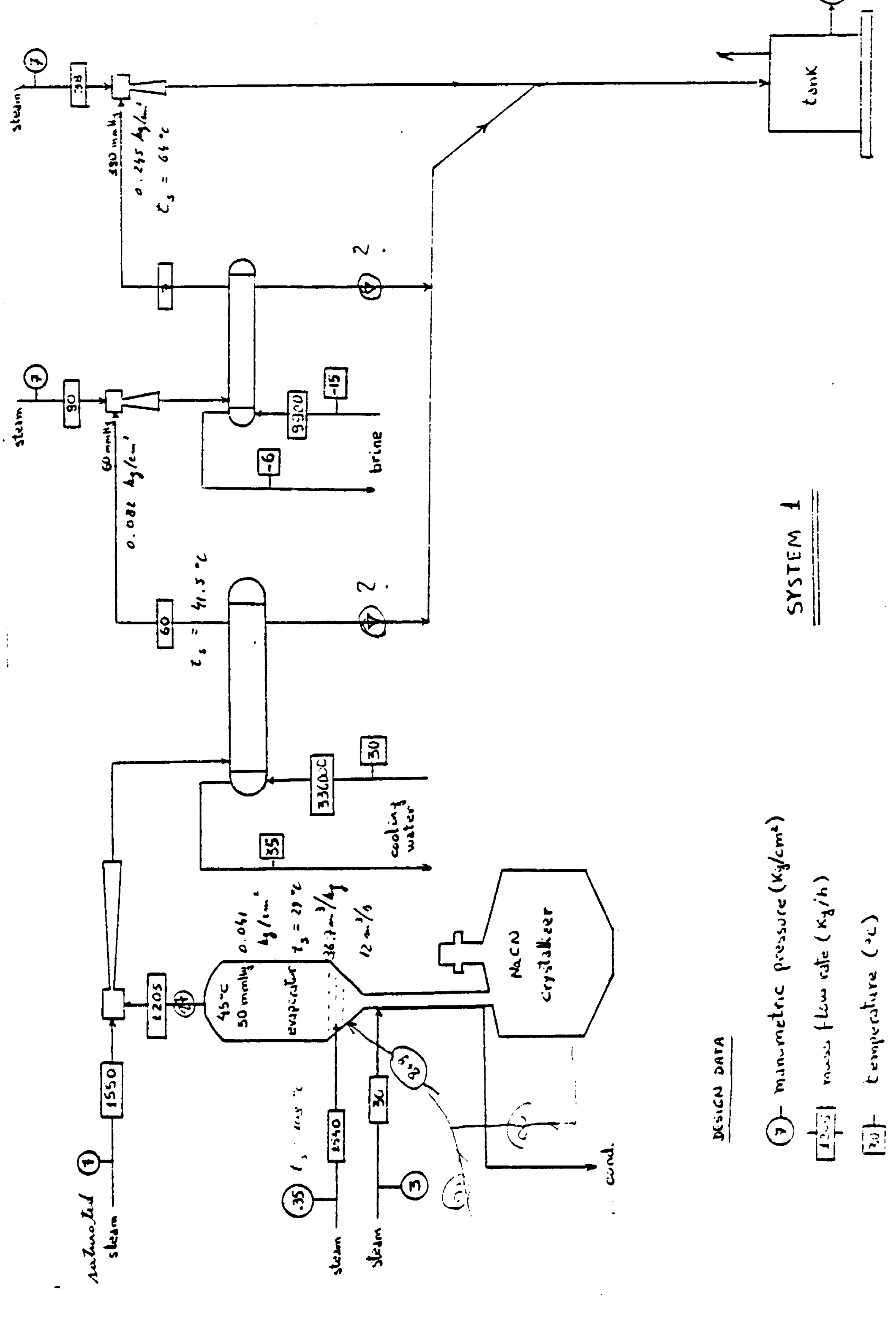
SYSTEM 1

- Vacuum system for NaCN evaporator (3 ejectors) (see scheme)

Conditions at the evaporator:

- temperature of the solution into the evaporator = 45 °C
- pressure into the evaporator = 30 mmHg (abs.)
- flow rate of the evaporated = 1205 Kg/h

1) How do we economize steam here?
2) It's technically possible to replace the entire system of ejectors by vacuum pumps? And economically?
3) It's economic in this case to use a mixed system? How much steam could we ecomize so?
4) What's the economic solution that would give us the major steam economy?


SYSTEM 1
steam
tank
brine
cooling water
NaCN crystallizer
evaporator
45 °C
50 mmHg
saturated steam
cond.
1550
1205
1540
30
60
90
38
9900
33600
-15
-6
35
DESIGN DATA
manometric pressure (Kg/cm²)
mass flow rate (Kg/h)
temperature (°C)

air → 6 kg/h ?

[illegible] → [illegible] kg/h

p → 800 mmHg abs

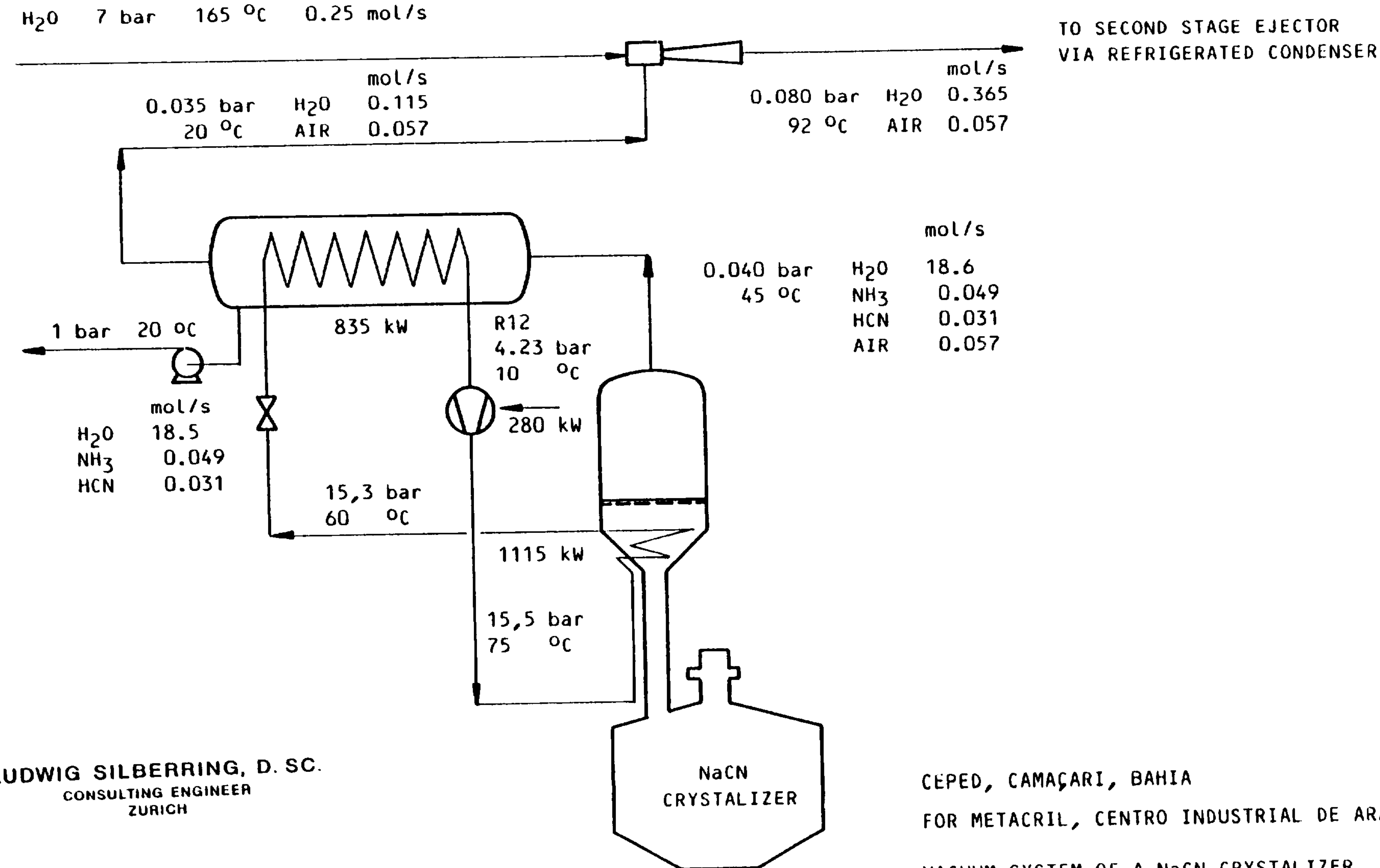
2)

air → 36 kg/h ?

[illegible] → 45 kg/h

1)

[illegible] → 1205 kg/h	66.9	kmol/h
NH_3 → 3 kg/h	0.2	"
HCN → 3 kg/h	0.1	"
air → 5 kg/h	0.2	"
	67.4	kmol/h = 18.7 mol/s



LUDWIG SILBERRING, D. SC.
CONSULTING ENGINEER
ZURICH

DRAWING NR 526/7/2
16 NOVEMBER 1983

CEPED, CAMAÇARI, BAHIA

FOR METACRIL, CENTRO INDUSTRIAL DE ARATU

VACUUM SYSTEM OF A NaCN CRYSTALIZER
RECOMENDATION OF A MODIFICATION

AMMONIUM SULPHATE PLANT OF METACRIL AT THE CENTRO INDUSTRIAL DE ARATU. POSSIBILITIES OF THE RECOVERY OF THE HEAT OF FORMATION OF AMMONIUM SULPHATE ACCORDING TO THE ENCLOSED SHEET

A problem presented by CEPED

According to the enclosed sheet, saturated steam having a temperature of 105 oC is produced by the exothermic reaction between ammonia und sulphuric acid at a rate of 2110 kg/h. The steam is contaminated by sulphur trioxyde and possibly by droplets of sulphuric acid. The reactor used for the synthesis of ammonium sulphate is made of stainless steel AISI type 316 L.

It is understood that some use can be found for the latent heat of the produced steam, even taking into account that the temperature level of the available heat is moderate. The recovery of this heat could eventually lead to an economy of about 1000 t of fuel oil per year. An increase of the temperature level of the heat recovery is possible by increasing the reaction pressure. However, this would mean a significant modification of the existing process. All consequences of such a modification must be carefully examined prior to taking it into consideration.

The corrosive contaminants of the steam represent a major obstacle for the heat recovery. The same steel as used for the reactor would not be adequate for a heat exchanger since its resistance to the corrosion by diluted sulphuric acid is only moderate. High corrosion allowances are uneconomical for a heat exchanger and the lifetime of the tubes would be anyway too short if AISI type 316 L steel were used anyway. Other materials can be, however, successfully applied. In particular, the heat exchanger can be made of Hasteloy B, Hasteloy C, or Alloy 20 (Carpenter).

The condenser under consideration will be of moderate size provided that at least 5 oC difference can be allowed between the temperature of the saturated steam and the outlet temperature of the heated medium. Therefore, if the available heat can be efficiently used the installation of such a steam condenser is recommended. Repayment of this investment can be achieved in less than one year provided that the recovered heat leads to a corresponding economy of fuel oil.

Enclosures

System 2: 1 sheet

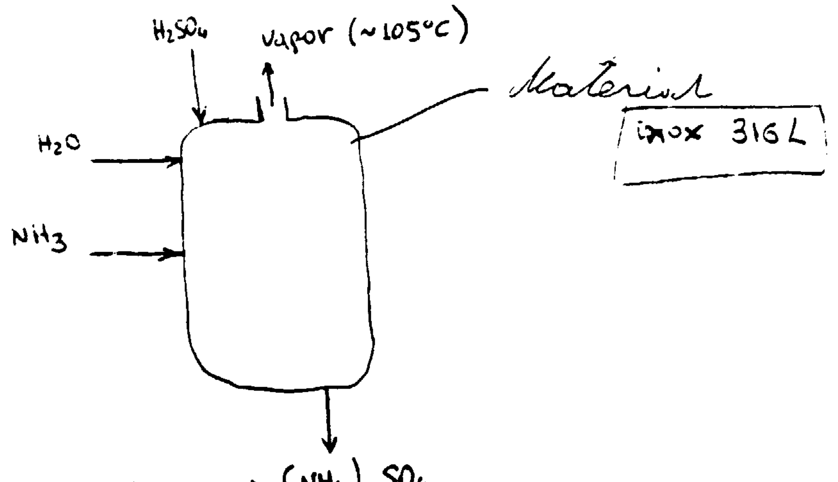
Ammonium Sulfate Plant METACRIL (CIA)

Ammonium Sulfate formation heat is not recovered. The crystalizer is open to the atmosphere and the vapor formed goes out at a temperature about 105 °C. It takes away about 1.200.000 Kcal/h. There may be corrosive products with the vapor (Ex: SO3) SO_3

Assuming that there is a place where use the heat recovered:

1 - what type of recovery equipment could we use?
2 - what type of materials could be used? Types of problems.
3 - what the highest temperature we could get?

Notes: Temperature of inlet NH_3 and H_2SO_4 ≈ 30 °C
Flow rate of the vapor is about 2110 Kg/h



$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$
(sol + crist.)

ETHYLENE OXIDE PLANT OF OXITENO CAMACARI. POSSIBILITIES
OF ENERGY ECONOMY IN THE SCRUBBING AND STRIPPING SECTION

Problem presented by Mr Raphael Viana of CEPED.

The process flow diagram of the plant section under consideration is shown on the enclosed sheet prepared by CEPED. According to it, a heating power of about 34 MW is rejected due to the necessity to cool the circulating water from 75 oC to 31 oC.

When heat is rejected in cooling towers the stage for this has been usually already set elsewhere in the plant. Consequently, the cooling tower can hardly be blamed for heat losses since it is generally difficult to make any use of low grade heat in chemical plants except for heating of make-up water for boiler plant. In the case of the Camaçari petrochemical pool, it is known that steam is distributed among the users from a central point, namely from the COPENE UTIL plant. Condensate is not recycling because of its possible contamination. On the other hand, it is not clear how the COPENE UTIL plant heats the demineralized water to replace the lost condensate. It is most probably done by steam originating from the exhaust line of the steam turbines. This is still quite high grade steam (15 bar). In any case, oil must be ultimately fired in the boiler in order to preheat the demineralized water unless this water is preheated by some waste heat. If this is not the case at the COPENE UTIL plant, it is recommended to decentralize the deminaralizing plants and to replace the condensate lost in any factory by deminaralized water. The latter can be locally preheated as far as possible by waste heat prior to the delivery to the COPENE UTIL plant.

The suggestion made above represents a major change in the existing water preheating system of the Camaçari pool. Its feasibility and economics must be carefully studied since the potential fuel economy is quite high. If this suggestion was realized, the cooling tower of the ethylene oxide plant could be replaced by a heat exchanger, preheating demineralized water to a temperature of about 70 oC. As a consequence, the heat loss would be eliminated.

Another possibility to reduce the heat loss of the cooling tower exists by increasing of the heat recovery between the scrubber and stripper as already suggested in the enclosed CEPED sheet. The heat exchanger, which already exists for this purpose, operates at quite high temperature differences, namely 14 K on the hot end and 15 K on the cold end. Using a better heat exchanger the temperature differences in question may be easily reduced to about 1/3 of the present value. As a consequence, the heat rejection in the cooling tower could be reduced to about 78 % of the present value.

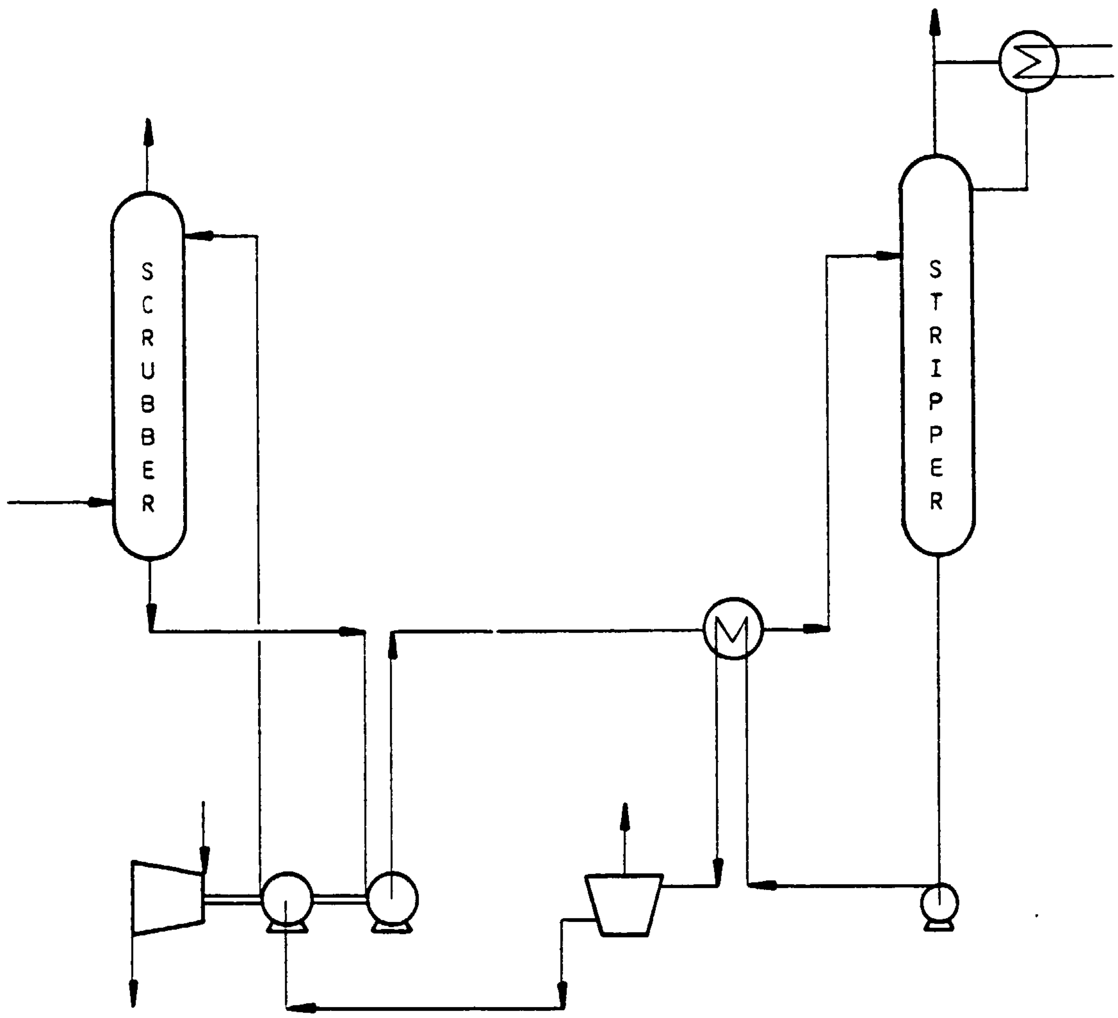
An additional heat exchanger can be added in series to the existing heat exchanger but replacement of the existing heat exchanger by a better one would represent a better solution: For exemple a plate type heat exchanger could be economical even if the minimum difference of temperatures between the heating and heated medium were as low as 3 K. Doing so, the steam input to the stripper can be reduced to the quantity necessary just for stripping. That is slightly more than one half of the present steam input. In the present situation, another half of the steam input is used to preheat the feed at its inlet from 98 oC to 112 oC.

Operating conditions of the stripper will change if the temperature of the feed is increased. The precise flow rate of the steam required for adequate stripping must be determined by a careful analysis of the equilibria within the stripper. At present, it can be expected that the actual steam flow rate of nearly 36 t/h can be reduced to no more than 20 t/h. That means that nearly 10'000 t of oil can be economized per year. This economy would very quickly pay back a better heat exchanger.

Another significant economy is possible within the part of the plant which is represented on the enclosed sheet. In particular, significant power is necessary to pump the bottom effluent of the stripper to the pressure in the scrubber, which is as high as 22 bar. At least one half of the power necessary for driving this pump can be economized if the expansion of the bottom effluent of the scrubber will be made in a hydraulic turbine, the shaft of which is coupled with the pump shaft (see enclosed drawing nr 526'7'3). This is a standard technology in all carbon dioxide removal systems in ammonia plants. As a consequence, about half of the steam flow rate to the pump driving steam turbine can be economized. The fate of the back-pressure steam from this turbine is unknown but probably the heat delivered by this steam can be replaced by some waste heat from within the plant. If so, another 2'000 t of oil can be economized per year, which could again allow a quick repayment of the investment necessary for the installation of a hydraulic turbine.

Enclosures

Drawing nr 526/7/3
Sheet from CEPED



LUDWIG SILBERRING, D. SC.
CONSULTING ENGINEER
ZURICH

ETHYLENE OXIDE PLANT OF OXITENO
CAMAÇARI, BAHIA

DRAWING NR 526/7/3
16 NOVEMBER 1983

SCHEME FOR A SUGGESTED INTRODUCTION
OF A HYDRAULIC TURBINE

Rafael

Enclosure of Annex 10
to R. 526'7'1

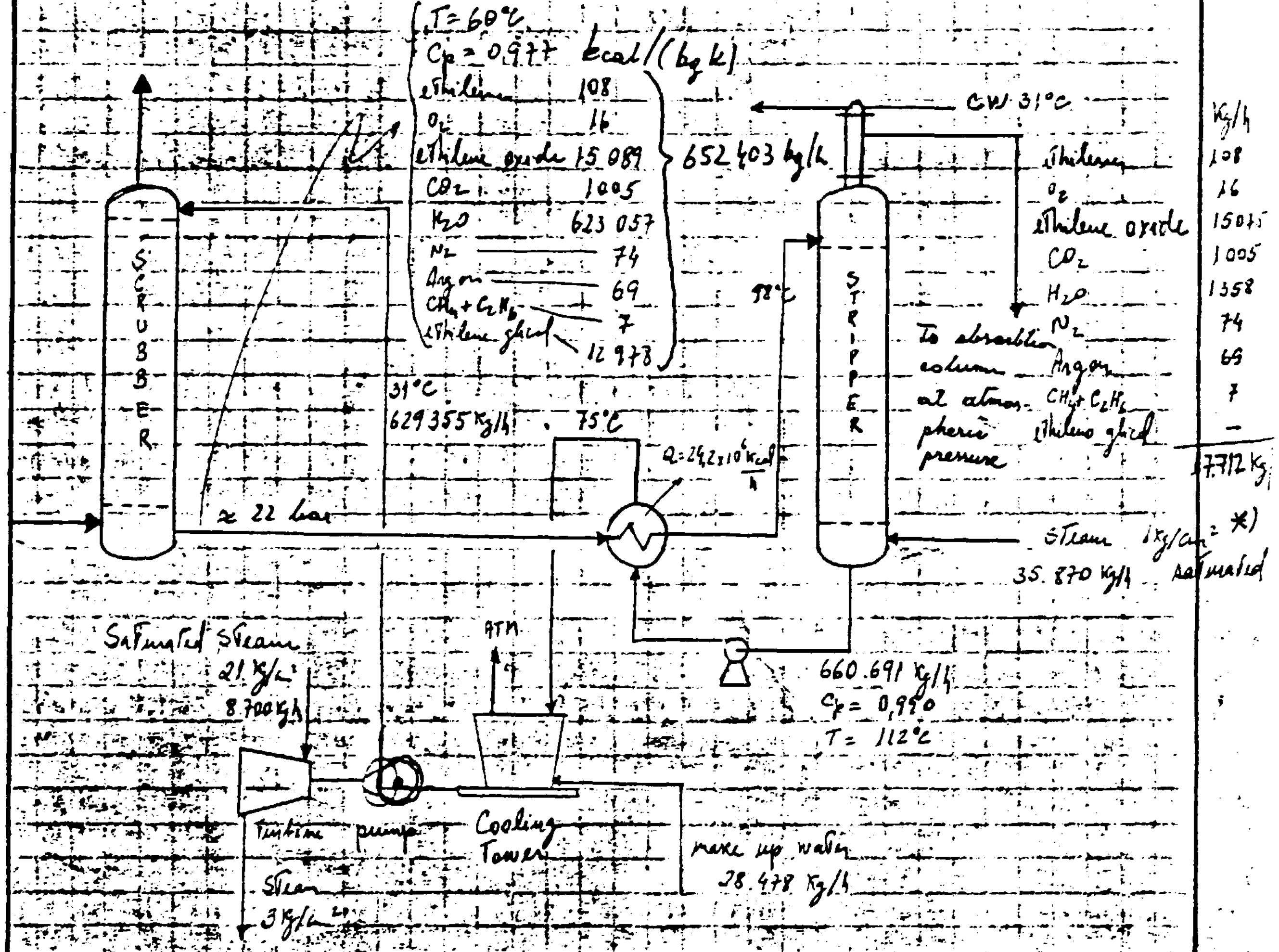
centro de pesquisas e desenvolvimento

Folha ____ de ____

Projeto: ____ Nº ____ Arquivo nº ____

Assunto: ____ Projetado: ____ Data: ____

Item: ____ Conferido: ____ Data: ____



How to recover the steam lost at the cooling tower?

Is it possible to recover further heat at the heat exchanger?

~~Condensate available at 112°C~~

Demineralized water available for make up

Ethylene oxide plant of OXITENO (Camaçari)

*) Manometric pressure

Cod. 0 38.020

NE 7530-168-0589.1

DRYING OF COCO FRUITS

A problem presented by Mr. Ernesto Paulo Cencia of CEPED

Bahia delivers 240'000 t/year of the coco fruits product having a final humidity of 10 %. Initial humidity is as high as 50 % so that nearly 200'000 t of humidity must be removed during the quite short drying season lasting about 40 days per year, from September to December.

Present drying systems use warm air at a temperature of 35 to maximum 60 oC, the air flow rate being 49 m3/min per ton of the wet product. Coco is supplied in 12 cm thick layers, drying time is 44 hours and air humidity increase from the inlet to the outlet by 3 g/m3.

Small producers deliver 3 to 38 t/year. Medium sized producers deliver between 38 to 63 t per year and large producers above 63 t per year.

Heat is presently supplied to the dryers by different ways. Some producers use solar energy which is quite troublesome since every time when rain approaches (which is often the case from September to December) they have to cover the product layers and uncover them again as soon as the sun reappears. Larger producers use different but also not very sophisticated dryers in which air is preheated by various fossil fuels, mostly by wood.

It has been already mentioned in section 5.5.2. that fossil fuels are too valuable to be used for low grade heat supply as it is necessary for drying processes. As far as the coco fruits are concerned, there is an additional need to improve the drying process, namely in order to increase the quality and to rise the value of the product.

As mentioned in section 5.5.2, the heat pump is a very suitable device for most drying processes using either closed or open air cycles. There is no problem in applying the heat pump to preheat air upstream a dryer and to use dryer effluent as a heat source for the same heat pump. In the case under consideration, it appears that most work has to be concentrated on the development of a suitable dryer which allows an increase of the quality of the product. Some key ideas for such a development may be summarized as follows:

- Continuous counter-current movement of dried product and drying air
- Automatic feeding of the fresh product and automatic extraction of the dried product. Both feeding and extractions should be adequately tight in respect to the leakages of the outside air

It is suggested to develop a pilot plant which has a capacity between 10 and 20 t of dried product per year. The heat pump necessary for a plant of this size would need 5 to 10 kW of electric power. Standard hermetic or semihermetic compressors using refrigerant 12 can be applied. More or less standard heat exchangers used in the air conditioning industry can be adopted to the process, but as it has been already said, the key development must be concentrated on mecanical elements of the dryer.

If all coco fruits in Bahia were eventually dried by heat pumps the electric power necessary for this purpose would be between 100 and 150 MW. Simulataneously, however, at least a 5 time higher heating power of wood, presently used for the same purpose, would be economized.

It is recommended to start the development and construction of the pilot drying plant.

DRYING OF ORANGE BAGASSE

A problem presented by Mr. Sylvio Oliveira
and Marco Giulietti of IPT

Orange bagasse originates from the fruit juice industry. It is used as animal food but must be dried in order to limit the transport weight.

Actually, 30 t of oil per hour are burned to dry the bagasse during 9 months per year, that is 180'000 t of oil per year. Just one factory uses 1.4 t of oil per hour to evacuate 22 t of moisture per hour. Altogether about 20 such factories are in operation.

The drying air is actually heated up to a temperature as high as 600 oC and leaves the drying process at a temperature of about 150 oC. Material humidity is at the inlet 75 % and at the outlet 14 %.

As mentioned elesewhere in this report, even electric resistance heating would be better than oil firing for the heat supply as long as hydroelectric energy is wasted. But for prolonged periods neither oil firing nor electric resistance heating can be recommended for such low grade heat as mandatory for drying processes (see section 5.5.2.)

Heat pumps can be certainly applied for the drying of orange bagasse too. The main problem to implement the process is the development of suitable dryers. They will be certainly bigger and more costly than oil fired dryers using very hot air, but the investment will be returned very quickly keeping in mind the fact that presently about 180'000 t of oil are imported for the purpose under considertion at a cost of more than 30 millions dollars per year. Electric energy for driving the heat pumps will cost less than 2 % of the above sum. Besides, most money necessary for the electric energy supply will be spent inside of the country rather than for the imports.

It is strongly recommended to start the development of dryers using moderate air temperature in order to apply heat pumps efficiently to the heating of the drying air (see also annex 11 for some additional indications related to a similar subject).

ETHANOL DISTILLATION

A problem presented by Mr Sylvio Oliveira
and Marco Giulietti of IPT

The reboilers of the main ethanol distillation columns are operating at a temperature of 105 oC whereas the temperature at the column top is 79 oC. Between these two temperatures a vapour compression process with a very high coefficient of performance, namely about 8, is possible.

In a typical unit 120 m3 of ethanol are produced per day. The volume flow rate of the vapour to be recompressed and introduced as a top reflux is about 3.6 m3/sec, which would lead to a moderate size (preferably centrifugal) compressor, having a pressure ratio of about 3.2 to 1.

The problem of vapour compression in ethanol plants has been already examined elsewhere although not always very logically. A careful examination of the existing process would be necessary prior to any recommendations about retrofitting of such processes by vapour compression. Any new ethanol plant could be optimized from the very beginning in view of the application of vapour compression.

As already mentioned in section 5.2., it is recommended to start the action on above lines in order to free the sugar cane bagasse used presently for heating the reboilers for a better purpose. This can improve significantly the economics of the process and can even reduce the necessary investments for ethanol distillation plants since the equipment for the combustion of the sugar cane bagasse is certainly not inexpensive.

BIOMASS AS FUEL

Problems discussed at CEPED, COPENE UTIL and IPT

Several attempts have been made towards the replacement of oil by biomass, particularly by wood. Suggestions were also made to use charcoal as an intermediate product from biomass. Some programs suggest wood gasification in order to yield an intermediate product, which can be easier applied as fuel for a number of purposes.

The author of this report is of the opinion that the use of biomass should be encouraged in the interior of the country, particularly at sites which are located near renewable sources of biomass and which are not yet connected to the national electric grid. Small electric power plants (up to a few hundred kW) should preferably use wood gasification followed by internal combustion engines. If the required electric power output is in the range of a few MW, steam power plants using wood fired boilers represent a better solution since they avoid the losses in the gasification process which are at least as high as 20 % of the heating value of the wood used for the gasification. On the other hand, the efficiency of electric energy generation by a small steam power plant is roughly the same as in a gas engine but the maintenance cost is significantly lower and the lifetime of the plant is significantly higher in the former case as compared to the latter.

Charcoal is a valuable fuel for a number of special small applications. For industrial furnaces it does not represent any substancial advantage over a direct firing of wood. However, the main disadvantage of the large scale application of charcoal is due to the high losses of the heating value of wood when transformed to the charcoal.

During the visit to COPENE, a program of converting one steam boiler into wood firing was mentioned but the author of this report has not receive a feasibility study describing any details of this program. At least one half of a m3 of air dried wood would be necessary to produce one ton of steam at COPENE UTIL plant. Therefore, about 5'000 m3 of air dried wood should be brought everyday to the plant in order to cover the fuel requirements of one boiler, having a steam output of 400 t/h. A transport distance of 150 km has been mentioned but no statement has been made about the transport means which are foreseen in the program.

The author of this report considers as uneconomic the use of biomass for industrial furnaces of the size as in Camaçari. If oil has to be replaced in the furnaces of this size, the priorities for alternative fuels should be given to uranium, thorium, coal or peat in this sequence.

As far as wood gasification for small applications is concerned, it should be mentioned that both CEPED and IPT are running some research programs on the subjects. The merits of these programs have not been well understood. Wood gasification is a quite well known process and the technology has been already used on a significant scale many decades ago. For example during the World War II, many trucks in the Soviet Union and in Switzerland were quite quickly equipped with wood gasifires in order to economize gasoline. It is suggested that any new research should, as a first step, acquire the full knowledge about the technology which was developed already long time ago. This technology can certainly be improved using todays possibilities but the targets of such possible improvements must be clearly set prior to start any major theoretical or experimental experimental programs.

GAS SUPPLY FOR PRESSURE RISING IN OIL DEPOSITS

Problem exposed by CEPED and IPT

Pressurized gas is introduced worldwide to many oil deposits in order to get additional yield from existing oil wells. Since oil is in most cases accompanied by natural gas the latter is usually compressed and introduced underground.

However, Brazilian oil fields do not dispose of enough natural gas which could be used for the purpose under condiseration. A program has been therefore started in Brazil in order to produce arificially some gas able to fulfil the objective. For reasons unknown to the author of this report the selection has been made for carbon dioxide. In particular, the author did not receive any information about the role, which should be attributed to the carbon dioxyde in the oil field. Rising the level of oil wherever it is not mixed with sand can be achieved at signigicantly lower expense just by introducing water, as it is done in many fields even in the Sahara, where water is scarce. Claims are known, according to which carbon dioxyde at supercritical pressure can be used as solvent in order to separate oil from sand, but to the author's knowledge, the feasibility of the process has not been proved yet and it is more than doubtful, whether it can be successfully applied in situ to the oil bearing sand.

Production of the carbon dioxide by any of the possible processes is quite expensive and needs a significant amount of fossil fuels. If the gas should be used only for the purpose of rising the underground pressure, the author of the present report suggests to use nitrogen rather than carbon dioxyde. The former can be separated from air at much lower cost than the cost necessary to produce the latter artificially. Air separation units whould be preferable mobile in order to move them always near the place of nitrogen requirements. In this way, the necessity of delivery of liquified nitrogen can be avoided and as a consequence, the energy consumption per unit of the produced nitrogen will remain moderate.