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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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ORIGINAL: ENGLISH

STUDY ON THE FEASIBILITY OF DEVELOPMENT OF INTEGRATED INDUSTRIAL COMPLEXES WITH MINIMIZED POLLUTION

id.75-3904

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UNITED NATIONS INDUSTRIAL
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ORIGINAL: ENGLISH

STUDY ON THE FEASIBILITY OF DEVELOPMENT OF INTEGRATED
INDUSTRIAL COMPLEXES WITH MINIMIZED POLLUTION

Prepared under the joint UNIDO/UNEP
Environmental Programme

Corrigendum

The title of document UNIDO/ITD.339 should read as above.

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CONTENTS

ANNEXES

INTRODUCTION

[illegible] William J. [illegible], ecologist, Olle Ohlsson, economist and Sermpol Ratasuk, environmental engineer were engaged by United Nations Industrial Development Organization (UNIDO) to conduct a study of industrial complexes in the Netherlands, the Philippines and Iran. The objective of the project, as stated by UNIDO, was:

"To study the material flow (inputs and outputs including present waste products) in three industrial complexes in order to: (1) identify and determine the feasibility of establishing additional production units to conserve raw materials and reduce pollutants; and (2) evaluate collective actions for waste disposal."

Drawing on the team's background experience in ecology, economics and environmental engineering, the following specific objectives were identified:

(a) To evaluate the impact of the industrial complexes on the regional economy in terms of per capita income, employment, industrial planning, etc;

(b) To evaluate the social effects of the industrial complexes in terms of population dynamics, urbanization, recreation, basic sanitation amenities, etc;

(c) To evaluate the ecological consequences of industrialization in terms of water, air and land pollution;

(d) To describe and quantify the inputs and outputs of as many types of industries as possible within the region of the "complex";

(e) To examine the possibility of pollution reduction through utilization of waste products, and modification of production techniques;

(f) To examine the possibility of centralized treatment of wastes from several industries;

(g) To propose guidelines for the development of an industrial complex with minimized environmental consequences.

To achieve the seven objectives stated above the following data are needed:

(a) Physical characteristics of the area. Information is required on topography; meteorology, especially wind direction and frequency, and precipitation; and major water resources. From such information the ecological effects of the industrial complex can be characterized;

(b) Basic sanitation amenities. Information on water supply, sewage disposal, and solid waste disposal is required to evaluate the extent of environmental pollution and public health problems caused by domestic sources, and to explore the possibility of joint disposal of domestic and industrial wastes. Inadequacy of these basic sanitation amenities may also indicate one social effect of industrialization i.e. urban sprawl;

(c) Legislation and authorities concerning environmental control. Success in environmental protection depends, to a great extent, on both the legal and political institutions of the control system. Industrial planning policy is one of the most important factors in environmental pollution control. Information on these matters can be used to evaluate progress in environmental control of the country or the area;

(d) Population statistics. Population statistics are used to assess the social effect of industrialization in terms of over-population, urbanization, and employment;

(e) Land use. Information on land use reveals industrial planning policies, and effects of industrialization on recreational and residential areas;

(f) Economics of the region. Information on the economy of the region is used to assess the impact of industrialization, public demand for environmental quality, and economic impact of pollution abatement;

(g) Ecological conditions. Information is required on the extent of air pollution, water pollution, and other environmental degradation, and on the resultant ecological disruptions;

(h) Industries. Information on the nature of industries, production capacity, number of factories, process technology, inputs, and outputs are needed to identify the sources of pollution, to estimate major characteristics of wastes and the amount of wastes produced. In addition, information on waste characteristics and practices of waste management is needed to determine possibilities of reuse or recovery of waste products, utilization of waste products by another industry, synergetic effects of different wastes and to identify economic and technical problems associated with these possibilities.

Counterpart assistance proved to be the most crucial item governing effective use of time. Both a counterpart and full-time transportation were provided in Manila, courtesy of the National Pollution Control Commission. This not only permitted efficient use of time, but opened many doors.

Clearly, the success of this project depended on the availability of the required basic data on industries. Unfortunately these data were not readily available for our use. We had to search for them at each site, often finding that data did not exist or were confidential and could not be seen. To work out the inputs and outputs of all major industries at each site would have taken one engineer a period of many months.

Of lesser importance were such problems as finding that the only available copies of literature on various aspects of this study were printed only in a language unfamiliar to the team members, and that often simple things like accurate maps of the area were not readily available.

This report is an evaluation of the achievement of the stated objectives at the pre-selected sites. Chapter I summarizes major findings of the study and draws the conclusions. Chapter II presents the recommendations on planning and organizing a further mission to collect the necessary data to complete this project. The annexes contain detailed background information on Rotterdam, Manila and Teheran and data on individual industrial activities at each site.

I. MAJOR FINDINGS

A. Rotterdam

Economic aspects of waste use and pollution control

The refinery and petrochemical complex is a highly developed complex with tight economic linkages between the activities. Agglomeration and integration have been strengthened by economies of scale in the industrial processes and the accessibility to a good infrastructure.

The monitoring system which monitors air pollution in the form of SO_2 levels around the industrial area is run by the public sector and is an example of an advanced monitoring system which is practicable only in connexion with large industrial complexes. This system consists of a circle of air sniffers around the industrial area and telephone switchboard, manned 24 hours a day to receive complaints from citizens. A computerized system of plotting SO_2 levels facilitates location of any emission source.

Treatment of solid waste is another example where the agglomeration of petrochemical industries has motivated the construction of a technically advanced system. An incinerator, which started in 1973, is public owned and its activity is incineration of domestic and industrial wastes. Charges are levied upon the industry generating the waste, such charges being based on the difficulty of handling the particular waste type. The plant is a non-profit enterprise. At present, the plant does not work at full capacity and therefore does not cover its costs but in the future the revenues are expected to cover all of the costs.

In the Netherlands, waste water is controlled by effluent fees based on the oxygen demand of the waste. Municipalities as well as industries are subject to payment of the fees. Of the different pollution control techniques practiced in the three study areas of this mission, this is the only example where effluent charges are used. The effluent charge system is a method of internalizing the external diseconomics caused by polluters and to attain a desired reduction in pollution at the least cost. A polluter will treat his waste water up to the limit where marginal treatment cost is equal to the fee. If the marginal treatment cost is higher than the fee, the polluter will pay the fee instead of treating the waste. Consequently, effluent fees are a control technique whereby the pollution which is relatively cheap to control will be eliminated and the pollution which is relatively expensive to reduce will remain. The desired pollution reduction is controlled by the level of the effluent fee. This system also provides an incentive to the industry to find methods to reuse the waste water, recover the waste materials and reduce the wastes by improving production techniques in order to avoid the fee.

The existing effluent charge in the Netherlands can be considered as a trial and error method to find the charge which gives the optimum control. Charges began at about 5 guilders per population equivalent two years ago, are at present (1974) about f.11 and are expected to rise until a level of about f.25 is attained. The stepwise introduction of the effluent charges also gives the industry time to gradually adapt to the control system. The revenues from effluent fees are used for subsidizing construction of municipal waste water treatment plants.

An integrated economic and environmental model has been worked out at Rotterdam University and has been applied to air pollution in the Rijnmond area. From the model, one can calculate the industrial structure which maximizes the regional income subject to economic restrictions and pollution standards, the cost (in terms of regional income) of pollution standards, the optimal level of environmental investments at different pollution standards and the optimal allocation of these investments between industries. Applied to air pollution standards in the Rijnmond area the model gave as the optimal solution a continued expansion of the refinery and petrochemical complex provided that the environmental investments in this sector were increased many times over. The environmental investments had to increase substantially in the electrical power generating sector too, while the investments in the other sectors were approximately unmodified.

Environmental pollution and its control

Clearly, many of the industries in refinery and petrochemical complex are major polluters of air and water. Due to a very wide range of production activities many types of pollutants can be expected. Since information on characteristics of wastes was not available, qualitative information was worked out. Considering the nature of industries and their pollutants, air pollution would be the most important problem and disposal of solid wastes the least important.

Air pollution

Although there are many types of air-borne pollutants in the region, it appears that sulphur oxides, nitrogen oxides, and hydrocarbons are of major concern. A survey of the amount of SO_2, NO_x (see tables 1 and 2) and hydrocarbons from industrial sources has been conducted by the Rijnmond Authority. It should be noted that some of the data were obtained by actual measurement and some by theoretical calculation.

The most important sources of NO_x and SO_2 in the industrial area are combustion activities. The total amount of NO_x and SO_2 released into the atmosphere was [illegible] kg/[illegible], [illegible] per cent of the total amount of both pollutants are emitted by five oil refineries and the power stations. This indicates that for effective control of industrial emissions these major sources should receive prime consideration.

The total amount of hydrocarbons emitted into the atmosphere was 7[illegible],[illegible]39 tons/year. Oil refineries were responsible for [illegible] per cent of this amount and the remainder was due to oil storage and handling activities. While the emission of SO_2 and NO_x is continuous that of hydrocarbons is intermittent, with varying frequencies and duration. Hydrocarbons are also emitted near the ground level, therefore their distribution will cover a smaller area compared with that of SO_2 and NO_x.

It must be emphasized that the industries are not the sole polluter of the atmosphere. There are some other sources which contribute to the problem. Heating in houses and green-houses, and internal combustion engines also greatly affect the ambient air quality of the region. The maximum ground level concentration of SO_2 contributed by the industrial sources during the winter period of 1973 (January, February and March) was only [illegible]0 ng/m^3 at Schiedam. The total concentration of SO_2 counting all major sources rose to 140 ng/m^3, indicating the combination of shipping, green-houses, automobiles and homes contributed 90 ng/m^3, some 50 per cent more than industry. It must be remembered, however, that shipping, green-houses, automobiles and homes emit SO_2 at or near ground level, while most emissions from industry occur at a greater height.

The ambient concentration of SO_2 normally, reaches maximum values during the winter because of the high degree of atmospheric stability and greater use of energy. In the summer the air quality can be expected to improve.

There do not appear to be any air pollution standards as such, rather the air pollution law appears to be aimed at limiting emissions at the source. However, it appears that the concentration of SO_2 in many places in the region exceeded the limit of 150 ng/m^3 set by some European countries such as Union of Soviet Socialist Republics and Czechoslovakia. For NO_x and hydrocarbons the values were still far below 100 ng/m^3 for NO_x and 750 ng/m^3 for hydrocarbons.

Table 1. SO_2 emissions from industrial sources in Rijnmond area

Name of the source	Emission rate (kg/h)	Stack height (m)
(Refinery)	3 000	120
Gulf (Refinery)	1 815	90
Climax	1 315	165
Tiofina	1 300	134
Ketjen	6	40
	444	100
Verolme	300	32
Continental Columbian Carbon	60	25
Esso (Refinery)	342	35
	1 375	150
DOW-Chemical	1 550	90
Paktank (Botlek)	12	56
Aluchemie	60	20
Windmill	15	50
	26	34
	128	105
	30	23
Albatros	25	84
	300	80
	420	100
Vondelingenplaat	16	50
	57	24
Shell (Refinery)	50	35
	4 900	213
Chevron (Refinery)	3 100	80 to 120
	960	120
	300	90
Paktank (NCM)	478	25 to 46
Centraales (Power Stations)	30	42
Cailoi		
Roteb	870	125
	1 250	89
Total:	24 482 or 587.6 tons/day	

a/ The industries not listed in this table are not significant source of SO_2 emission.

Table [illegible]. NO_x emissions from industrial sources in Rijnmond area

Name of the company a/	Emission rate (k./h)	Stack height (m)
BP (Refinery)	510	120
Synres	3	18
Gulf (Refinery)	149	[illegible]
	82	165
	32	49
Kemax	52	30
	23	23
Esso Chem.	[illegible]	27
	21	30
Paktank (Europ.)	5	
I.C.I	25	25
Climax	4	135
Tiofine	28	60
Ketjen	42	38
Chem. Ind. Rijnmond	38	100
	7	21
Roteb Botlek	85	111
Akzo-Zoutchemie	52	30
	2.2	30
	1.6	45
	3.0	30
Verolme	3	25
Continental Columbian Carbon	1	18
	10	35
Esso (Refinery)	157	150
	203	90
Dow-Chemical	5	50
Paktank (Botlek)	9	20
Aluchemie	2	50
Windmill	4	23
	5	23
Albatros	123	80
	21	33
Paktank (Vond.)	4	20
Vondelingenplaat	15	27
	13	24
Shell (Refinery)	460	213
	770	80 to 120
	10	25
Chevron (Refinery)	146	120
	16	90
	165	25 to 46
Paktank (NOM)	9	42
Centrales (Power Stations)		
Galilei	600	125
Schiehdam	200	100
Waalh.	700	120
Roteb	40	89
Total	5 090.8 or 122.2 tons/day	

a/ The industries not listed in this table are not significant source of NO_x emission.

It appears that several factors have influenced the levels of SO_2 and NO_x in this area, including but probably not limited to the following: (a) use of natural gas as a source of heating fuel; (b) the Rijnmond air quality monitoring network, coupled with the complaint telephone; and (c) greater awareness on the part of industry of the need for more care in minimizing such emission. No information was available on the ground concentration of other air pollutants such as fluorine, dust, sulphuric acid, etc.

Water pollution

Much of the waste water from the industrial complex is discharged into the New Waterway and its tributaries. The river has already been polluted by upstream industries in France and the Federal Republic of Germany, a situation in existence for many years. Under present laws in the Netherlands, industries are permitted to discharge pollutants under licence, with a fee structure which requires increased payment over time. Waterborne liquid discharges have increased since 1970, and some industries now treat at least part of their wastes prior to discharge to the river. It is expected the trend towards individual, or perhaps some collective treatment of industrial wastes will continue as costs of discharging untreated wastes rise.

One effect of pollution is indicated by the absence of usable aquatic life in these water courses. In addition, pollutant concentration in the river rose to such levels during low flow periods that water could not be purified for drinking, and the city of Rotterdam was forced to construct large reservoirs in which to store acceptable water for purification and use during these periods. These purification plants use the latest and most advanced technology in water treatment. This is a good example of external diseconomies in water pollution.

There has not been sufficient time under the present law to amass and compile very much data on either the quantity or quality of wastes discharged into the river, or upon the quality of the river water. Data on water quality in the river at the Honingerdijk treatment plant reflects upstream pollution, but indicates the water entering the Rotterdam area has a high BOD level (20-50 mg/l mean 33) and low dissolved oxygen content (1-2 ppm), poor quality for aquatic life.

For control purposes the water pollution control authority (Rijwaterstraat in this case) has been constantly monitoring effluent discharged from each industrial source. Unfortunately, the compiled data are confidential and could not be released for use in this study.

Solid wastes

At present disposal of solid wastes in the industrial complex presents a minimum hazard to the environment. Most of the solid wastes are sent to the Rijnmond Incineration plant while the rest is incinerated by the industries or is disposed of by sanitary landfill.

The amounts of solid waste from 36 industries as estimated by the organization Stichting Europoort/Botlek Belangen (EBB) are as follows:

(a) 66,000 tons per year of non-toxic combustible materials such as wood, paper, etc.

(b) 8,100 tons per year of inert materials such as stone, sand, etc.

(c) 2,000 tons per year of plastics.

Most of the plastic wastes are recovered.

Miscellaneous wastes

There are a few wastes too hazardous to be disposed of either by discharge into the river or by incineration near inhabited areas. These wastes are presently incinerated on the North Sea in special ships, a practice which should be evaluated by all countries bordering this valuable, food-producing, marine resource.

Waste recovery and utilization and joint treatment

Complete quantitative data on inputs, outputs, and waste characteristics of all industries at each site are needed to determine the feasibility of pollution reduction through waste recovery and utilization, and joint treatment. Opinions on the subject presented herein have been derived from general observation within a very short period, limited amounts of data, and from the team's experiences. Naturally, the opinions must be thoroughly reviewed when more data are available.

In Rotterdam, only one industry, the municipal incineration plant, was visited. Information obtained from the previous study was therefore analysed and used as a framework for discussion. The results of analyses are given in annex I.

Recovery of air pollutants

Air pollution is the most important problem in this complex. The major air pollutants are sulphur oxides, nitrogen oxides, and hydrocarbon. Only sulphur oxides, which are the most important pollutants in stack gases are technically feasible to remove, which can be done simultaneously with nitrogen oxides. Water scrubbing of the stack gas to produce dilute acid is not practical because it creates a visible plume and loss of thermal lift.

At the present state of technology, there are five processes to remove SO_2 and convert it into various by-products:

Process	By-product
Limestone-dolomite injection, dry process	Gypsum
Limestone-dolomite injection, wet process	Gypsum
Alkalised-alumina sorption	Sulphur
Catalytic oxidation	Weak sulphuric acid
Caustic scrubbing	Sodium sulphate

Information on results of operation of these processes is limited. Obviously, selection of the process would depend on characteristics of the flue gas and value of the by-product. At present, the limestone injection process is marketed by Mitsubishi Heavy Industries Co., Ltd. of Japan.

The total amount of SO_2 released into the atmosphere was about 24.5 tons/h but the highest quantity discharged from a single source was only 4.[illegible] tons/h (see table 1). Since joint treatment of gaseous waste is not feasible, removal of SO_2 has to be done at each individual source. The total amount of SO_2 therefore, could not be used to indicate economy of scale in removal. Obviously, the unit cost of removal would vary from one source to another. In evaluating economic feasibility of any recovery scheme, information is needed on the unit cost of SO_2 removal for various scales, and also on marketability of the recovered by-product. The amount of by-product can be readily calculated using stoichiometric equations.

Recovery of other air-borne pollutants is normally practised by industries in the complex mainly to increase the productivity rather than to control pollution. A typical example is recovery of fine particles of such materials as cement and phosphate fertilizers. For some industries control of air-pollution simply transfers the problem from air to water pollution. An interesting example is the phosphate fertilizer industry. The wet process for superphosphates evolves a toxic gaseous mixture of fluorine compounds, predominantly silicon tetrafluoride, hydrofluoric acid, and fluorosilicic acid (H_2SiF_6). This mixture is passed through water-absorption towers, yielding fluorosilicic acid and a silica precipitate. The dilute acid is presently used in fluoridation of drinking water and in producing aluminium fluoride. When there is no market for it the fluoride water is discharged into the river. It is technically possible to produce fluorosilicic acid of commercial strength (generally 30 to 35 per cent) by recycling or distillation of the dilute acid. A large use for this acid is in the brewing industry as a disinfectant for copper and brass vessels. It is also employed as a preservative, in electroplating, as a concrete hardener, and in the manufacture of fluoride salts.

Recovery of water pollutants

The most common practice in this complex is recovery of oil from waste products. This recovery is very simple in technology and is not capital intensive. Recovery of other waste products has not been widely practised. One interesting case found is the titanium dioxide plant which presently discharges into the river about 12,000 tons per year of ferrous sulphate in the form of dilute acidic waste water. It may not be economically feasible to evaporate and recover the ferrous sulphate because of its low concentration. However, this solution can be used in water or sewage treatment as practised in St. Louis, Mo.

Joint treatment of waste water in the complex on a large scale would not be feasible because of the great differences in waste characteristics and dispersion of the industries.

Recovery of solid wastes

Recovery of solid wastes in the Rotterdam area is one of the best practices in the world. Most of industrial solid wastes are burned with domestic refuse in a municipal incineration plant strategically located in the industrial area. The incineration process is thermally self-sustained and heat is recovered from the flue gas to produce electricity and distilled water. Fly ash and slag are also recovered and sold as fill and building materials. Metals are recovered and sold as scrap metal.

For recovery of other types of solid wastes the plastic industry is a good example. Some plastic scraps are sold and some are reprocessed. However, there are a number of industries which have not been successful in recovery of their solid wastes. The most interesting example is the phosphate fertilizer industry. At present the waste gypsum cannot be economically utilized due to high concentrations of impurities. By changing the process and using phosphate rock of higher quality the company is expected to produce high quality gypsum suitable for manufacturing building materials.

B. Manila

Economic aspects of waste utilization and pollution control

Between 25 and 40 per cent of the pollution in the Philippines emanates from industry and about 60 per cent is caused by people. In metropolitan Manila with its agglomeration of industries the industry's share is probably greater. The major contributor to air pollution, other than industry, is motor vehicle. Industrial plants contribute significantly to water pollution too but it is the discharge of domestic sewage and disposal of refuse by the population that accounts for the greater part of water pollution in the urban regions.

From these facts it is apparent that a reduction of pollution from industry will alleviate only part of the problem, and result in only a modest improvement of the environment in metropolitan Manila. A considerable amount of resources must be invested in the transportation system in the region in order to reduce air-pollution from the traffic and a sewerage system is necessary to prevent indiscriminate dumping of domestic refuse and untreated wastes into the rivers and streams. A programme for a sewerage system in metropolitan Manila has been designed but is not yet implemented.

The economics of gainful recovery of industrial waste for use in other processes are not only dependent on the mixture of industries but also on the size of the plants and their location. If the production in one industry is split into many small plants at scattered locations, which seem to be the case in metropolitan Manila, the possibilities of economic utilization of waste will be reduced. The amount of waste from each plant is small and handling and recovery of waste products in each plant or transportation to a common recovery plant may be difficult from a technical point of view or expensive. Thus even if the metropolitan Manila area partly meets the criteria of a diversified industry which should facilitate use of waste products from one industry as inputs into other industries, these possibilities are highly reduced by the existing industrial structure and location pattern.

The cost of pollution abatement equipment will be higher too when the production is distributed among many small plants unless the economies of scale can be taken care of by erecting common treatment plants. A study by Economic Development Foundation, Manila, has shown that the cost of waste-water treatment could be reduced by 30 per cent in common treatment plants. So far there is no example of factories using a common treatment facility, although several companies attempted to arrange for one, only to find they could not agree on cost sharing. Probably the only way by which a common plant can be established is by the public sector playing an active role. A common plant would also facilitate competent planning and operation of a waste water treatment facility.

Industries in the Philippines are given incentives in order to meet the standards of air and water pollution. Industries initiating pollution control are given tax incentives in the form of exempting imported anti-pollution devices from import taxes. Research expenses for pollution control are also allowable as deductions from taxable income of the industries. However, tax incentives and capital subsidies are not always efficient as instruments in pollution control. Tax incentives tend to favour big firms over small ones. Capital subsidies for abatement equipment make capital intensive techniques preferable to labour intensive techniques and are not incentives to change production processes or input into processes which many times are more efficient ways of reducing pollution.

Environmental pollution and its control

Most of the industries in the area utilize organic materials and produce large volumes of liquid organic wastes. Considering the nature and sizes of industries it can be inferred that water pollution is the major problem as far as industrial pollution is concerned.

Air pollution

Major sources of industrial air pollution are combustion activities. There is no quantitative information on the amount of air pollutants from industrial activities. However, their contribution to pollution would be less than that from over 400,000 cars in the metropolitan area. Topography and climate are not conducive to the formation of prolonged temperature inversions or other atmospheric phenomena favourable to smog formation, so authorities felt air pollution would never become a severe problem. There was an admission that pollution was becoming uncomfortably evident. Most pollution comes from cars, trucks and buses, many of which are poorly tuned and emit clouds of exhaust fumes. In 1970 about 3,200 tons of particulate emissions were released per day from some 31,000 diesel-powered and [illegible]0,000 gasoline-powered vehicles. Along busy thoroughfares people were observed wearing masks or holding cloths over their mouths to filter the air they breathed. Fumes could be both smelled and tasted.

Industrial sources of pollution could be observed in all portions of the city. It appeared few of the large stacks had any functional emission control systems.

Water pollution

A survey of estimated pollution loads from 170 large firms was conducted in 1969 and the estimates were based on results of grab samples and questionnaires. The results showed that of the 20 groups of industries only 8 groups were major polluters. They are, in order of pollution loads, dairy products, textile industries, breweries and distilleries, chemicals, pulp and paper, food, soft drinks, soap and cosmetics. Their shares of the total pollution load ranged from 24.3 per cent to 2.3 per cent with a combined load of about 85 per cent. Development in pollution control and industrialization between 1969 and 1973 may have changed these figures, however, the pattern of pollution distribution would not have been significantly changed.

It should be noted that the total industrial pollution load of 88,000 kg BOD per day was about half of the total domestic pollution load from 3.6 million people based on a per capita BOD load of 50 g per day. Therefore the industrial pollution load was only 1/3 of the total load.

At present only a few factories have efficient waste treatment plants and almost none of the domestic wastes are treated. These wastes are discharged into public sewers, streams and rivers and are finally drained into the Manila Bay. During the dry season the polluted water of the Pasig River is flushed into the Laguna Lake during flood tide. This pollution load coupled with that from industries along the lake is the main cause of pollution of the lake.

The water pollution problem in the metropolitan area is so severe that all streams and rivers are septic for the greater part of the year. The water is black emitting a foul odour with distinct methane bubbles on the surface. No aquatic life can exist under these conditions.

At present, all wastes from the metropolitan area are dumped into Manila Bay. Recent studies of the bay, designed to assess the problem of sewage disposal, revealed some areas displaying adverse effects from organic pollution. Benthic studies were limited to the eastern region of the bay, so the full extent of changes is not known. Off the metropolitan shore the bottom contained large quantities of organic waste and little aquatic life. The northern portion of the bay contained hydrogen sulphide, but not in sufficient concentrations to eliminate benthic organisms. Some differences in benthos composition were noted from one area to another, of a nature believed related to pollution.

Solid wastes

There is no information on the amount of solid wastes from industries. From general observation solid wastes from domestic and industrial sources are collected by municipal trucks and are dumped on the shore of the bay. A great part of the wastes which are not collected are simply dumped into streams or burned.

Waste recovery and utilization and joint treatment

In Manila seven industries were visited but information on the inputs, outputs, and waste characteristics was mostly unavailable. The seven industries visited were a brewery, coconut oil factory, soap factory, paper mill, textile mill, food factory and tannery. Results of the visit are presented in annex II.

Recovery of air pollutants

There is no information on industrial air pollution. Considering the nature and size of industries recovery of air-borne pollutants would not be economically possible for many. However, some would practise recovery to a certain extent to reduce production lost. This cannot be considered as recovery of waste products in the true practical sense.

Recovery of water pollutants

Legal requirements in water pollution control have made the industries aware of pollution reduction through reuse of water and recovery of waste products. In cases where technologies of recovery are well established the industries would recover their waste products to the fullest possible extent. Good examples found were recovery of spent grain and yeast from brewery waste, recovery of fibres from paper-mill waste, recovery of glycerine from soap waste, and recovery of fatty acid from coconut-oil refinery waste. In the absence of detailed information on manufacturing processes of the industries it is difficult to identify recoverable wastes. However, individual recovery systems would not be economical for most factories in this area because of their small production capacities. A central recovery plant may be one possible solution for such industries as molasses distilleries (recovery of potash), slaughterhouses (blood recovery), and metal plating (recovery of metals).

There was one example of an industry using wastes from another to reduce pollution problems. The Economic Development Foundation had recommended to some textile firms that they construct a common storage facility for acid-spent pickling liquor from nearby steel mills, and use this to neutralise their alkaline wastes. They were also reminded that sludge from lime production could be used to advantage in another section of the textile industry.

Joint treatment between industrial wastes and domestic wastes is most likely the most effective strategy in industrial pollution control of the metropolitan area. This scheme is economically feasible because most industries are in residential areas. Although separate complete treatment of industrial wastes is now required, this will not adequately reduce the effects of pollution since the industrial load is only about one third of the total.

Recovery of solid wastes

Recovery of industrial solid wastes has not been reported, but in developing countries almost any solid wastes can be sold. Scrap paper, metals, and glass bottles are three typical valuable solid wastes which are raw materials for small paper mills, foundries, and glass factories respectively. Unsaleable solid wastes are haphazardly dumped, open burned or disposed of with domestic refuse. It may be economically feasible to set up an incineration plant to utilize the calorific value of solid wastes, however characteristics of solid wastes in the developing countries might be significantly different from those of the developed country. This matter will have to be investigated in depth before any conclusions on the economic feasibility can be drawn. At present the municipality has an incineration plant, presumably with no heat recovery system. The plant has not been able to function since its completion due to some technical faults in the design.

C. Teheran

Economic aspects of waste use and pollution control

The problems in waste recovering and pollution control are mainly the same in Teheran as in Manila. Many small plants make recovery of waste material and implementation of pollution standards difficult and expensive. However there are some examples of initiative from the public sector in this field. Thus the Regional Water Board plans to build a common waste water treatment plant south of Teheran for leather factories agglomerated there.

Plans of utilisation of solid waste are also under consideration. The solid waste from Teheran, now dumped outside the city, is planned to be used in a fertilizer plant.

A serious problem in Teheran is the increasing ground water levels in the south of the area. The economic effects of this phenomenon should be evaluated. The rising ground water has been beneficial to the agricultural production but caused damages in residential areas.

Environmental pollution and its control

Air pollution is readily apparent, with moderately clear air early in the morning rapidly converted to a thick haze before noon. A combination of many motor vehicles, lack of emission controls by industry and air borne dust account for most of this. At this time emission of pollutants is not controlled, although serious polluters like brick works and cement factories have been forced to move further from the city.

Efforts are being made to control water pollution, but it is too early to evaluate these at present. Ground water pollution and increasing ground water levels are strange problems for an arid area, where efficient water use should alleviate such problems.

Waste recovery and utilisation and joint treatment

Recovery of air pollutants

Considering the sources of industrial air pollution such as cement industries, brick factories, stone grinding, etc., removal of such pollutants as dust may be necessary. However, recovery of gaseous pollutants such as SO_2 from stock gas may not be economically feasible due to the small sizes of factories.

Recovery of water pollutants

Recovery of water pollutants may not be as important as water reclamation because of the shortage of water. According to the Master Plan for a sewerage system, industrial wastes will be pretreated and discharged into the municipal sewerage system. The combined waste water will receive secondary treatment using the conventional activated sludge system. Treated effluent will be used for agricultural purposes, however, advanced treatment may be needed in the future to recycle water for domestic or industrial consumption.

As far as waste recovery is concerned there is no information on the practice by industries. Waste recovery may be possible in such industries as food processing, electroplating, chemical, distillery and brewery. The recovery and utilization of wastes may be more economical than pretreatment.

Recovery of solid wastes

Judging from the types of industries solid wastes are mainly inert materials including scrap metals, rags, papers, plastics, slag, etc. Most of these wastes would be commercially valuable as in most developing countries.

D. Conclusions

1. Lack of time and counterpart support were the most critical factors limiting fulfilment of our objectives.

2. Little or no written material related to the data required was available in most cases.

3. The idea of several disciplines on the team was good, but the industrial data should have been collected prior to fielding this team for best use of its talents.

4. Some industries appear to be aware of the possibilities of waste recovery and utilization. The technology in many cases is known, but economic factors appear to be a problem. Industry will not move in this direction until forced by law.

5. Most industries in developing countries are small and cannot afford the investment for skilled technicians and recovery installations.

6. No attempt has been made in the industrial complexes studied to integrate industries in a manner likely to reduce the cost of pollution mitigation. Therefore we have no basis on which to judge the feasibility of the basic idea which appears theoretically possible.

II. RECOMMENDATIONS

We recommend the following as the minimum necessary to achieve the aims of future studies of this nature:

1. Conduct preliminary work at sites which are to be utilized, to ascertain whether data are available, the sources, form and language, and to compile lists and location of industries prior to sending a team of experts afield.

2. Investigate the possibilities of reuse or waste combination. Such information is available in reference works, as long as there is a list of industries (see recommendation 1) from which to work. This would leave more time for examination of industrial situations in the field.

3. One means of accomplishing this would be the commission of a study by a university or consulting firm to characterize wastes from a wide variety of industry types, with a means of cross indexing for comparisons. From this an attempt could be made to recommend the least polluting and/or the most resource efficient industrial estate mix.

4. Field a team of engineers to compile information on the practicality of reuse, common treatment etc. Two weeks is not sufficient time to accomplish much at one site. More time should be scheduled.

5. After the basic work has been accomplished, assemble a multidisciplinary team to evaluate the total effects. The economist and ecologist on the present team spent much time assisting in the collection of engineering data, without which they could not begin to evaluate the effects of various alternatives.

BIBLIOGRAPHY

Rotterdam

Havenbedrijf der Gemeente Rotterdam. Stichting "Havenbelangen". Rotterdam-Europoort 197[illegible] statistical review.

Keel, I. van der. Refuse disposal in the Rotterdam industrial area. In Haus der Technik-Vortragsveröffentlichungen. no. 1[illegible]. p. 27-30. [n.d.]

Muller, F. Een geintegreerd economie-milieumodel voor Rijnmond. In Milieu en economie. Rotterdam, Universitaire Pers Rotterdam, 1974.

Muller, F. and W. Pelupessy. Economische waardering van de schaarse lucht in Rijnmond. In Economisch-statistische Berichten. 1971.

Openbaar Lichaam Rijnmond. Geintegreerd Milieuonderzoek. Interim report. March 1974.

_____ Ontwerp Streekplan Rijnmond.

_____ Ontwerp Streekplan Rijnmond, annexes.

_____ Rijnmond-economie in de jaren zeventig. Schets van een beheerste ontwikkeling. June 1973.

_____ Secretariaat. Het Economisch Structuurmodel van Rijnmond. Oppervlakten per regio in verhouding tot het bruto regionaal produkt. E.S.S.O.R. Werkgroep. Economische ontwikkeling op lange termijn.

Public authority Rijnmond, 5 p. Mimeographed.

Rotterdam; seaport, industrial fulcrum, trade centre. Press and information services, Bureau Voorlichting en Publiciteit, Stadhuis, Coolsingel 40, Rotterdam.

What is Rijnmond? Openbaar Lichaam Rijnmond, Stationsplein 2, Schiedam. Information pamphlet.

Other sources

Hinderwet (Tekst van de Wet) Nuisance Act of the Netherlands Enacted in 1952, last amended in 1970.

Hinderwet (Tekst van het Hinderbesluit) Public Nuisance Regulations. Enacted in 1953, last amended in 1967.

Wet Inzake de Luchtverontreiniging (Tekst van de Wet). Air Pollution Act of the Netherlands. Enacted in 1970 and amended after 1970.

Wet Verontreiniging Oppervlaktewateren (water pollution)

Manila

Caces-Borja, P. On the ability of otter trawls to catch pelagic fish in Manila Bay. Report prepared for the Fifteenth Session, the Indo-Pacific Fisheries Council, Rome, F[illegible]

Industrialization within the Philippine environmental setting, national report. Manila, October 197[illegible].

Integrated development of the Manila [illegible] region; over-all framework plan, Manila, April 197[illegible].

Kamo, A.E. Manila Bay oceanography and pollution [n.l.] unpublished manuscript.

Master plan for a sewerage system for the Manila Metropolitan area. Geneva, World Health Organization, December 19[illegible]. IHI-2[illegible]/Philippines 0111)

Philippines. [illegible] Listing of establishments. Bureau of Census and Statistics. Manila, [illegible].

_____. Four-year development plan, FY 1974-77. Manila, 197[illegible].

Ronquillo, I.A., Caces-Borja, P. and Mines, A.N — Preliminary observations on the otter trawl fishery of Manila Bay. Proceedings of the Indo-Pacific Fisheries Council 13 (III) p. 6[illegible].

Tiews, K., Ordonez, J.A. and Ronquillo, I.A. — On the Benthos biomass and its seasonal variations in Manila Bay and San Miguel Bay and a comparison of their formaniferan Fauna. Proceedings of the Indo-Pacific Fisheries Council 13 (III) p. 121-138.

Teheran

Akerlindh, G. Sewarage and sewage treatment for Kermanshah, Iran. (EM/ES/215, Iran 3302/R). Geneva, World Health Organization. 197[illegible].

Badakhshan, A. Techniques and experience of measurement and observation of major atmospheric pollutants of Iran, [n.d.] Unpublished manuscript.

Mehrt, L.C. and Feraldis, A. 1974. Report of a joint UNDP/UNIDO industrial sector review mission for Iran.

World Health Organization Pre-investment survey of sewerage needs and facilities in Teheran. Geneva, 1973. (IRA/[illegible]1/52[illegible]).

_____. An air pollution programme for Iran (Prepared by H.C. Wohlers). Geneva, 1974.

Annex I

ROTTERDAM

A. Background data on the Rotterdam site

[illegible]

Water supply

[illegible] water drawn from the Rhine River. Originally one old treatment plant, located on the New Waterway, provided all the water for Rotterdam, the contiguous industrial areas and some of the towns in the vicinity. The continuing process of providing ever deeper harbours and channels for the increasingly larger ships resulted in the intrusion of brackish water upstream to this plant during periods of low river flow. Increasing industrialization in upstream areas resulted in pollution loads too high to be economically treated either by classical biological or chemical purification during low flow periods. A new treatment plant plus a series of large storage reservoirs have been interconnected with the old plant. Water is now pumped from both the Rhine and the River Maas into the reservoirs during periods of high river flow when water quality is acceptable, and stored there for use during periods of low flow. Water consumption was more than 1[illegible] million m^3 in 1970, with a predicted demand for 1980 of 160 million m^3.

Sewage treatment

An example of problems caused by long practice of environmentally detrimental procedures are those faced by Rotterdam in attempting to design a sewage collection and treatment system. Only a few limited areas of the city are now served by such a system, while the remaining areas have many separate collection systems comprised of laterals and main drains flowing towards the river. The sewage is pumped along the system and up into the river without any form of treatment. This system cannot be used, or even modified without heavy costs for installation of new pipes and pumps to direct the flow towards a large treatment facility. With the unique problems of an area below sea level, built on soil of poor support capabilities and with a myriad of pipes and wires already installed beneath the streets, an entirely new sewer system would not be economically feasible.

Solid wastes

Solid wastes from the city of Rotterdam are trucked to a municipal incinerator. This old installation lacks sufficient capacity to process any wastes other than those from Rotterdam. Wastes from industrial areas and other towns in the area are trucked to the Rijnmond Incinerator (N.V. Afvalverwerking Rijnmond) in the Botlek area. This facility, completed in February 1973, is capable of processing all solid wastes from towns in the area and all but certain types of industrial wastes for many years to come.

Political units and their administration

Political power in the Rotterdam/Europort area flows from the local municipalities to provincial and finally national levels. Historically each community controlled its own destiny, but the extensive development of the Port of Rotterdam and the Rotterdam/Europort industrial complex extended the sphere of influence of commerce across numerous civil boundaries, reducing local autonomy and control. Concomitant environmental degradation of both air and water, reduction in the amount of open space and green areas close to Rotterdam and increased traffic congestion kept local amenities below the levels enjoyed in other parts of the country.

A public authority, Rijnmond Authority, was created by an act of Parliament on 5 November 1964. The Rijnmond area includes 60,000 ha with 1.1 million inhabitants in 23 communities of which Rotterdam, with 700,000 inhabitants is by far the largest. Rijnmond is governed by a Council of 81 members, elected by the population in the area. The Council chooses six of its members to function as an Executive Committee, presided over by a chairman nominated by the Crown. Elections for the Council are held every four years. Rijnmond powers as established by the legislature are:

(a) Elaboration and determination of a master plan for the entire Rijnmond area; municipal plans should be consistent with the masterplan;

(b) Co-ordination of all policies, which are instrumental in the realization of such a plan, such as policies in the field of port development, industrialization, transportation, recreation, environment, waste disposal etc.;

(c) The right to issue directives and recommendations to municipalities in the fields mentioned under (b).

Not all municipalities in the area decided to grant Rijnmond jurisdiction over the appropriate portions of their affairs, so at present Rijnmond can only advise in these cases. Proposed changes in the law may alter this situation.

There are now a number of overlapping responsibilities in the Rijnmond area which, while they appear confusing, may offer a possible solution to the vexing problems which beset the area. Each Community governs itself, but the effects of nearby industry, and even decisions on whether an industry may expand or locate near the community, are beyond control of the community. The city of Rotterdam owns most of the land suitable for industrial use, and thus could make decisions which would influence the future of other communities. Harbour basins, docks and sites in the port area are regulated by the Port Authority of Rotterdam, while control over water pollution and maintenance of channels is the responsibility of the state. Rijnmond functions as a centralized planning and regulating body, providing a line of communication between the many public and private operations in the area. Establishment of emission standards for aerial discharges, along with the installation of an air quality monitoring network has led to a stabilization of air quality. Suggestions by Rijnmond, accepted by Rotterdam, include proposals for all industries to minimize gaseous and dust emissions by careful control procedures, the installation of better emission control equipment, and for control over siting and choice of new industry to prevent any further deterioration in air quality.

Population

The population in the Rijnmond area has increased very little since 1967 (table 1). An increase of 14,000 people in 1967-1972 was a result of a decrease of 28,000 in the New Waterway area and an increase of 42,000 in the other parts of Rijnmond. The population in the surrounding area (zones II and III) which can be included in the labour market of the Rijnmond area, has increased by 48,700 during the same period.

Table 1. Population statistics of the Rijnmond area (Thousands)

Area	1947	1952	1957	1962	1967	1972
New Waterway a/	766.3	834.5	881.5	907.6	928.0	900.0
Rest of Rijnmond	68.8	73.8	83.2	105.4	134.0	176.0
Total Rijnmond	835.1	908.3	964.7	1 013.0	1 062.0	1 076.0
Zones II and III b/	234.8	250.6	265.3	293.9	325.2	373.9
Total	1 069.9	1 158.9	1 230.0	1 306.9	1 387.2	1 449.9

a/ Including Rotterdam, Schiedam, Vlaardingen, Maassluis, Rozenburg and Spijkenisse.

b/ Areas surrounding Rijnmond where 5 per cent of the labour force are employed in the New Waterway area.

In the Rijnmond area and zones II and III the population has increased by 35 per cent since 1947, corresponding to the population growth of the Netherlands. Consequently, the rapid industrial expansion in the Rijnmond area has not given rise to an increased share in the population of the nation. Population movement to more peripheral territories inside and outside of the Rijnmond area is a well-known urbanization phenomenon. The extent to which this movement has been strengthened and accelerated by rapid industrialization with its related environmental problems, is difficult to determine. However, the Rijnmond area has for a long time suffered from a migration loss, as can be noted in table 2.

Table 2. Migration balance for the Rijnmond area

Year	Gain or loss		
	To other regions in the Netherlands	From foreign countries	Total
1965	-4 164	+2 2[illegible]7	-1 897
1967	-3 395	-2 443	-5 838
1968	-6 299	+2 014	-4 285
1969	-9 143	+2 581	-6 562
1970	-7 445	+4 789	-2 656
1971	-13 676	+6 293	-7 383

The migration loss to other regions of the Netherlands has been increasing and reached more than 13,000 in 1971. About [illegible] per cent of the domestic emigrants, however, go to the surrounding areas and thus remain in the labour force of the Rijnmond economy. The domestic migration loss is partly balanced by immigration from foreign countries. The immigration from abroad has been increasing, and in 1971 was more than 6,000 people.

Land use

Land has been classified into five categories in order to permit a comparison of its various uses in the Rijnmond area, South Holland and the Netherlands (table 3).

This shows clearly the very intensive use of land for housing and industry in the Rijnmond area. Twice as much land is used for dwellings and industry in the Rijnmond area as in South Holland, and four times as much as in the Netherlands.

Table 3. Comparison of land use by area, 1970
(Percentage)

Area	Cultivated land	Nature land[a]	Land for traffic[b]	Water	Land for other uses[c]
Rijnmond	5[illegible].1	4.0	2.5	16.1	27.3
South Holland	66.7	4.3	1.8	13.3	14.0
Netherlands	6[illegible].7	13.5	1.[illegible]	7.8	7.1

a/ Forests, reed etc. and uncultivated land.

b/ Roads, railways and trams, airports.

c/ Residential areas, industrial areas, municipal parks and extension plans.

Economy

Economic growth in the Rijnmond area has been very rapid during the last decade. From 1965 to 1970, growth in production averaged 6.7 per cent per year (5.2 per cent for the Netherlands). Growth in the Rijnmond area, however, has been unbalanced, mainly influenced by the very rapid expansion of the refinery and petrochemical industrial complex in the Europort/Botlek area. Production in the petrochemical industry increased at the rate of 15 per cent per year during the 1960s. The refinery capacity has also expanded rapidly, from 6 per cent per year between 1960 and 1965 to 13 per cent per year between 1965 and 1970. Table 4 illustrates the growth of capacity of the oil refineries in the Rijnmond area.

Table 4. Capacity of oil refineries, 1950-1972
(Million tons of crude oil)

Refineries	1950	1960	1965	1969	1971	1972
Shell	5	15	18	25	25	25
Chevron	1	3	4	12.5	12.5	15
Esso	-	5	8	16	16	16
Gulf	-	-	1.5	4.5	4.5	5
BP	-	-	-	5	15	23
Total	6	23	31.5	63.0	73.0	84

Rapid expansion of refinery and petrochemical complex has given it a dominant role in the economy of the region. In 197[illegible] the value of the total production in this area was f.10,[illegible] million (exclusive of the public sector, price level, 1965) while production in just refinery and petrochemical industry was f.2,1[illegible] million, which means that this complex accounts for [illegible] per cent of the production in the Rijnmond area. The importance of this industrial complex can also be illustrated by noting that, in 1970, [illegible] per cent of the value of the goods exported abroad from the Rijnmond area came from the refinery and petrochemical industries.

This industrial complex is, however, of much greater economic importance than mere production values imply. It also generates activities in other sectors in the region in the following ways:

(a) Production in the complex requires inputs from other sectors;

(b) Production expansion generates investment activities in other sectors;

(c) Income which is generated by the complex and allied activities is spent on commodities and services of other sectors.

To calculate the total economic effects of the refinery and petrochemical complex on the Rijnmond area is a complicated matter and cannot be done within a short period of this study. An estimation of the effects in (a) could have been accomplished with an input-output table for the Rijnmond area. Such a determination includes the production in other sectors which deliver intermediates to the refinery and petrochemical industries. The available input-output table, however, is based on data from 1965 which cannot be expected to be valid at present. In 1965 the production multiplier for the refinery and petrochemical industries was estimated to be 1.14. Consequently, in order to increase the export of products from the region by f.1 million, the total production in the region would have to increase by f.1.14 million. This multiplier was lower than the average of 1.23 for all sectors in the Rijnmond area. The following sectors were most affected by the activity of the refinery-petrochemical complex: wholesale and retail trade, construction, maintenance and repair, electricity, gas and water, oil, sand, peat etc., metal products and machine construction, unclassified activities, banks.

The multiplier for the petrochemical industry can be expected to rise rapidly as the complex attracts more activities to the Rijnmond area. This has been true for the period 1960-1965 when the ratio of input delivered by firms inside the Rijnmond area to the total input rose by 70 per cent. The complex has, over time, become a more integrated part of the economy of the region and other sectors have become increasingly dependent upon production in the industrial complex.

The rapid growth of the industrial cluster has also generated an intensive investment activity. Private investment (exclusive of residential investment) has doubled during the 1960s, from f.1,130 million in 1960 to f.2,262 million in 1970 (price level = 19[illegible]). Investments in the refinery and petrochemical complex alone accounted in the late 1960s for f.700 million per year. The public investment (main infrastructure) increased during the same period from f.230 million to f.3[illegible]9 million.

An estimation of the total economic effects of the refinery and petrochemical complex, which has been completed by the Rijnmond Authority, shows (in terms of an employment multiplier) that every new job in this complex generates 3 new jobs in other sectors (a corresponding value for the metal industry is 2).

The refinery and petrochemical industrial complex is not as dominant an employer as production implies as shown in table 5. The complex accounts for 26 per cent of the production in the area (in 1970), but employs only about 5 per cent of the labour force. This complex is highly capital intensive, resulting in a very high labour productivity.

Table 5. Employment in Rijnmond area, by sector, 1965-1970

Sector	1965	1970
Agriculture	6 400	6 018
Mining and manufacturing (except refining and petrochemical)	109 230	112 414
Refining and petrochemical	19 400	20 592
Construction	43 000	43 346
Services	231 900	250 977
Total	409 930	433 349
Public sector		38 000

In the Netherlands the international sectors have the highest labour productivity of all industries, and in the Rijnmond area productivity in this sector far exceeds that for the nation as a whole (table 6). The difference in labour productivity expressed in terms of standard deviation, is twice as large in Rijnmond area as in the Netherlands and indiates very clearly the unbalanced structure of the Rijnmond economy. The labour productivity in Rijnmond averages 40 per cent higher than in the Netherlands. The difference in labour productivity is in part, reflected in wage differentials.

Table 6. Indices of labour productivity in various sectors, by area, 1969-1970

Sectors	Rijnmond (all sectors=100)	The Netherlands (all sector =100)	Rijnmond (as percentage of Netherlands)
International[a]	1[illegible]1	132	211
National	[illegible]7	90	135
Regional	71	10[illegible]	9[illegible]
Construction	69	72	96
Consumer Service	60	94	112
Average			137
Standard deviation in labour productivity	34	16	.

a/ In Rijnmond consists of [illegible]4 per cent (1970) of refinery and petrochemical industries.

The refinery and petrochemical complex has given the area a very unbalanced economic structure. Simplified, the economy is composed of one capital-intensive industrial complex with high labour productivity and one unqualified service sector with low productivity. This structure of the economy has raised problems in the labour market characterized of a high demand of unskilled labour but insufficient demand of qualified labour. Diversification of the regional economy is urgently required from both social and economic viewpoints.

At present, efforts are being made to dampen the industrial expansion of the Rijnmond area. The Establishment of new industries and expansion of existing industries must be approved on the basis of regional as well as interregional policy. The examination from the regional point of view is handled by the Rijnmond Authority taking into account over-all effects on environment, labour market and congestion in the region. An expansion of economic activity in the Rijnmond area must also be approved by the National Authorities. The object of the interregional policy is to transfer part of the rapid expansion in the western part of the country to depressed areas in the east.

Nature of industries

The Rotterdam/Europort industrial complex, one of the most complicated industrial areas in Europe, consists of 5 oil refineries with a total capacity of 64 million tons per year, many petrochemical industries, chemical process industries and other types of associated industries such as tanker cleaning, oil storage, power generation, and incineration. Products from the complex are numerous, including oil products, plastics, liquid organics, fertilisers and cement. All of the industries are important from an environmental point of view.

Table 7 gives names of major industries and their activities. These industries are located along the New Waterway between Rotterdam and the North Atlantic, a distance of more than 30 km

Table 7. Names and activities of the industries in Rotterdam/Europort industrial complex

Name	Products or activities
British Petroleum	Refinery
Chevron Petroleum Mij	Refinery
Esso Nederland B.V.	Refinery
Gulf Oil	Refinery
Shell Nederland	Refinery
Shell Nederland Chemie	Polyvinyl chloride, latex, herbicides
Akzo Zout Chemie Nederland (KONAM)	Vinyl chloride, monomer, chlorine, caustic soda, hydrogen
Skzo Chemie Nederland B.V.	Methanol, formaldehyde, urea-formaldehyde, normal and iso-butyl acetate, ethylacetate, vinylacetate, acetone, acetic acid etc.
Alcoa Nederland B.V.	Aluminium oxide
Aluminium and Chemie	Carbon anode for aluminium
Air Products Nederland B.V.	Oxygen, nitrogen, hydrogen, carbon monoxide, steam
Brinkers' Margarinefabrieken B.V.	Margarine
Cementfabrick Rozenburg	Portland cement
Chemische Industrie Rijnmond B.V.	Phenol products
Cindu-Key Kramer B.V.	Pipe coating materials
Climax Molybdenum B.V.	Molydenum oxide
Continental Columbian Carbon Nederland B.V.	Carbon black
V.O.F. cryoton	Nitrogen, oxygen
Cyanamid B.V.	Polyamide compounds
Dow Chemical (Nederland) B.V.	Latex, thin plastic films
Essochem Benelux B.V.	Aromatic compounds (e.g. benzene, toluene)
Esso Chemie N.V.	Fertilisers, urea, nitric acid, ammonia
Fabriek van Chemische Producten Vondelingenplaat B.V.	Mercaptan, dyes, fungicides

(continued)

Table 7. Names and activities of the industries in Rotterdam/Europe industrial complex (continued)

Name	Products or activities
I.C.I. Holland N.V.	Polyethylene, acrylate, perplex, nylon, terylene
Ketjen Carbon N.V	Carbon black
Lever's Zeep Mij B.V.	Soap, detergent
Milchem Nederland, B.V.	Cooling agent for oil drilling
Oxirane Chemie (Nederland)	Propylene oxide
Synres Nederland B.V.	Alkyd resin
TDF Tiofine B.V.	Titanium dioxide
Unie van Kunstmestfabrieken	Phosphate and other fertilizers
Windmill Holland B.V.	Phosphate fertilizers
N.V. Afvalvermerking Rijnmond	Municipal and industrial waste incinerator
Tankercleaning N.V	Tanker cleaning
Central Powerstations	Electricity

Many of these industries are potentially major polluters of air and water. Due to a very wide range of production activities, many types of pollutants can be expected. Considering the nature of industries and their pollutants, air pollution would be the most important problem and disposal of solid wastes the least important.

Administrative aspects of pollution control

This material is based on information obtained during interviews, since there do not appear to be any copies of the laws in English. Differing views of these laws and their workings were obtained from different people, so the following is based on a collective understanding of this rather confusing situation.

Laws

Public Nuisance Law (Hinderwet, 1952 and amended in 1958, 1960 and 1964). This is the oldest of the present pollution control laws. Under this law a business that could result in danger, damage or a nuisance to its surroundings is required to obtain a permit for operation. Businesses which are covered by this law are specified in the Public Nuisance Regulations (Hinderwetbesluit, 1953 and amended until 1967). Any modification of the business requires a new permit. The permit is issued by municipal authorities, and usually specifies certain operational procedures and the means and methods of controlling nuisances, which include pollution. Up until the enactment of the further laws, and the participation of citizens demanding better environmental conditions, this law did little to control pollution.

Air Pollution Act of the Netherlands (Wet Inzake de Luchtverontreiniging, enacted in 1970, with amendments since). Under this law a business, required to obtain a permit, must also report to the agency issuing the permit, the volume and percentage composition of gaseous emissions. Communities may establish emission standards, to regulate the amount of pollutants released from any source. With the combination of the Nuisance and Air Pollution Acts, communities may thus exercise control by limiting availability of a permit, by the specifications of the permit and/or by regulating the concentration of gaseous emissions.

Water Pollution Act (believed to have been enacted in 1970 and amended in 1972). According to this law, surface water in the Netherlands is divided into national waters, provincial waters and municipal waters. Rivers, estuaries and waterways important to transportation are national waters. Discharge of waste into any surface water is illegal, unless a permit is obtained from national, provincial, or municipal authorities. Fees are charged for waste discharge, the amount based on the oxygen demand of the waste. Municipalities as well as industries are subject to payment of these fees In 1974 these charges were about f.11 per population equivalent.[a]

The effluent charge system is one method of internationalizing the external diseconomies caused by polluters, which can lead to an optimum control of pollution. A polluter will treat his waste waters up to a limit of marginal treatment cost. In addition, the system also provides an incentive to the industry to find a means to reuse the waste water, recover the waste materials, and reduce the wastes by improving production technologies. The existing effluent charge in the Netherlands can be considered as a trial and error method in trying to find the charge which gives the optimum control. At the same time the industry has time to gradually adapt to the control system.

Administration and enforcement of pollution laws

Air pollution. As noted previously, Rijnmond Authority exercises the air pollution control powers normally granted to municipalities, and thus can coordinate planning and regulation over the entire Rijnmond area.

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a/ Population equivalent is the quantity of waste in an effluent stream that has an equivalent BOD (5 days, 20°C) to the average domestic waste discharged per person. The accepted figure is 1/6 lb per person per day.

Two separate intercepting or monitoring systems have been set up by Rijnmond: a circle of air samplers or sniffers around the industrial area to monitor SO_2 levels, and a telephone switchboard, manned 24-hours a day, to receive complaints from citizens. A computerized system of plotting SO_2 levels facilitates location of any emission source, and mobile units can investigate and locate the source causing citizen complaints. Rijnmond may notify the industry involved and request reduction, or in extreme cases cessation of emissions. In those few cases where the municipality has not granted Rijnmond authority for such acts, the municipality is notified of the problem, and may take such action as they believe necessary. Home and greenhouse heating and transportation (boat and automobile) also contribute to the air pollution problem, but are not regulated under these laws.

Figure I presents a diagrammatic scheme of the air pollution control system. There is an informal network included in the diagram. An organization named Stichting Europoort/Botlek Belangen (EBB), comprised of many of the businesses and industries in the Rijnmond area, has as one of its aims the minimization of annoyance inflicted upon the inhabitants of nearby residential areas due to air, water and soil pollution. Informal contacts between Rijnmond Authority, municipalities and EBB result, in some cases, in the EBB persuading members to co-operate and abate nuisances without formal protests being made.

<u>Water pollution</u> Experience under the water pollution act has been limited to such a short time that there were little data available. Figure II shows the diagrammatic scheme of the water pollution control system.

Rijkswaterstaat, the national transportation agency, has two divisions, one of which is responsible for water quality in national waterways. Organizations discharging waste, or wishing to, must apply to Rijkswaterstaat for a permit to pollute. RIZA (Rijksinstituut voor Zuivering van Afvalwater), which is a research organization within Rijkswaterstaat, offers advice on design, construction and operation of waste disposal systems. Rijkswaterstaat must be supplied with data on the specific pollutants, including quantities and concentrations which allows them to determine potential problems and effects. From this they can suggest possible treatment methods, and also specify maximum pollutant levels for each specific pollutant. The licensee is expected to provide reliable data, but Rijkswaterstaat also monitors the effluents. This licensing procedure is so thorough, that it takes an estimated two years to process a licence application. The novel aspect of this system is the imposition of fees upon licence holders. Initially the fee

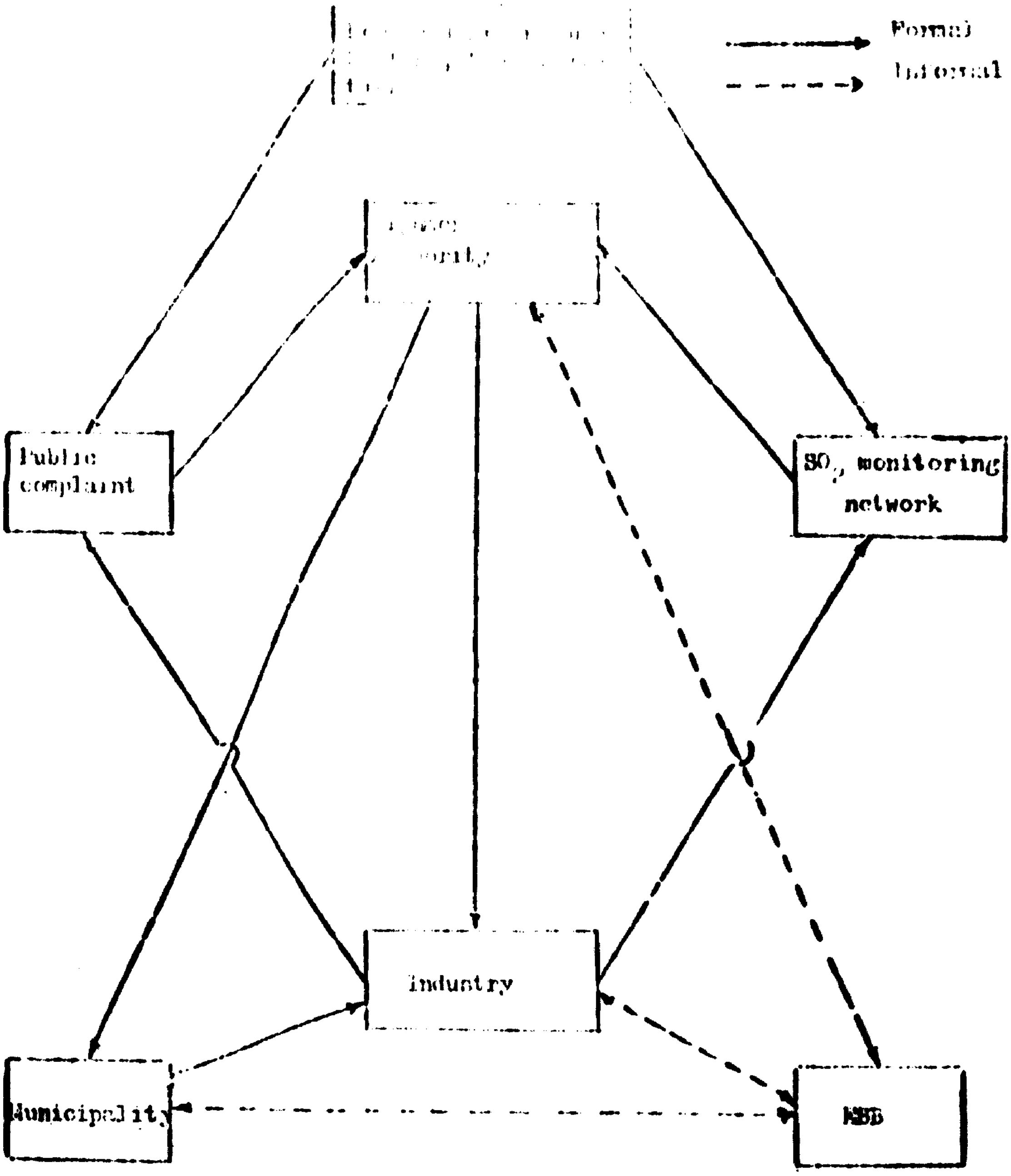


Figure 1. Diagrammatic scheme of air pollution control system

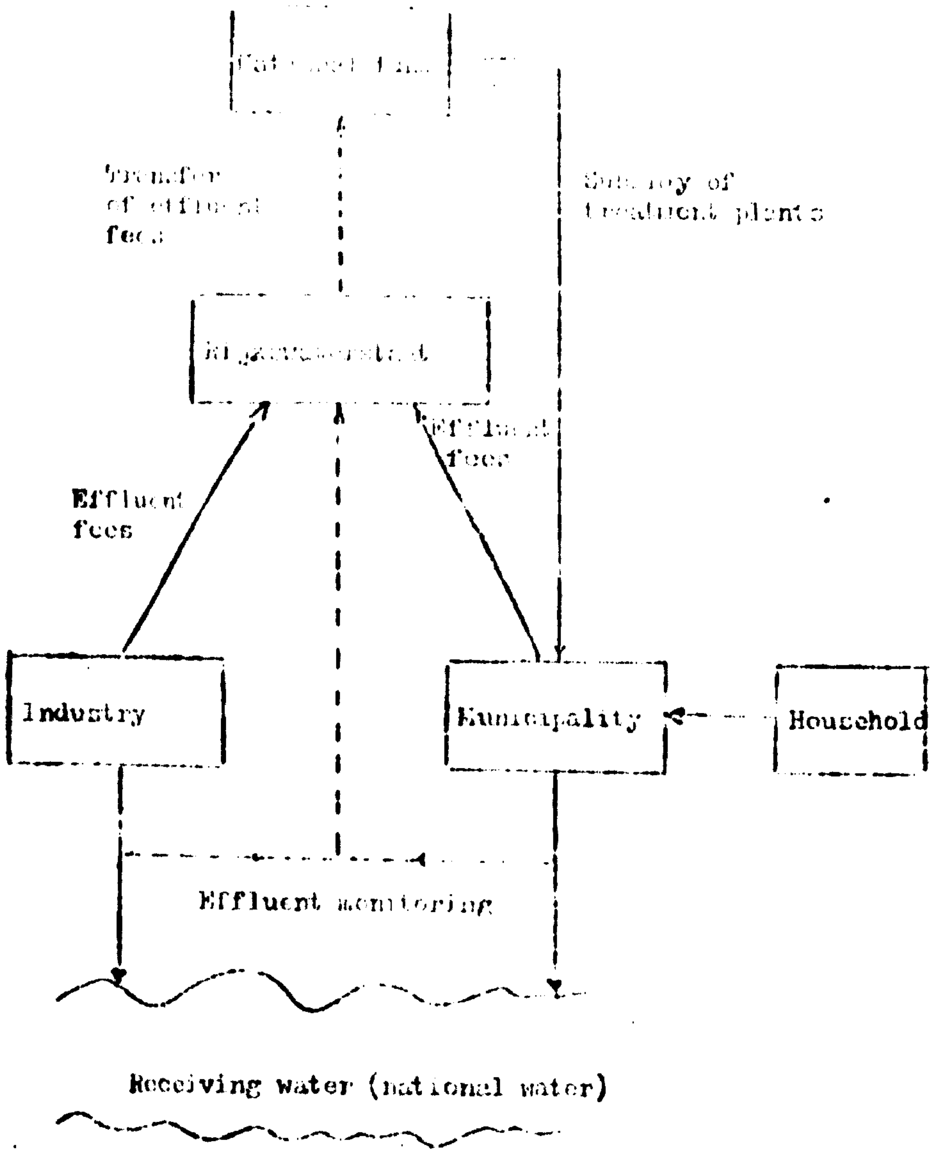


Figure II. Diagrammatic scheme of water pollution control system

scale was low, but it rises in regular increments until discharging untreated wastes is no longer economically attractive. Since implementation of the law, use of municipal water and volume of wastes discharged by industry are both reputed to have declined, evidence that at least part of the external diseconomies have become internalized by reuse and/or waste treatment of water.

Extensive planning and evaluation of various schemes to combine wastes from the industrial area for treatment in one municipal facility apparently have resulted in a decision that this would not be feasible. The linear conformation of the industrial area, coupled with the amount and location of surface water in the area makes a single collection system too complicated and expensive. Individual industries, or groups on one area will be responsible for providing their own treatment facilities. This would provide an opportunity for combining wastes to achieve a more neutral product, and also for reuse of treated water where that was acceptable.

Environmental control by means other than environmental regulations

Pollution from industries is regulated not only by specific pollution legislation (Air pollution law etc.); examination and control of the environmental effects of industrial activities also take place in other ways.

If the municipality is the owner of the industrial ground, the leasing contract may stipulate more rigorous conditions concerning environmental effects than do existing laws. The Municipality of Rotterdam owns the ground in the Europoort/Botlek area. A leasing contract for this ground is a civil contract and can, for example, prescribe conditions which make it possible to take action against practices which have undesirable effects on the environment. The leasing-contracts in this area state that the owner is justified to terminate a contract if broken by unacceptable practices. If however the industry takes the necessary steps to correct the problem within six weeks, termination action on the contract is withdrawn. Consequently, the fact that the municipality is the owner of the ground must be considered as an important factor in controlling the environmental effects of the industries.

Establishment of new industries and expansion of existing industries in the Rijnmond area at present must be approved on the basis of regional as well as interregional policy. The examination from a regional point of view is handled by the Rijnmond Authority with regard to the over-all effects on environment, labour market, congestion etc. in the region. An expansion of the economic activity in the Rijnmond area must also be approved by the National Authority. The object of the interregional policy in the Netherlands is to transfer part of the rapid expansion in the western part of the country to depressed areas.

B. Firms visited in Rotterdam

N.V. Afvalverwerking Rijnmond

Background

This company is publicly owned and non-profit making. The stocks are held by the Rijnmond Authority and the 23 municipalities in the Rijnmond area. The principal activity of the company is incineration of domestic and industrial wastes. It went into operation in the beginning of 1973 with a total capital investment of f.211,500,000.

Inputs

Domestic solid wastes. Charge is f.22 per ton.

Non-poisonous solid wastes from industries; charge varies from f.30 per ton for those under contract to f.45 for those not under contract.

Solid and liquid chemical wastes: charge varies from f.53 per ton for easily handled material to f.120 for the most difficult.

Outputs

Electricity: 14 MW; 3 MW used in plant, 11 MW sold for the equivalent of the cost of fuel to run a power plant, thus price fluctuates with fuel costs.

Distilled water: 450 m^3/h, a small portion is used internally, the remainder sold to Rotterdam at cost, about f.2 per ton (about f.880 per hour or f.21,120 per day).

Major components

Six grate furnaces with waste-heat boilers. Total normal operation calls for five furnaces in operation and one in reserve while being maintained.

Two rotary furnaces with after-burning chambers for input of 7 tons per hour of chemical wastes (3 tons/h of solid and 4 tons/h of liquid wastes). Only one furnace operates at a time.

Steam turbine generators for production of 14 MW of electricity.

Water distillation plant using low pressure steam in the flash distillation process.

Raw wastes

R1 - Flue gas from domestic solid wastes containing fly ash, SO_2, NO_x and HCl.

R2 - Flue gas from industrial non-poisonous solid wastes containing SO_2, NO_x and HCl.

R3 - Floor washwater

R4 - Slag

R5 - Slag quench water.

Waste characteristics

Flue gas composition calculated from material balance.

Sources	Volume (m^3/kg waste)	Composition of flue gas in the fire box (percentage by volume)					
		CO_2	O_2	H_2O	N_2	NO_2	HCl
Grate furnace	6.5	9.25	10.5	±10	±70.0	0.027	0.0028
Rotary furnace	4.1 (including cooling air)	9.00	10.5	±12	±67.5	0.196	0.935

Some of the nitrogen must be in NO_x forms.

Control technologies

For R1: electrostatic precipitators for removal of fly ash no control of gaseous pollutants

For R2: no control

For R3: no control

For R4: separation of scrap metal

For R5: removal of solids in a settling basin.

Useful waste products

From R1: fly ash (720 tons per week; sold for f.3 per ton = f.2,160 per week).

From R4: scrap metal and slag (metal is recovered and sold, slag is sold as fill material).

From R5: dried sludge (sold as fill material).

Waste residues to the environment

From R1 and R2: SO_2, NO_x, HCl (total volume of gas is 19.2 million m^3 per day).

From R3: BOD, solids (amounts unknown)

From R4: none.

From R5: solids, alkalines (amounts unknown).

Comments

(i) At present a pilot plant study is being conducted at the site to test the feasibility of removing the pollutants from the flue gases using a dry process: possibly the limestone-dolomite injection process. This indicates the commitment of the company to control all forms of pollution;

(ii) A large animal-rendering plant was moved from the municipal area of Rotterdam to the land adjoining the incineration plant. Malodourous gas from the animal-rendering plant is conveyed to the incineration plant and used in the combustion of solid wastes. This is one good example of economical control of pollution achieved through co-location;

(iii) The electricity generated and the distilled water produced are sold as are the fly ash, scrap metal, slag and dried sludge;

(iv) The incineration plant provides the most economical method for disposal of liquid chemical wastes which are difficult to treat by conventional methods. Normally, these wastes are produced in small volumes. Collective treatment therefore, provides economy of scale and effective control;

(v) An economic study of the incineration plant should be conducted to determine its feasibility in developing countries. The incineration plant can be considered as one industry which may be economically viable and yet reduce pollution of the industrial region.

TDF Tiofine B.V.

Background

This is a private company with a capital investment of about f.5 million. It produces about 30,000 tons per year of titanium dioxide pigment from concentrated ore imported from Canada.

Inputs

Concentrated ore containing 70 per cent TiO_2 and about 10 per cent ferrous ions.

Concentrated H_2SO_4.

Outputs

Titanium dioxide pigment.

Major sources of pollution

(a) Digestion tanks, calciners, micromixers

(b) Sedimentation and filtration of the ore digested with concentrated H_2SO_4

(c) Filtration of the washed digested product obtained from (b).

Raw wastes

R1 - Waste gases from source (a) containing TiO_2, dust, SO_3 and SO_2

R2 - Strongly acidic sludge from source (b) consisting of silica, and other solids.

R3 - Waste water from source (c) containing H_2SO_4 and ferrous sulphate.

Waste characteristics

No data available.

A typical composition of calciner exhaust gases as experienced elsewhere

Materials	Percentage of volume
N_2	54.0
H_2O	35.0
O_2	7.0
CO_2	4.0
$SO_3 + SO_2$	0.3
TiO_2	0.45

Control technologies

For R1: electrostatic precipitator followed by water scrubber

For R2: no control, dumped into the river

For R3: no control, discharged into the river.

Useful waste products

TiO_2 recovered from R1 dust may be recycled.

Waste residues to the environment

From R1: acid waste water

From R2: solids, acids

From R3: COD ($FeSO_4$), acid.

Comments

(i) Disposal of the acid sludge and the waste waters will be a major problem for this type of industry. For the sludge, a study should be made to find the appropriate drying method and utilization of the dried solids. For the waste waters R1 and R3 neutralization with lime or caustic soda may be too costly and will also create a problem of sludge disposal.

(ii) It was estimated that about 12,000 tons of ferrous sulphate is discharged into the river every year. Direct recovery of ferous sulphate in the waste water R3 would not be economical due to its low concentration. However, it might be economically feasible to utilize it in water or sewage treatment.

Unie van Kunstmestfabricken B.V.

Background

An integrated fertilizer industry producing ammonium nitrate, urea, ammonium phosphate, triple superphosphate, and mixed fertilizers. Production of ammonia, nitric acid, sulphuric acid and phosphoric acid are integrated parts of this industry.

Major sources of pollution

(a) Unloading of phosphate rock
(b) Sulphuric acid plant
(c) Phosphoric acid plant
(d) Nitric acid plant
(e) Diammonium phosphate plant
(f) Triple super phosphate plant
(g) Urea plant

(a) Unloading of phosphate rock

Raw wastes: dust

Control technologies: none

Waste residues to the environment: dust.

(b) Sulphuric acid plant

Background: two single contact plants each having a capacity of 900 tons per day

Input: pure sulphur

Output: concentrated H_2SO_4 to be used in production of H_3PO_4

Major sources of pollution: absorber

Raw waste: waste gases containing SO_2, SO_3 and acid mist

Waste characteristics: no data available. Typical tail gas concentrations in the USA: SO_2 1,500 - ,000 ppm; acid mist 2 - 20 mg/scf; SO_3 0.3 - 1.3 ppm.

Control technologies: none.

Comments:

(i) One of the sulphuric acid plants is very old and is to be replaced by a new one. The new plant will use the double contact system which can reduce the SO_2 emission to about 500 ppm;

(ii) The present amount of SO_2 discharged into the atmosphere is about 736 kg per hour;

(iii) A study should be conducted on economic feasibility of the double contact process compared with the single contact process taking into account the pollution control factors.

(c) Phosphoric acid plant

Background: Two plants, one of which is over 20 years old. The estimated capacity of each plant is about 550 tons per day in terms of P_2O_5.

Inputs: Phosphate rock; concentrated H_2SO_4

Outputs: Concentrated H_3PO_4 containing 50 - 55 per cent P_2O_5

Major sources of pollution: reactor, condenser, gypsum pond

Raw wastes: R1, fluoride gases mainly silicon tetrafluoride and hydrosilicic acid; R2, gypsum contaminated with cadmium, phosphorus and fluorides

Waste characteristics: no information available.

Control technologies: R1, water scrubber; R2, no control.

Useful waste products: from R1 - fluoride water; from R2 - gypsum.

Waste residues to the environment: fluoride water discharged into the river; gypsum dumped into the river.

Comments:

(i) At present the waste gypsum cannot economically be utilized due to high concentrations of impurities. A new plant is to be built shortly to replace the old plant. The new plant, using a new process, can produce high quality gypsum. The company plans to produce building materials from the recovered gypsum;

(ii) The fluoride water is presently used for fluoridation of drinking water and for production of aluminium fluoride. When there is no market for it, the fluoride water is discharged into the river;

(iii) It is important to note that cadmium, a very toxic heavy metal, is present in the phosphate rock in varying percentages depending on the source of the rock. The company uses the rocks from two sources, one containing 27 ppm of cadmium and the other containing 115 ppm. This indicates a potential danger in gypsum waste from the phosphate fertilizer industry;

(iv) Ideally, this type of industry should be located near a water treatment plant where fluoride water can be economically used. An industry producing building materials should be set up to utilize the gypsum byproduct.

(d) Nitric acid plant

Background: production of nitric acid from ammonia and air using the ammonia oxidation process.

Input: ammonia; air

Output: 15,000 tons per year of acid calculated as N

Major sources of pollution: absorption tower

Raw wastes: tail gas containing NO_x

Waste characteristics: about 146 kg per hour of NO_x

Control technologies: none

Waste residues to the environment: about 146 kg per hour of NO_x

Comments:

(i) The waste gas has a yellowish brown colour due to NO_x. The factory, so far, has been requested to stop production 8 times during bad weather conditions.

(ii) The amount of NO_x emitted was about 10 kg per ton of acid. This indicates that the process technology is old. A new process can result in an emission rate as low as 1 kg per ton.

(iii) The company is planning to control the air pollution problem using the catalytic combustion process.

(e) Diammonium phosphate plant

Background: production of diammonium phosphate from phosphoric acid, sulphuric acid and anhydrous ammonia.

Inputs: ammonia; H_2SO_4; H_3PO_4

Major sources of pollution: no information available

Comments:

(i) The information obtained was very limited. However, this type of process will result in the emission of ammonia, particulates, and fluoride;

(ii) About 120-150 tons per year of ammonium compounds were reportedly discharged in the form of waste water into the river

(f) Triple super phosphate plant

No information was available. Expected pollutants are dust and fluoride.

(g) Urea plant

Information was limited. The major emission was ammonia gas. The most interesting point is the interaction between this ammonia with the SO_2 from the sulphuric acid plant forming the bluish haze. This particular haze has no odours but was rather stable. The problem has still not been solved.

Comments:

(i) Dusts, SO_2 and fluoride are three principal air pollutants from the integrated phosphate-fertilizer industry. Fluoride can be recovered using wet scrubbers and the fluoride water is used for fluoridation purposes. Dusts which are mainly fine particles of phosphate rock, can be removed and recycled. SO_2 emission from the sulphuric acid plant can be significantly reduced using the double-contact process;

(ii) In addition to the fluoride gases, acidulation of the phosphate rock also results in gypsum wastes. The new process can produce high quality gypsum which can be used as a raw material in making building materials;

(iii) The phosphate rock with a low cadmium content should be used to avoid cadmium pollution problem, unless a means of extracting cadmium can be developed, or cadmium containing waste products can be processed into other usable products.

<u>Akso Dout Chemie B.V.</u>

Background

This company produces vinyl chloride monomer from ethylene using the oxychlorination process. Chlorine gas used is generated at the site by electrolysis of brine in mercury cells.

Inputs

Ethylene (C_2H_4)
Brine ($NaCl + H_2O$)

Outputs

Vinyl chloride monomer
Hydrogen
Caustic soda

Major sources of pollution

Chlorine plant.

Raw wastes

Chlorine gas and mercury vapour
Waste water containing mercury

Waste characteristics

No information available

Control technologies

Removal of mercury from gaseous and liquid wastes but no information on the methods used.

Waste residues to the environment

Mercury

Comments

(i) A well operated and controlled vinyl chloride monomer plant should result in practically no air pollution problems. For this plant the main problem is mercury pollution in terms of gaseous and liquid wastes;

(ii) The company is planning to install a second chlorine plant. Authorities now require a diaphragm cell in the new plant instead of a mercury cell. This will solve the mercury pollution problem. However, caustic soda as produced in a diaphragm-cell plant leaves the cell as a dilute-solution along with unreacted brine. The caustic solution can be purified by evaporation to increase the concentration to a range of 50 to 75 per cent. Evaporation also precipitates most of the residual salt which is then removed by filtration. In mercury cell plants, high-purity caustic soda can be produced in any desired strength and needs no concentration;

(iii) The company knows from experience that production of caustic soda using the diaphragm cell is profitable. The caustic solution should be mixed with carbon dioxide gas to produce sodium carbonate. The economic feasibility of this process depends on low cost carbon dioxide;

(iv) This case study demonstrates that under certain conditions process technology can be modified, economically, to achieve better pollution control.

<u>Akzo Chemie N.V.</u>

Background

This is an integrated petrochemical industry producing a great variety of organic chemical products such as methanol, formaldehydes etc.

Inputs

Natural gas, propylene, butane, urea.

Outputs

Methanol, formaldehyde, urea-formaldehyde, butanol, butylacetate, ethylacetate, vinylacetate, methylethylketone, acetone, acetic acid.

Major sources of pollution

(a) Acetic acid plant
(b) Methanol plant
(c) Ethylene plant.

Raw wastes

R1 - Odorous liquid waste from (a)
R2 - Liquid waste from (b)
R3 - Viscous liquid waste from (c)
R4 - Bleed-off from cooling tower.

Waste characteristics

No information available.

Control technologies

Incineration for R1, R2 and R3

No control of R4, discharged into the river.

Waste residues to the environment

Organic compounds in R4 (BOD).

Comments

(i) By careful operation and maintenance this industry has practically no air pollution problem;

(ii) The waste water R4 has an oxygen demand equivalent to 15,000 people per day which can easily be treated.

<u>I.C.I. Holland B.V.</u>

Background

Plastic manufacturing industry.

Inputs

Ethylene, phosgene, ethanol, methanol, cyanates, etc.

Outputs

Various types of plastics such as nylon, polythene, isocyanates, polyesters, persplex, terylene.

Major sources of pollution

(a) Washing operation;

(b) Regeneration of the demineralization plants.

Raw wastes

R1 - Waste water from (a) containing organic compounds

R2 - Acid and alkaline waste water from (b).

Waste characteristics

No information available.

Control technologies

R1 is purified in a bilogical filter plant.

R2 is controlled by mixing the acid and alkaline waste streams for neutralization before discharging into the river.

Comments

(i) This industry shows a good example of pollution control. Only a small amount of waste residues are released to the environment;

(ii) The most interesting point is the utilisation of solid wastes in the form of plastic scraps. Ethylene is economically produced from polythene scrap. Terylene scrap is also processed to make dimethylterephtalate which can be used in making terylene plastic.

Annex II

MANILA

A. Background data on the Manila site

Physical environment

Topography

The physical and economic environment of the Manila metropolitan area is greatly influenced by water. Manila Bay borders metropolitan Manila on the west and fish ponds and salt beds extend inland from the bay. Creeks and canals divide the coastal cities into a series of islands.

Metropolitan Manila is bordered on the south-east by Laguna de Bay, a large freshwater lake. The Metropolitan area is crossed from east to west, by three river systems; in the north by the Malabon river, in the south by the Parañaque river and in the middle by the Marikina-Pasig river system. The Pasig river flows out of the Laguna de Bay, through Manila City and out into Manila Bay at the port of Manila.

The Manila metropolitan area is characterized by three belts of terrain running north-south parallel to the bayshore. The belts are in order from west to east, the coastal plain, the Guadalupe hills and the Marikina-Laguna Valley. The parellel configuration is broken by the Pasig river which breaks through the hills at Guadelupe pass and dissipates in the coastal plain.

Fishponds occupy most of the north coast and much of the south coast of the metropolitan area. Gradual reclamation of fishponds for residential development is taking place.

Most of Manila is less than two metres above sea level and during the rainy season the flow in the streams rises to street level.

The Guadelupe Hills rise to summits of 90 to 100 m north of the Pasig river and 30 to 40 m to the south. Drainage from the hills is generally westward to the San Juan river in the north and directly westward to Manila Bay in the south.

Climate

The climate of the Philippines is influenced by high pressure zones between November and February. This causes the prevailing north-eastorly winds over Manila during these months. January is usually the coolest month. Local topography causes the north-east trade winds to come from the south-east in the Manila area during

March, April and May, and these hot, rainless months form the summer season. The temperature during these months can exceed 35° C (average 28° C). From June to October, the south-west monsoon prevails over the Philippines bringing rain and light westerly winds.

The most rainy months are June to September, the months of the south-west monsoon. The north-east monsoon brings much less rain while the easterly trade winds are virtually without rain. The south-west monsoon between May and October also brings thunderstorms; there are an average of eight days of thunderstorms per month during this period.

<u>Sanitation amenities</u>

Water supply

Water for the distribution system is obtained from four separate surface sources and from deep wells. Three of the surface water sources are north-east of Manila, drawing upon sources of good quality. The fourth, the Marikina river, is polluted and during the dry season contains as much as 2,300 mg/l of chloride because of salt water intrusion. All surface waters now are treated at one plant, where chemical coagulation, sedimentation, rapid sand filtration and chlorination are performed. The capacity of the treatment facilities is 1.14 million m^3/day (300 million gal/day). Ground water, when used, is pumped directly into the mains without treatment.

The distribution system is old and inadequate, resulting in low pressure in some areas, and intrusion of polluted water in others. A programme for upgrading this system is under way, but has not progressed as rapidly as planned.

Sewage treatment

Only a very small portion of the sewage generated in Manila passes through treatment plants. In most cases the present load exceeds the capacity of the plant, resulting in poor quality outflows. The remainder of the sewage flows directly into streams, passes through septic or Imhoff tanks and then to surface waters, or flows into sewers.

The Manila sewer system was constructed in the early 1900s, with little extension or repair work since. As of 1969, only 12 per cent of the population was served by sewers.

Operation of the system is poorly co-ordinated with the needs of the city. Pumps operate only at night when waste water flow is minimal. This has caused officials to refuse to accept waste from industries willing to pump materials to a sewer, forcing the industry to dump waste into nearby streams. Extensive modification and improvements were suggested as a result of a recent study.

Sewage from the collection system is discharged into Manila Bay via a single outfall. Sewage and wastes discharged into surface waters flow into the bay from the Pasig, Tullahan and Paranaque rivers, all along the east shore. Effects of such discharges will be discussed later.

Solid waste

Refuse and garbage hauled from urban areas are dumped near the shore of Manila Bay. A major portion of the solid waste generated in Manila is deposited along the banks or in the water in streams and rivers. From here it is carried into Manila Bay.

Political units and their administration

There is a rather complicated, interlocking system with responsibilities related to industry and pollution. Although the following does not include all agencies involved, the system appears to function as follows. National policy is established by publication of Presidential decrees. The National Pollution Control Commission (NPCC) was founded in 19 4 to maintain reasonable standards of purity of the water and air in the country for their utilization for domestic, industrial and other legitimate purposes, and to plan, co-ordinate and adopt research activities for the prevention and control of environmental pollution. The NPCC has been placed under the control of the National Science Development Board (NSDB), which has responsibility to insure that all community interests are represented in matters concerning environmental protection as well as developments in science.

Standards for air and water quality as developed by NPCC are used as guidelines by additional agencies and foundations which have regulatory or advisory roles in relation to industry. Thus the National Economic Development Authority (NEDA), which is responsible for economic development planning, takes cognizance of NPCC standards, and encourages development and/or expansion of industries in areas where their effects would be most environmentally acceptable. A recent Presidential decree stipulated there would be no new polluting industries permitted within a 30 km radius of the centre of Manila, and this distance has now been increased to

50 km by an unofficial directive. While an industry could attempt to establish a facility in an area not favoured by MIDA, there are a number of ways such undesirable siting could be discouraged. High priority industry is given various incentives, such as a rebate of taxes or import duties on pollution control equipment. Refusal to refund such taxes is one economic encouragement to select a site in an approved area.

Another agency with influence in this area is the Board of Investment (BOI). This board accepts registration of high priority industries, and provides services in locating acceptable sites and granting tax-exempt or reduced-tax status. BOI insists that new or expanding industries meet NPCC requirements by installing the latest in pollution control equipment and using the most acceptable processes. Withdrawal of BOI recognition carries a severe stigma, so BOI can act as both arbiter and enforcer to get industry to comply with NPCC regulations. Government controlled banks also help in this regard, controlling the supply of money needed by industry.

Additional agencies, the Human Settlements Task Force (HSTF) and Manila Bay Regional Planning Group (MBRPG) have responsibilities in relation to environmental quality also. These agencies develop plans for future urban and industrial development, both of which must be co-ordinated with NPCC guidelines. Plans developed would influence the programme of MIDA and BOI.

Finally, there is a private group, the Economic Development Foundation (EDF), whose aim is to assist industries in various ways. One section of EDF, Engineering and Industrial Research, is devoted to providing assistance in identifying and developing proper waste treatment schemes. This includes pilot research on methodology and also investigation of the feasibility of common treatment for multiple industries and utilization of wastes as resources. There was some evidence this group lacked the breadth in capabilities needed to develop acceptable waste treatment plans.

Examples of waste utilization mentioned by one or more of the above groups included:

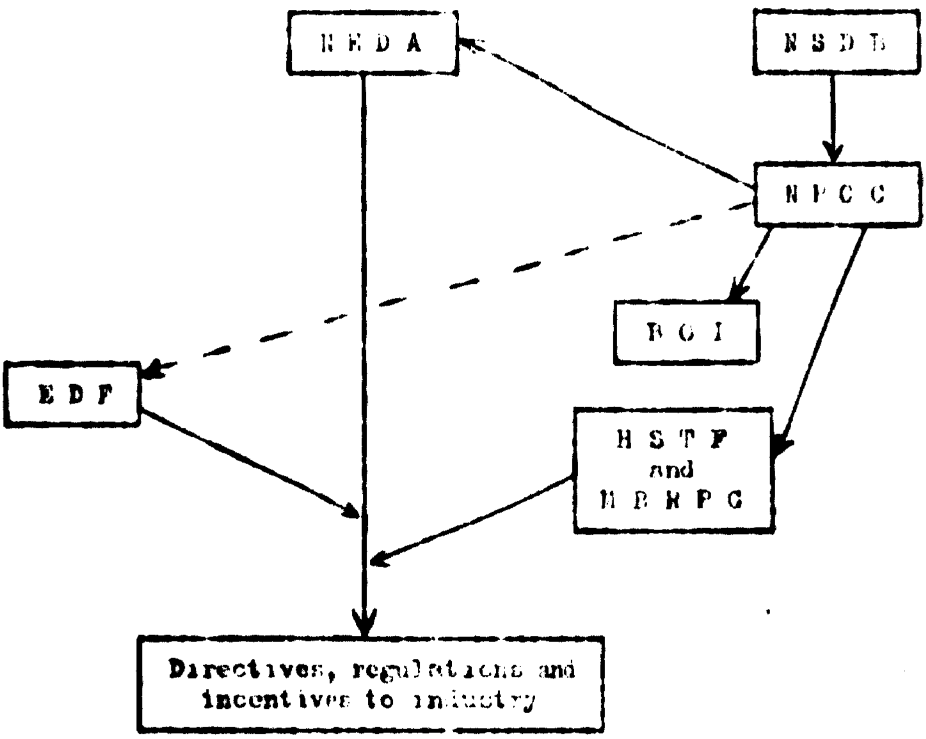
(a) Gypsum in wastes is now used by the cement industry, which reduces imports of raw materials from 100 per cent to only 25 per cent for the cement industry.

(b) Spent caustic soda from an oil refinery, formerly dumped at sea, is to be supplied to a pulp mill. This will require barging from southern Luzon to Mindanao Island, but both industries feel they will save money this way.

(c) [illegible] by a textile mill to neutralize [illegible] wastes. [illegible] common storage facility for several textile mills, [illegible] would [illegible] as needed.

An approximation of the [illegible] relationships of the above mentioned agencies appears in Figure 1. The relationship is more complicated than this, because members of one agency may also serve on governing or advisory boards of another, and also because there are feedback loops not shown in the figure.

Figure 1. Functional relationships of some of the agencies regulating or affecting industries in Manila.



Note: BOI - Board of Investment
EDF - Economic Development Foundation
HSTF - Human Settlements Task Force
MBRPG - Manila Bay Regional Planning Group
NEDA - National Economic Development Authority
NPCC - National Pollution Control Commission
NSDB - National Science Development Board

Population

The metropolitan area of Manila at present covers 1600 km^2 and contains a population of [illegible].7[illegible] million. It is a rapidly expanding area, both spatially and in terms of population. From 1[illegible] to 1[illegible], the population of metropolitan Manila increased by [illegible]1 per cent compared to a 3[illegible] per cent increase for the Philippines as a whole. The metropolitan area covers only about 1 per cent of the country's land but contains nearly 1[illegible] per cent of the population. It has an average density of 2056 persons per km^2. The very rapid population growth in metropolitan Manila has an unequal distribution however. Manila's increase in population between 1960 and 1970 was 17 per cent, compared to about [illegible]6 per cent and 79 per cent for the intermediate and outer zones, respectively. This pattern represents a typical phenomen of metropolitan growth. Such rapid urbanization has brought problems to the area. Utility systems have failed to develop to serve the expanding metropolis and immigration has exceeded available jobs, resulting in lower real incomes unemployment, poverty and high criminality. The number of squatters, at the end of the 1960s, was estimated at about one million persons.

Land use

The land used for different purposes in metropolitan Manila is approximately:

	Percentage
Residential	23
Commercial	1
Industrial	3
Institutional	4
Open etc.	64

The location of activities in the area can be characterized by:

An intensive land use in the central business district

Marked ribbon developments along major roads

Indiscriminate mixture of land uses

Presence of blighted areas and slums in many sections of the city

These conditions may be attributed to the absence or inadequacy of zoning regulations and land development controls.

Land uses are generally mixed with economic activities carried on within residential areas. Some broad patterns are clearly discernable: the central business district; manufacturing and industries along the Pasig and Marikina rivers, along the South Super Highway and in Malabon and Caloocan City.

Economy

The Philippines is primarily an agricultural country with more than two-thirds of the gainfully employed engaged in farming and related activities. It is the biggest world supplier of major coconut products. Despite the efforts to hasten the tempo of industrial growth, the agricultural sector still leads the other economic sectors. At present manufacturing sector's contribution to domestic production is about 20 per cent. Industrial activity in the country is highly concentrated in the Manila metropolitan area, where about 55 per cent of the country's industrial capacity is located.

The concentration of industries in metropolitan Manila is illustrated by the following table.

Table 1. Concentration of industrial establishments in metropolitan Manila (percentage)

	Total	Manufacturing	Large manufacturing
Metropolitan Manila	25	28	73
The Philippines	100	100	100

Though metropolitan Manila accounts for 1/8 of the population in the Philippines, 1/4 of all establishments in the country are located there. Particularly noticeable is the concentration of large manufacturing establishments, of which about three-quarters are located in metropolitan Manila.

The number of manufacturing establishments in metropolitan Manila in 1972 was listed as 15,166.

Metropolitan Manila is divided into three parts:

1. The city of Manila,

2. The intermediate zone (composed of the cities of Caloocan, Quezon, Pasay and the municipalities of Navotas, Malabon, Marikina, San Juan, Mandaluyong, Pasig, Pateros and Makati, all in Rizal province),

3. The outer zone composed of the remaining municipalities in metropolitan Manila.

Table 2. Distribution of manufacturing establishments in metropolitan Manila

Item	Number of establishments
City of Manila	4 877
The intermediate zone	7 709
The outer zone	2 580
Total	15 166

Table 2 shows that about one third of the manufacturing establishments are located in the city of Manila, mainly along the Pasig river. Half of the manufacturing units are located in the intermediate zone. Agglomerations of factories in this zone are to be found along the Pasig river outside Manila (Mandaluyong, Makati), along Marikina river (Marikina, Pasig) and along Tinajeros and Tullahan rivers in Caloocan city north of Manila. In the south, factories have agglomerated along the South Super Highway in Makati and Pasay.

The industrial agglomeration are characterized by a haphazard distribution of industries and there is little evidence of industrial type grouping. Industries producing much waste water have located along the major rivers and lack of space has forced the new large industries out of the metropolitan periphery. However, some private industrial estates have been successfully developed in the environs of Manila since the middle of the 1950s. The largest and best known are the Ayala (along the South Super Highway) and the three Ortigas estates (north of Marikina river). These estates have offered fully developed industrial land with varying lot sizes. These estates are regarded as successful.

At present, a new industrial estate is being planned west of Laguna de Bay. It covers 400 ha and is intended for small scale industry.[a/]

Any recent list of the industrial structure in metropolitan Manila is not available. The latest information is from 1961 and covers Manila and Rizal province, roughly corresponding to metropolitan Manila. The distribution of employment by manufacturing establishment at that time is shown in table 3.

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a/ UNIDO, "Studies for West Laguna Industrial Estate: the Philippines", report prepared by W.D. Scott (April 1974).

Table 3. Distribution of employment by industrial sector for city of Manila and Rizal Province in 1961

Industrial sector	Description of the product	Number of establishments	Number of employees	Average number of employees per establishment
Food	Manufactured, canned, preserved and dairy	1 245	18 200	15
Beverages	Beer, wines, distilled and soft drinks	53	5 720	108
Tobacco	Cigars and cigarettes	57	12 300	218
Textiles	Spinning, weaving, dying, local synthetic, and cotton fibre goods	108	25 580	237
Wearing apparel	Foot-wear, made up textile goods	4 641	31 350	68
Wood and cork products	Preserving, plywood and veneer, excluding furniture	232	6 730	29
Furniture and fixtures	Wood and metal	439	5 420	12
Paper products	Pulp, newsprint, paper	132	4 590	35
Printing and publishing	Printed and published materials, cartons and allied products	454	12 370	27
Leather and leather substitute products	Tanneries and finished articles, excluding foot-wear and wearing apparel	64	1 580	25
Rubber products	Boots, mats, tubes, etc.	144	5 710	40
Chemicals	Chemicals, soap, paints and pharmaceutical products	259	11 850	46
Petroleum and coal products	Coal and hydrocarbon products plastics, lubricating oils	4	240	60
Non-metallic mineral products	Glass, ceramics, cement, excluding products of petroleum and coal	183	7 200	40
Basic metal products	Bars, structural shapes, plate, nails, bolts, nuts	83	4 630	56
Metal products	Fabricated steel products excluding machinery and transport equipment	448	11 010	25

Table 3. Distribution of employment by industrial sector for city of Manila and Rizal Province in 1961 (continued)

Industrial sector	Description of the product	Number of establishments	Number of employees	Average number of employees per establishment
Machinery	Excluding electrical machinery	302	7 730	25
Electrical products	Machinery, apparatus, appliances and supplies	4[illegible]6	7 000	15
Transport equipment	Automobile and cycle assembly and rebuilding	343	6 460	19
(Other)	Laundries, toys, pencils, novelties etc.	815	6 730	8
	Total	10 475	192 470	

Table 3 indicates that industry in the area is dominated by sectors based on agricultural production (Food, beverages and tobacco products) and textiles and garment production. Together these sectors accounted for nearly 50 per cent of the industrial employment in 1961. The remainder of the employees are rather evenly spread among the other sectors, which to a great extent are based on the assembly of imported components and the processing of imported raw materials.

Information about the size of the establishments in various sectors is not available. In order to get some indication of the average size of the plants in various industries, the average number of employees per establishment has been calculated in table 3. The average number of employees per establishment is far higher in three sectors, beverages, tobacco and textiles, than in other sectors. Of course, big plants exist in the other sectors also, but most of the plants seem to be small in terms of employees. Consequently, the general conclusion must be that the industrial structure in the area is characterized by many small plants.

Nature of industries

Information on number and types of industries obtained from various sources are not in agreement. Only about 900 factories are recorded by the National Pollution Control Committee (NPCC), while the Bureau of the Census and Statistics reported 10,475 factories in the metropolitan area. The discrepancy is obviously caused by different criteria in classification of the industries.

Table 3 gives number and types of industries based on the 1961 statistics. Clearly, the types of industries are very diversified and the majority of them are small-scale industries. Though the data are thirteen years old the pattern of industrial distribution remains the same.

A programme for industrial dispersal out of metropolitan Manila is at present under preparation. The dispersal of industries to the countryside, especially the agricultural processing plants, is aimed at reducing the pollution load of the urban areas and contributing to the solution of problems including population, employment, housing and transportation.

Environmental conditions

Air

It appeared that the opinion of the government was that air pollution is not and never will be a problem here. Climatic conditions favour relatively rapid removal of pollutants from the area. However, at present much air pollution arises from cars, trucks and buses, many of which are poorly tuned and emit clouds of black exhaust fumes. Along busy thoroughfares people were observed wearing masks or holding cloths over their mouths to filter the air they breathed. Fumes could be both smelt and tasted.

Rivers and streams

The Pasig is the largest river flowing through Manila. It originates at Laguna de Bay, a large fresh-water lake south-east of Manila, and flows westerly through the city. Two large tributaries, the San Juan and Marikina rivers also flow through portions of the city prior to emptying into the Pasig. During the monsoon season, when fresh-water levels are high and the flow out of Laguna Lake is high in volume, there is a potential for flushing the Pasig river. During the dry season fresh-water flow is sufficiently reduced for tidal action to push salt water the full length of the Pasig and into Laguna Lake.

During the period of this study (during the dry season) river flow was low and the water septic. More organic wastes are dumped into the river than can be degraded in this system, with the result that the water is black, methane bubbles appear at the surface everywhere and the water emits a foul odour. Aquatic life cannot exist under these conditions. For the past 10 years or more there have been no fish in the Pasig river. Dissolved oxygen levels as high as 7 mg/l were noted on several sample dates during high flow periods in 1969, but values were generally lower in 197[illegible]. While fish were noted in the river during high flow the past year, septic conditions soon eliminated them. Most of the San Juan and lower Marikina rivers are similar to the Pasig in pollution load.

Laguna Lake

This large ([illegible] km² surface area) fresh-water lake is shallow (mean depth 2.8 m) and eutrophic. Its watershed is about 4 times the area of the lake, providing an inflow of some 1.5 times the lake volume. Lake water is used for raising fish, irrigation and some industrial uses. Plans for the future include using this as a source of water for Manila. Under eutrophic conditions, production of fish and shellfish is high, but the dense growths of algae diminish both the esthetic appreciation and industrial and domestic value of the water. Salt water and heavily polluted Pasig river water intrude into the lake during low water level periods. Deaths of fish in ponds along the shore near the Pasig river have been reported, and increasing mortalities are expected unless a water control structure is utilized to prevent inflow of water from the Pasig river.

At present there is industrial pollution from industries located along the west and north-west shore and from vessels carrying oil and refined products to and from an oil refinery on the east shore. Proposals by the Laguna Lake Development Authority (LLDA) include an interceptor line to collect the industrial and sewage wastes along parts of the northern and western shores and transport them across the divide and into Manila Bay. No attempt has been made to evaluate the effects of this increased pollution load on the bay.

Manila Bay

Manila Bay covers an area of 1,800 km^2, fed from a watershed of 17,000 km^2. Peak inflow of fresh-water is 2,500 m^3/sec. Virtually all inflowing fresh-water is polluted, some severely. Pollutants include raw sewage, industrial wastes, garbage and trash from streams and rivers, raw sewage from the Manila sewage outfall, garbage and trash from the Manila dump on Balut Island, fertilizer from agricultural lands north of the bay, fertilized and/or polluted water from fish ponds and washings, trash, garbage, oil and grease from ships.

Recent studies of the bay, designed to assess the problems of sewage disposal revealed some areas displaying adverse effects from organic pollution. Benthic studies were limited to the eastern regions of the bay, so the full extent of changes is not known. Off the metropolitan shore the bottom contained large quantities of organic waste and little aquatic life. The northern portion of the bay contained hydrogen sulphide, but not in sufficient concentration to eliminate benthic organisms. Some differences in benthos composition were noted from one area to another, of a nature believed related to pollution.

Administrative aspects of pollution control

By an act of the Philippines congress the National Pollution Control Commission (NPCC) was established in 1964. The NPCC is charged with prescribing and enforcing standards of air and water quality. A permit is required to construct anything, except for certain specified exceptions, that would cause emission of air contaminants. After construction a permit to operate must also be obtained. An increase in size or power of equipment would require payment of special fees, based on the amount of increase. Levels of emission are specified for various materials like dust and fumes, and other substances like SO_2. The Commission has the power to rescind permits, call public hearings and file suits in court.

As with gaseous emissions, a permit to construct is required for anything that will discharge liquid wastes into waters of the Philippines or for treatment works, except for sewage works and small residential developments. After construction a permit to operate must also be obtained. An increase in size or power of equipment would require payment of special fees, based on the amount of increase. Stream classification standards are prescribed according to "best usage" doctrine. Industrial or other effluents must not cause a lowering of classification of the receiving stream.

Stream waters are classified according to their uses:

Class A-A - potable
Class A - potable
Class B - bathing
Class C - fishing
Class D - agricultural and industrial
Class E - navigation and waste disposal

B. Firms visited in Manila

San Miguel Corporations Polo Brewery

Background

This brewery produces about 820 m^3/day of beer (2.5 million 11-oz bottles). The company was aware of a water pollution problem as early as 1947 when separation of spent grain and yeast was practised.

Input

The information was not obtainable. However, the following figures are common; 1 US barrel of beer (or 119 litres) requires: brewer's malt (processed barley) 35-38 lb; malt adjuncts (cereals, eg. rice) 12-14 lb; hops[b] 0.5 - 1.25 lb; yeast 0.75 - 1 lb.

Outputs

Beer: 820 m^3/day,

Carbon dioxide for dry ice.

Major sources of pollution

Waste waters from various washing operations and from malting of barley.

Waste characteristics

No information available.

Control technology

The waste water is treated in an activated sludge process plant with an aerobic sludge digester.

Useful waste products

Spent grains and yeast.

Waste residues to the environment

100 per cent of the original BOD load.

Comments

(i) This brewery has a complete system of waste product recovery. The spent grain and yeast is separated, dried and used as chicken feed in a chicken farm also owned by the company;

(ii) The treatment plant designed by a Japanese firm costs ₱2.9 million.[c] By visual inspection the treatment plant seemed to be oeprating efficiently. However, there is no sludge dewatering unit. The digested sludge is simply dumped in a nearby shallow lagoon. The supernatant from the sludge digester is also directly discharged into the river instead of returning to the influent stream;

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b/ The brewery uses hop-concentrate to eliminate the problem of spent hop disposal.

c/ During the period of the project the equivalent of the Philippines peso (₱) to the United States dollar ($US) was ₱6.70 = $US1.00.

(iii) The receiving water is a small sluggish river which is septic. Reduction of the pollution load from the brewery has a negligible effect on the receiving water quality;

(iv) The operating cost and the capital cost of the treatment plant are minimal compared with the similar costs of the brewery. This indicates that for the brewery industry economic impact of pollution control is insignificant.

Philippine Refining Corporation

Background

This is an integrated industry producing refined coconut oil from copra (dried coconut meat). Crude coconut oil is first extracted from copra by a mechanical process. The crude oil is further refined to eliminate impurities causing objectionable taste, colour and odour. A waste product from the refinery is used as raw material in the soap factory.

(a) Crude oil production

Inputs

200-220 tons/day of copra with about 8 per cent moisture.

Outputs

62-68 per cent of the input as crude oil.
33-34 per cent of the input as solids (copra meal).

Major sources of pollution

No pollution.

Comments

In crude oil production, there is practically no waste, the copra meal can be considered as a by-product. It contains 18-20 per cent protein and 5-6 per cent of oil, and is sold as aminal feed at a price of about ₱20 per 50 kg (about $3).

(b) Refinery

Background

The crude coconut oil is refined using the alkali method. Crude oil containing about 3 per cent free fatty acid is neutralized with caustic soda. The solids formed are removed by sedimentation and the sludge is treated by sulphuric acid to remove the oil. The acid oil removed is used in soap making. The oil is bleached with an absorbent medium consisting of diatomaceous earth and activated carbon. The absorbent materials are removed using filter processes and the bleached oil is then deodorized by steam distillation at high vacuum.

Inputs

500 tons/week of crude oil

Caustic soda

Outputs

Refined oil.

Major sources of pollution

R1 - acid water from sludge treatment, about 60 tons/week.

R2 - filter cake (spent absorbent materials), about 5 tons/week.

R3 - washwater and condensate from deodorization unit, unknown quantity.

Waste characteristics

No information available.

Control technologies

For R1: oil is removed from R1 in a grease trap. The waste water is then neutralized by lime slurry. After the solids are removed the effluent is discharged into the river. The sludge is presumably dumped in a lagoon.

For R2: the filter cake is used in the bleaching of crude oil before dumping as land fill

For R3: waste water contains a significant amount of oil and is treated in a grease trap, followed by sedimentation before discharge into the river. Sludge is presumably dumped in a lagoon.

Comments

(i) It was apparent that the treatment methods were very rudimentary. Expansion of the treatment plant is not possible because there is no available space in the compound;

(ii) The receiving water is septic at present. Treatment of the waste waters would not materially improve the water quality due to a high pollution load from domestic sources;

(iii) The acid oil obtained from the treatment of sludge is a raw material in soap making. Therefore, this type of industry should be integrated with or located near a soap factory;

(iv) The acid waste may be useful to other industries. It may be used to neutralize alkaline wastes;

(v) Recovery of sulphuric acid from Hl may be technologically feasible. The economy of scale may be improved by setting up a central recovery plant.

(c) Soap factory

Background

This soap factory is in the same compound with the crude oil and oil refining factories. It produces about 500 tons per week of washing and toilette soaps using the batch kettle process.

Inputs

Waste acid oil from the refinery; coconut oil; tallow; caustic soda.

Outputs

500 tons/week of soap.

Major source of pollution

Spent lye.

Waste characteristics

High pH, high NaCl content and high BOD.

Control technology

The spent lye which is the main waste product from soap making is sent to the glycerine recovery unit. The glycerine is removed by steam distillation and the waste residue is probably dumped into the river.

Comments

(i) Recovery of glycerine from the spent lye is normally practised by a large soap factory. Small soap factories also give away their spent lye to the glycerine recovery plant to eliminate pollution problems;

(ii) The spent lye is a very concentrated waste with a BOD of over 20,000 mg/l. It is difficult to treat because of its high concentration of sodium chloride and caustic soda. Therefore, the glycerine recovery industry is important to the soap industry.

Lirag Textile Mills Inc.

Background

This textile mill processes daily 20,000 lb of cotton and [illegible],000 lb of polyester. A small chrome-plating unit is also integrated with the textile mill but is only occasionally operated.

Inputs

	lb per day
Cotton	20,000
Polyester	[illegible],000
	kg per day
Corn-starch	540
Syco-wax	208
Sulvel wax	80
NaOH	350
$Na_2S_{(i)}O_3$	130
Wetting agent	35
Detergents	40
Stabilizing agents	20
Optical brighteners	6
Enzymes	3
Various types of dyes	

Outputs

Finished cotton and polyester fabric.

Major sources of pollution

Combined waste waters from desizing, scouring and bleaching operations.

Waste characteristics

Flow:	280 gal/min
BOD5:	3,500 mg/l
SS:	1,445 mg/l
Total solids:	4,425 mg/l
Colour:	350 units
Turbidity:	250 standard turbidity units (STU)

Control technology

The waste water is treated in a ₱900,000 treatment plant designed by a plant engineer of the company. The treatment process begins by chemical coagulation using alum followed by an activated sludge process. The primary and secondary sludges are disposed of by lagooning.

Useful waste products

None.

Waste residues to the environment

The partially treated waste water containing organics and inorganics.

Comments

(i) Inspection of the waste treatment disclosed that the design was not correct in terms of the process and engineering features of all treatment plant elements. The treatment plant cannot be operated on the activated sludge process unless a significant modification of the treatment plant is made. At present, the treatment plant is functioning as an aerated lagoon with a total hydraulic retention time of about 4-5 days. With the present design, addition of alum does not materially reduce the pollutants. The alum dose is as high as 5,000 mg/l indicating a very high running cost for this treatment plant;

(ii) The BOD load can be significantly reduced by substituting a portion of corn-starch with carboxy methyl cellulose. Experience in the United States indicates that 65 per cent starch and 35 per cent carboxy methyl cellulose are optimum;

(iii) It is technologically possible to recover glucose from the desizing waste. Its economic feasibility is questionable.

Tannery

Background

This is a very small tannery processing about 200 tons per year of leather and skins. Both vegetable tanning and chrome tanning processes are used.

Inputs

No information available. The following figures are common: 100 lb hide requires: lime 10 lb, Na_2S 2 lb water 200 gal; for vegetable tanning, lactic acid 102 lb, tan bark 20 lb, water 175 gal. For chrome tan, HCl (30 per cent) 2.5 lb, NaCl 20 lb, $Na_2Ca_2O_7 2H_2O$ 5 lb, $Na_2S_2O_3$ 15 lb, borax 2 lb, water 400 gal, dye and oil.

Output

Leather.

Major sources of pollution

Combined process waste water.

Waste characteristics

About [illegible],000-[illegible],000 gal/day. Other information not available.

Control technology

The waste water is treated by alum coagulation. The treatment plant was designed by a local private firm.

Comments

(i) Inspection of the treatment plant showed a very poor design both in terms of process and engineering design. The designer did not understand the principle of chemical coagulation. The treatment plant is not effective in terms of BOD removal. Disposal of sludge is the major problem;

(ii) This tannery is typical of most small tanneries in the developing countries. They are major polluters of water due to their strong wastes. They cannot afford proper waste treatment systems. Grouping these industries for joint waste treatment purposes may be the only solution.

Manila Paper Mill

Background

This paper mill is typical of most paper mills in the developing countries. It produces 120-140 tons/day of industrial paper from waste papers and imported pulp. The waste papers are processed in hydropulpers. De-inking and bleaching are not practised.

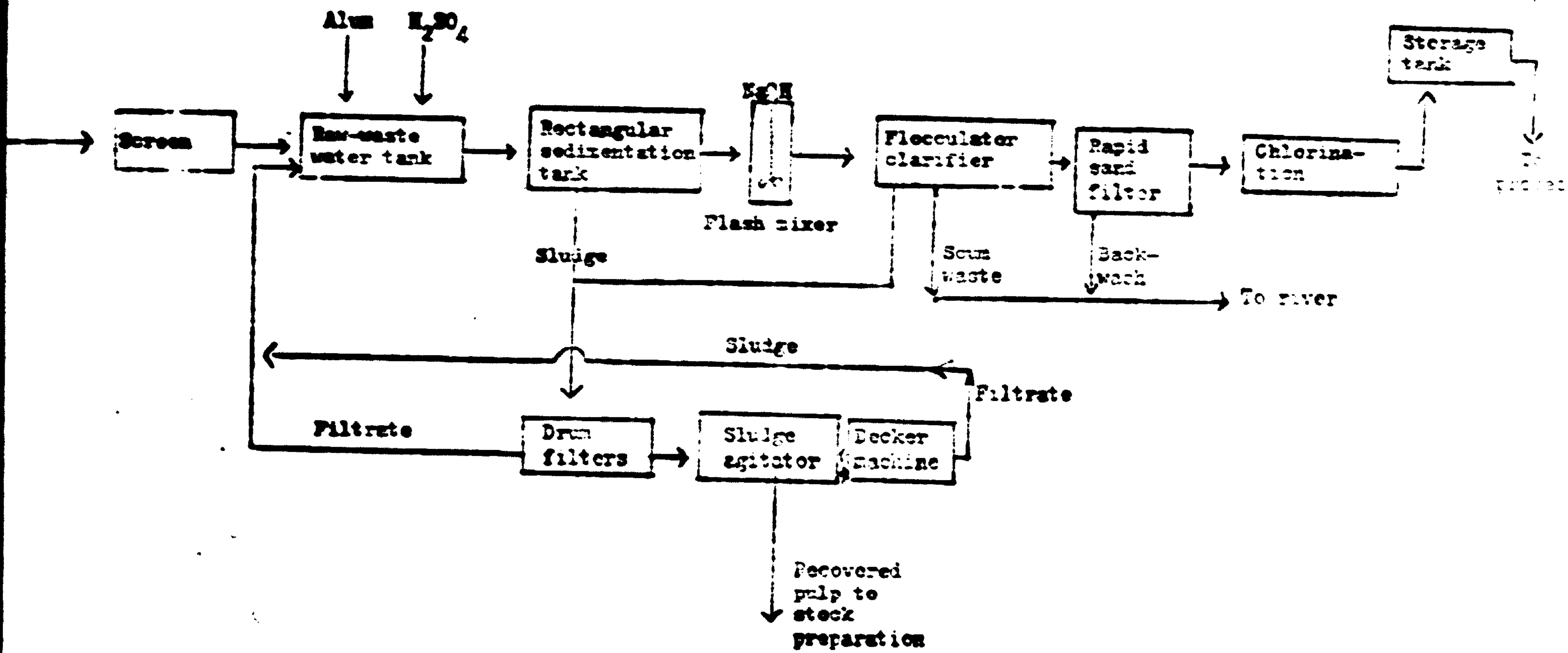
Major sources of pollution

About 13,000 m^3/day of combined waste water.

Control technology

This paper mill is a good example of waste recovery and water conservation. The suspended solids in the waste water are recovered and reused using the treatment process shown in the figure.

Waste water treatment plant for the Manila Paper Mill



Waste residues to the environment

Filter back-wash water and scum waste from the clarifier.

Comments

(i) The $200,000 waste water recovery plant was designed and built by a Japanese firm. Inspection of the plant showed that the plant was running at a very low efficiency. In the primary sedimentation tanks, the sludge scrapers did not work properly and they were taken out. Therefore, the primary sedimentation tanks are operated on the batch process,

(ii) At present, no chemicals are added due to economic reasons. Therefore, the suspended solids load on the rapid sand filters is very high, resulting in frequent back-washing of the filters and poor quality of the filtered effluent. About 120 m^3/day of filter back-wash water and a large volume of scum waste from the clarifier are directly discharged into the receiving water.

Pure Foods Co. Ltd.

Background

This factory processes about 10 tons/day of meat, mainly beef. The products are various types of sausages and canned foods. The factory has its own slaughter house.

Inputs

240 cows/week; 600 hogs/week.

Outputs

Food products.

Major source of pollution

Wash-water about 300,000 gal/day.

Waste characteristics

No information available.

Control technology

Only a small settling pond.

Useful waste products

Scrap meats and offal sold to animal feeder.

Comments

(i) The factory is at present undergoing expansion. An animal feed-lot and an animal tendering plant are being built as well as a new waste treatment plant;

(ii) Air pollution problem can be expected due to malodorous air from the animal rendering plant. Solution of similar problem at Rotterdam can be applied here.

Annex III

TEHERAN

Background data on the Teheran site

Physical environment

Topography

Teheran lies from 1,100 to 1,300 m above sea level at the foot of the southern slope of the Alburz Mountains. The land slopes from north to south and is gently rolling to the south of Teheran. To the north the mountains rise to a maximum of over 5,600 m.

Climate

Average temperatures range from 3.6° to 29.4 C and average rainfall is 213 mm. There is little rain in summer, scattered rain in fall, with most rain coming in winter as a result of Mediterranean lows. Some convection showers occur in spring.

Although winds may blow from any quarter, by far the dominant prevailing winds are from the south to southwest. These winds flow upslope toward the mountains as a result of solar heating. There are frequent strong winds, some of gale force, which blow in off the desert bringing dust and fine sand. Teheran airport has a poor visibility for many days each year because of this problem.

Sanitation amenities

Water supply

Drinking water is obtained from two streams north of Teheran, the Karaj and Letien rivers. The present rate of water use is approximately 800,000 m^3/day. Flow is occasionally augmented by deep well water, which is also an important source of industrial water.

Sewage treatment

There is no sewerage system. Most wastes are disposed of via cess-pools and pits excavated in the porous subsoil. Industrial and other wastes from locations near a canal running through Teheran are dumped into the Firousabad Canal.

Solid waste

Most is dumped somewhere in the desert. There was evidence of some industrial waste being dumpod on vacant land along the Karaj Road, an industrial area.

Political units and their administration

Precise relationships could not be determined among these agencies, but some areas of responsibility seemed clear. These were:

Ministry of Health - air pollution monitoring in addition to standard responsibilities;

Ministry of Housing and Town Planning - had a section called High Council for Urban Planning;

Ministry of Economy - matters related to national and regional development and control of industrial policy;

Ministry of Water and Power - national body operating at the policy level;

Regional Water Boards - operating at the working level. The Teheran Regional Water Board has been monitoring water pollution and industrial wastes for years, and has an impressive supply of data, in Farsi;

Department of Environmental Conservation - this newly established organization has very wide interests in all environmental aspects ranging from wildlife preservation to environmental pollution. It incorporates the old fish and game commission. Its Human Environment Division is responsible for air and water pollution, pesticides pollution, etc. The Division is presently conducting a programme of industrial waste surveys in some northern cities near the Caspian Sea. Shortage of technically qualified staff experienced in various aspects of pollution control is a major problem for this organization.

Population

Like most of the metropolitan regions in developing countries, Teheran is faced with wide-scale migration from rural areas and other towns and cities. Measures taken in recent years to decentralize economic activities have had some effect on reducing the rate of migration to Teheran, but unless additional measures are taken it is projected that by 1977 the city's population will have risen to 5.1 million, and by 1987 to 8.9 million. At present the population is estimated at about 4.25 million.

Land use

Maps and reports on land use were not available. Rampant land speculation and government efforts to control it may have had something to do with this.

Economy

Statistical reports about the industrial structure in Teheran showing the number of establishments in different sectors, production, size and location, are not available. According to people interviewed, primary statistics (in Farsi) exist to some extent, but the material is located at different authorities and organisations. Another complication is that the statistics are based on different frames which make co-ordination difficult. Competent people estimate the time necessary for collecting and combining the primary statistics from different sources at two months. Assistance from an Iranian counterpart is also necessary in this work.

Primary statistics have been collected at the following sources:

Ministry of Economy

Ministry of Industry and Mines

Bank Markazi (Central Bank)

IMDBI (Industrial Mining and Development Bank)

Municipality of Teheran

High Council for Urban Planning (Ministry of Housing and Town Planning).

Information about industry in Teheran which has been obtained in this mission is entirely based on interviews.

In order to damp the economic and population growth of Teheran, a limitation has been imposed on the establishment of new factories within a 120 km radius of the city. The expansion of factories already established within this radius is to be limited to cases where such expansion is based on advanced capital-intensive methods.

Nature of industries

There are possibly about 1,000 factories in the Teheran area, the majority of which are small industries. Many small industries are located in the city while medium and large industries are concentrated along the Karaj Road and east of the city. Their production activities are very diversified as shown in the table. However, most are rather clean industries such as engineering, assembly, garments, etc. Those which are important from a water pollution aspect are textiles, food processing, tannery, electro-plating, distillery, brewery, soft drink, and chemical industries. Cement, brick, wood products and steel industries are the major sources of air pollution. The remaining would produce only solid wastes which can be reused or easily disposed of. It can be inferred that water pollution would be the most important problem followed by air pollution and solid waste disposal.

Classification of industries in Tehran area

Description	Number of installations	Type of pollution
Textiles	43	(WP)
Food products (milk, fruits, bakeries, chocolate, sausages etc.)	72	(WP)
Metal and steel manufacture (steel furniture, office furniture, steel mills)	53	(WP, SW)
Clothing industry (spinning, weaving, garments)	38	(SW)
Pharmaceuticals and cosmetics	24	(WP, AP)
Plastics	18	(SW)
Wood products and furniture	13	(AP, SW)
Glass products	21	(AP)
Leather products (shoes, belts, bags)	17	(WP, SW)
Cement products (tiles, pipes, ceramics etc.)	14	(AP, SW)
Asbestos-cement products	1	(AP)
Paper and carton manufacture	22	(WP, SW)
Stone manufacture	14	(AP, SW)
Chemical products	28	(AP, WP)
Alcohol and other distilled products	7	(WP)
Beer factories	4	(WP)
Soft drinks	7	(WP)
Brick manufacture	1	(AP, SW)
Automobile and motor industry (tires, motor oil, auto parts)	44	(SW)
Household goods (venetian blinds, curtains, rugs, bed mattress, decorations, etc.)	18	(SW)
Plumbing and kitchen fixtures, sanitary fixtures	3	(SW)
Ice factories	11	(WP)
Tobacco and cigarettes	1	(AP)
Mechanical, industrial and construction materials and equipment	102	(SW)
Electrical appliances and products	47	(SW)
Printing industry	15	(SW)
Rubber products	12	(SW)
Small scale industry (cork, pencils, buttons, jewelery, records etc.)	17	(SW)
Total:	677	

Note: WP = water pollution, AP = air pollution, SW = solid wastes

[illegible]

Tehran [illegible] [illegible] the most [illegible] environmental problem [illegible] of the city [illegible].

At [illegible] Ministry of Health, [illegible] carbon monoxide [illegible]. [illegible] separate studies of air pollution [illegible] have been [illegible] to qualitatively evaluate the seriousness of the problem and to recommend air pollution control programmes. Five of these studies [illegible] by World Health Organization (WHO). Based upon the latest results of a WHO [illegible] carbon monoxide and suspended particulate concentrations in the Teheran area ranged from [illegible] and from 300-500 $\mu g/m^3$ respectively. If the units of these concentrations are correct the existing carbon monoxide level is very low compared to the permissible standard of 57.5 mg/m^3 (57,500 $\mu g/m^3$) in Pennsylvania, United States of America. The level of suspended particulate matter is however, two to five times higher than the standards adopted in the United States of America. Frequent sand storms may be the reason for the dusty atmosphere of Teheran.

As far as industrial air pollution in Teheran is concerned there are no data on the extent and severity of the problem. Sulphur dioxide, nitrogen oxides, smoke and dust seem to be the four major industrial air pollutants. An industrial air pollution survey would be needed to substantiate this assertion.

In preparing a Master Plan for a Teheran Sewerage System, an industrial waste survey of over 300 factories in the Teheran area was conducted by the Water Pollution Control Division of the Teheran Regional Water Board. All information is in Farsi and will be translated into English in the Master Plan Report to be released in the next few months.

Information obtained from interviews revealed that most factories at present discharge their waste waters into the ground (deep well disposal) since the city has little surface water. A number of industries discharge their wastes directly into the canal carrying domestic wastes to the desert area south of the city. The canal water, presently very polluted, is used for agriculture and crop damages have been reported. Since the land slopes toward the south ground disposal of waste water in the Teheran area has resulted in pollution of ground water resource and an increase in ground water level in the areas south of the city. The water table has reportedly risen to within a few feet of ground level, and just recently forced evacuation of some housing.

At present disposal of solid wastes seems to be the problem of least concern. Industrial and solid wastes are collected and disposed of in the desert. However, industrial solid wastes can still be seen along the roads in the industrial areas. There is no information on the amount and recovery of industrial solid wastes.

Administrative aspects of pollution control

Air pollution

At present there is no law on air pollution control in Iran. A government report has recommended both short-term and long-term air pollution control programmes including the necessary control regulations. The recommended programmes are presumably being evaluated.

Water pollution

Water pollution control regulations are incorporated in the "Water Law and its Nationalization" approved by the Cabinet on 21 November 1971. Salient features of the water pollution control regulations are:

1. Natural waters are classified into six classes according to their uses as follows:

Class 1	Potable water
Class 2	Water used for fishery or animal life
Class 3	Water used for irrigation
Class 4	Water used for industries
Class 5	Water used for recreation
Class 6	Other kinds of water which flow in small rivers or ditches of public roads and are not mentioned in the above classes.

Regarding water pollution control all the waters are considered as class 2 as long as their classes are not specified. This also applies to ground water.

2. Water quality standards are specified for classes 2 to 5, in terms of pH, dissolved oxygen, suspended solids, settleable solids, toxic materials and biochemical oxygen demand.

3. [illegible] standards. Only [illegible] effluent [illegible] colour, temperature, [illegible] requirements.

4. [illegible] industrial waste discharge into [illegible] pre-treatment of the waste water.

5. [illegible] are given on application [illegible], inspection [illegible] other pertaining matter.

[illegible] of these pollution control regulations are that:

(a) [illegible] waste [illegible] assimilation capacity of the receiving water. The degree of treatment required is flexible depending on judgement of the control authorities. This method of control is difficult in practice and the control personnel must have a thorough understanding of various factors effecting the process of self-purification and of the stream's ecology.

(b) It seems that combined treatment of domestic and industrial wastes is the ultimate objective of industrial water pollution control. In Teheran this scheme will be recommended in the Sewerage Master Plan.

Enforcement

Iran, at the present time, is undergoing a process of centralization of environmental pollution control. The Department of Environmental Conservation has recently been set up, presumably for this purpose. However, so far there has been no transfer of responsibilities and authorities from the various organizations involved in pollution control to the Department of Environmental Conservation. As a result, the situation is still confusing and work may be duplicated to a certain extent due to lack of co-operation among the concerned authorities. Since information on this aspect is limited, the views presented here are based entirely on a collective understanding of the situation.

Ministry of Water and Power

Presently, the Ministry of Water and Power is by the existing laws, still the responsible authority for water pollution control over the whole country, through its Regional Water Board. Permits and licenses for discharge of effluent must be obtained from the Ministry. Inspection of the premises is also done by the Ministry's officials. In Teheran, the Teheran Regional Water Board has a laboratory for analysis of water and waste water. This laboratory seems to be the central laboratory for all the Regional Water Boards. Reportedly, surveys of industrial wastes have been extensively conducted in Teheran and in other cities.

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