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INDUSTRIAL ENVIRONMENTAL MANAGEMENT IN THE GULF REGION:

AN OVERVIEW

By

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SUMMARY

Environmental problems in the region have appreciably increased in the last two decades as a consequence of rapid industrial development, population growth and urbanization. The fragility of the ecosystem and the limited natural resources underline the need for rational planning of resources and careful mangement of industrial activities so as to achieve optimum economic and social development without adversely affecting the environment and the welfare of the people.

The ROPME member States had traditionally derived their national incomes mainly from oil exports. However, the recent recognition of limited oil reserves led to gradual change from a largely oil-dependent economy into one based on growth of industry. To achieve this objective, industrial activities in most member States are progressing at an accelerated pace towards acquiring engineering expertise and technological know-how for advanced production, especially in the oil-based industries. Concerted efforts are made to attract high technology industries, expansion of industrial estates and strengthening the indigenous technical manpower base.

The rise of industry to prominence among sectors of national development plans has given new impetus to the study of the complex technological, social and economic factors associated with industrial growth and the management of resources.

Industrial pollution is a major contributor to environmental degradation in the region. This is not only due to the unprecedented growth of industrial activities, but because rapid industrialization has been accompanied in most cases by an ever-increasing use of new materials and substances which produce pollutants not amenable to treatment by the conventional waste treatment technologies. The potential hazards and long-term effects of these pollutants are unknown, making it difficult to predict their impacts on the environment and human health.

To sum up, the major concerns of environmental deterioration caused by industrial pollution comprise (i) release into the receiving environment of large quantities of toxic harmful gases, liquid and solid matter (ii) great input and dissipation of wasted energy resulting in eutrophication and unfavourable environment for aquatic organisms (iii) generation of hazardous substances with the concomitant problems of disposal (iv) excessive use of water and other natural resources which results in marked ecological disruption.

While industrialization is basic for economic growth and sustained improvement of the quality of life in this region, it is important that a proper choice of technology be made which would undoubtedly result in long-term better profit margins for the industry and protection and even enhancement of environmental quality.

INTRODUCTION

Industrialization is the corner-stone of the development strategy in the ROPME* region. The rapid industrial development was prompted by the desire of the member States to utilize the oil and gas potential of the region, thereby decreasing their dependence on imported products and capturing the high value-added component of oil processing. Increasing the processing of raw materials into basic materials and end products leads to diversification of the industrial base, creation of new jobs and development of regional technological capabilities. While industrialization means an increase in the throughput of raw materials, it also means an increased generation of waste materials and concomitant air and water pollution, since the environment is a free sink for waste products.

In the past decision-makers have tended to regard pollution abatement as a luxury for affluent developed countries, and have rarely enforced legislation for combatting industrial pollution. Recently, however, there has been a growing awareness among the public as well as government officials that the costs arising from indiscriminate discharge of industrial waste are rapidly outweighing the costs required for pollution control.

Pollution problems associated with rapid industrialization are evident in all ROPME member State and as the pace of industrial development accelerates these problems are likely to assume increasing importance. Concentration of manufacturing activities in 20 major industrial complexes along the Gulf coast has contributed to the present disequilibrium in the ecological balance and widespread deterioration of the environmental quality in the coastal areas of the Gulf. Despite the recognition of the adverse effects of industrial pollution, proper impact assessment and adequate pollution control measures have not yet become an integral part of the industrial development programmes of most ROPME countries.

Industry is a major contributor to environmental degradation. Environmental impacts of industrialization depend on various factors: geophysical, climatological, socio-economic and level of industrialization. Impacts arise from the individual components of the integrated industrialization system which encompasses exploitation of raw materials and their primary processing, transportation and stocking of materials, production processed and ancillary operation, use of end products, in addition to supporting infrastructure of power generation, transportation and distribution. Many of the land-based pollutants released in the environment

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* The Regional Organization for the Protection of the Marine Environment (ROPME) comprises the following member: Bahrain, Iraq, Iran, Kuwait, Oman, Qatar, the United Arab Emirates and Saudi Arabia.

originate from industrial processing operations. This is particularly important in the Gulf States since most industries are oil-based and this produces appreciable air, solid and liquid pollutants due to substantial chemical and physical processing of materials involved in petroleum refining, petrochemicals, cement, basic metals and energy-producing industries. Environmental deterioration by these industries can be attributed to the following:

(a) Release in situ and through it into the surrounding environment of toxic matter, biodegradable and inert wastes, and noise;

(b) Discharge and dissipation of wastes from energy production and ensuing thermal pollution;

(c) Improper utilization and disposal of hazardous substances and chemicals;

(d) Use of conventional technologies which consume excessive quantities of water and other natural resources and generate abnormal levels of wastes.

Although the experience demonstrates clearly that industrialization of any type and magnitude is always associated with various levels of environmental degradation, it is equally evident that development and industrialization can proceed harmoniously when adequate safeguards are taken.

In view of the fragility of the Gulf ecosystem, sustainable and environmentally - sound development can only be achieved when appropriate environmental measures are incorporated into the industrialization process. These include corrective, preventive and conservation measures. Resource conservation aims at wise management of inputs including raw materials, water, energy and reuse of by-products. Preventive measures are mainly directed towards avoidance or minimization of waste generation through use of proper equipment, processes, raw materials and fuel. Corrective measures include direct clean-up or recovery of pollutants and mitigation of the potential harmful effects of pollution by protective measures. These measures are interrelated. In practice, even with the most advanced equipment and processing technology, generation of waste is inevitable which requires add-on pollution control equipment. On the other hand, some resource-conserving measures such as scrap reprocessing, and material upgrading give rise to harmful substances which must themselves be controlled. Consequently, sound environmental management should consider the most cost-effective and overall cost-beneficial combination of measures for pollution control in any given local situation.

This review briefly outlines present perspectives on environmentally sound technology in the region, regulatory policies, the need for training in industrial environmental management and approaches for appropriate waste management strategies.

ENVIRONMENT AND INDUSTRIAL DEVELOPMENT IN THE ROPME REGION: CONSTRAINTS AND PROSPECTS

In the ROPME industrial sphere, the focus so far has been on improving productivity and maximizing returns on invested capital rather than on environment protection and the sustainable use of natural resources. Recent estimates of industrial investment in the region are shown in figure 1. Most of the ROPME member States have come to realize that the Gulf coast is under serious threat from the hyperdevelopment that has been progressively achieved in recent years. Industrial development has in the past given the illusion that it can be pursued without deletarious impact on man and his environment. Notwithstanding, socio-economic benefits, production facilities, particularly those employing conventional technologies often generate considerable waste. This no longer accepted as a necessary curse, as modern technology has clearly demonstrated that waste producing processes and practices can be minimized or avoided altogether.

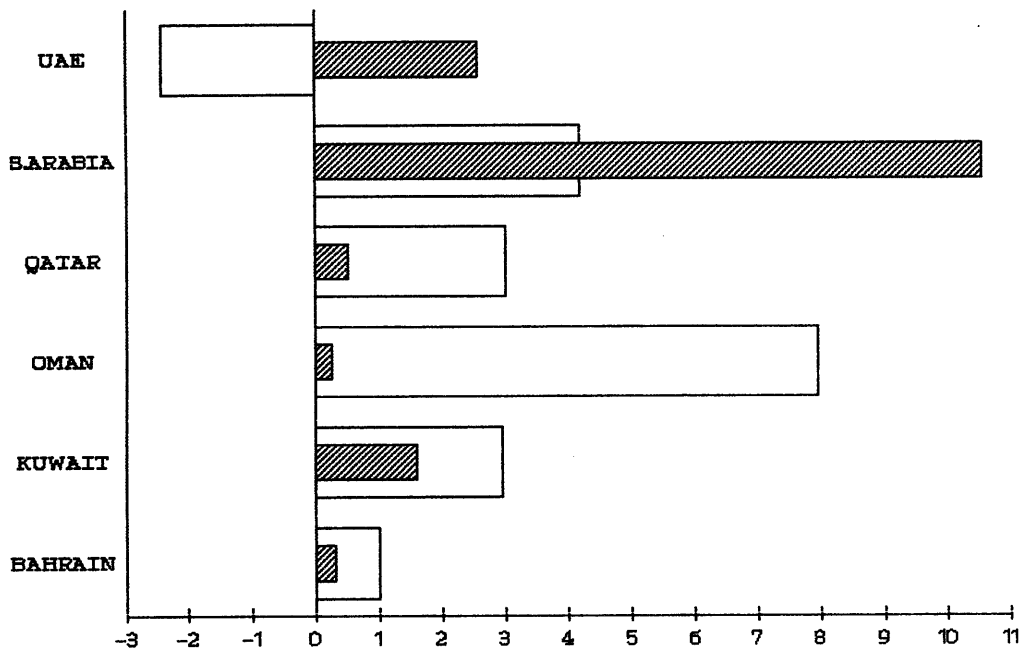
Water is undoubtedly a valuable resource in the region, and one that is in scarce supply. It is particularly important for industrial development as most manufacturing operations are water-intensive. Furthermore, most of natural water supplies in the region are nonrenwable; they are mostly fossil water contained in aquifiers shared by two or more countries. The estimates of water demands in some ROPME countries are shown in figure 2.

The ideology of industrialization in the region is generally based on discounting small-scale production units in favour of huge industrial complexes. Regional development strategies are based on developing large industry to feed another industry which in turn supply feedstock for a third large plant and so on. In this spiral, industry-intensive locations gradually appear which neither supports nor are supported by the surrounding environment. Such schemes are also socially unacceptable as they create congestion, physicological stresses and overloading of community services. This does not imply that existing industrial complexes along the Gulf coast should be scrapped.

What is really needed is to encourage wide distribution of small industries, particularly in ecologically fragile areas of the coast, while medium size plants should spring up wherever they are economically justifiable and environmentally compatible. Large industrial complexes would be needed as well, but under more rigorous environmental controls. In short, ROPME countries should emphasize in the future development small and medium size production units while only permitting large integrated complexes as a last resort.

The available evidence suggests that the ROPME region has substantial deposits of various metallic minerals including copper, zinc, lead, iron, chromium, zirconium, uranium, aluminum, gold, and silver and that the deposits are concentrated mainly in Saudi Arabia and Oman. Furthermore, there is now substantial capacity within the region to produce iron, steel, aluminum, and copper, and some expansion is planned. Although these industries form a critical link in the on-going process of industrialization, they often

FIGURE (1) INDUSTRIAL INVESTEMENT IN THE GULF



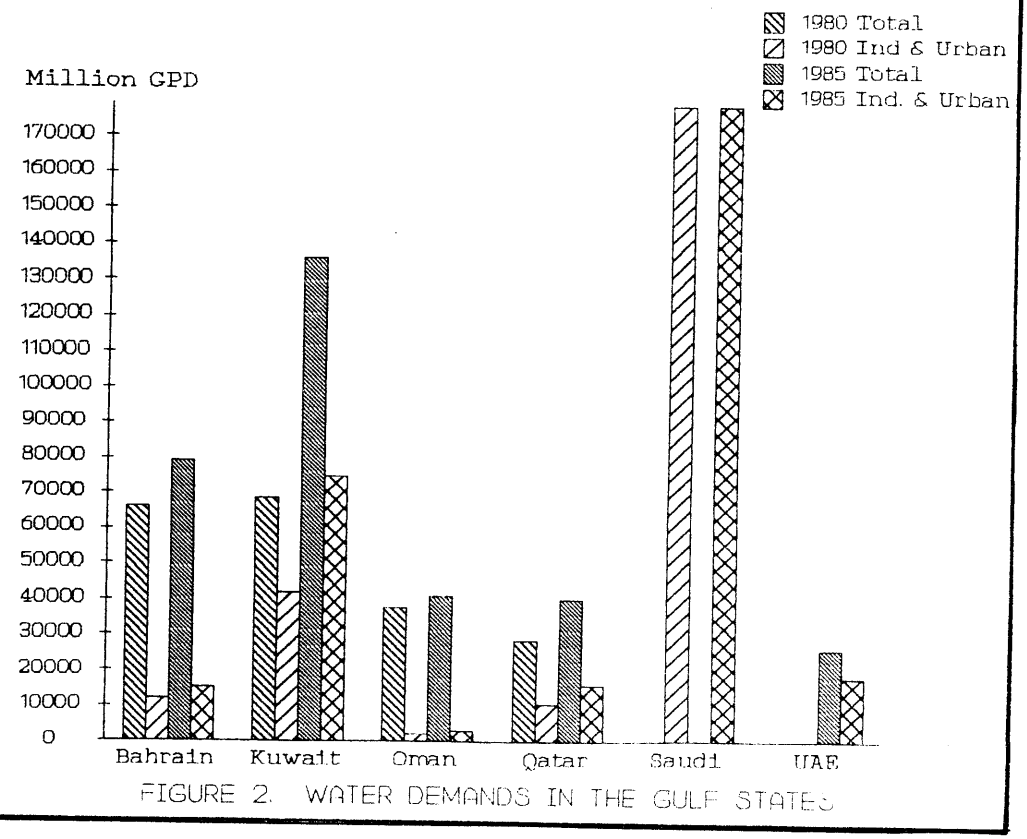


FIGURE 2. WATER DEMANDS IN THE GULF STATES

generate appreciable pollutants. The non-metallic mineral resource of the ROPME region are more widely distributed among the member countries. There are large reserves of gypsum, limestone, and clay which supply the cement industry, and of sand and gravel which supply the construction industry. These industries pose serious air pollution problems.

Industrial development and its environmental consequences in selected ROPME member States are highlighted below:

Bahrain. Despite the recent decline in economic growth, the country's industrial base continues to widen along the path of economic diversification necessitated by the depletion of oil reserve. Major industries comprise topping refinery, primary aluminium, oil-associated gas processing, iron pelletizing, power and shipping services. Most existing and anticipated developments point to a rapid expansion of energy intensive industries, depending crucially upon the use of natural gas. The largely export-oriented industry is likely to be strengthened by the new investments jointly undertaken with the Gulf states in steel, petrochemicals and aluminium. Effluents from existing plants are treated on-site before discharge to the Gulf. Several light industries are located in the capital city of Manama; their effluents are directly discharged to the public sewerage for combined treatment in the city sewage treatment plant.

Industries using natural gas and the associated downstream activities in aluminium and petrochemical industries are likely to dominate the future pattern of industrialization. These industries are prime generators of hazardous wastes and the government has recently placed emphasis on development of environmental legislation to control industrial emission and ensure proper handling of hazardous matter.

Saudi Arabia. Since 1970, a series of five-years development plans have been implemented in the Kingdom with considerable emphasis on industrialization. During the third development plan (1980-1985) a massive investment of $321 billion was spent mainly on achieving a basic infrastructure and laying the grounds for economic and industrial diversification. A key strategy has been the development of hydrocarbon-based and energy-intensive industries that convert the Kingdom's oil and gas resources into high-value manufactured products.

To house its new petrochemicals and heavy industries, the Kingdom built two new centres, Jubail on the Arabian Gulf and Yanbu approximately 1200 km on the Red Sea. In the planning efforts that went into their construction, environmental protection received a high priority. Envoronmental Design Guidelines and an Environmental Monitoring Plan were developed and cover air, water, solid, liquid, hazardous waste, noise and occupation health criteria, standards and practices that apply to design, construction and operation of both complexes.

Major plants of the Jubail Industrial Complex (JIC) are provided with on-site treatment facilities, pre-treated effluents receive a final treatment in a conventional activated sludge plant which is followed by rapid sand filtration and ozonation. The estimated flow in 1986 was 60,000 m^3/d, and the ultimate flow in 1999 is estimated at 125,000 m^3/d. Part of the treated effluent will be used for irrigation and the remainder will flow to the Gulf.

In 1980, about 60 per cent of the natural gas produced in the country was flared which resulted in an estimated emission of 2 million t/y sulphur dioxide SO_2. The flaring practice caused serious air pollution in addition to wasting valuable resources; this promoted the Government to establish new industries to utilize the wasted gases for production of liquified petroleum gas, urea, methanol, ethylene and other organic chemicals. At present, there are three operating gas plants at Berri, Uthaniyah and Shedgun which capture most of the SO_2. According to 1984 estimates, the quantity of SO_2 produced by flaring has been reduced to 0.4 million t/y only.

The amount of hazardous wastes generated in JIC was about 32,000 t/y in 1984 and will reach 341,000 t/y in 1996. Hazardous wastes consist mainly of inorganic sludges (brine, oily scales, desalter solids from petrochemicals, steel, copper and sulphur industries), organic liquids (oil skimming, spent monoethanolamine, hydraulic fluids and waste paints) and organic sludges (air flotation sludges, tars, heavy ends and polyethylene benzene). On-site incineration, transport or disposal of hazardous wastes outside the complex are prohibited. A new area in the general landfill of JIC has been set aside for interim storage of these wastes, while a feasibility study is under way for establishing a centralized treatment facility which encompasses an incinerator, sludge dewatering, landfill, etc.

Kuwait. In the last two decades, there has been a marked acceleration of industrial development in Kuwait. The exploitation and sale of oil have resulted in the accumulation of massive revenues which in turn have stimulated and sustained rapid industrial growth. Most of the emerging industries are petroleum-based, with heavy industries being concentrated in the Shuaiba Industrial Area (SIA) south-east of the capital city.

SIA now accommodates 30 industrial plants (power and desalination, refining, petrochemicals, fertilizer, cement, plastics, paper, canning, asbestos, insulating materials, construction and fabricated steel). Concentration of major industries in SIA has created appreciable pollution problems within the complex and in the nearby areas.

Several small industrial establishments are currently operating in Kuwait, mainly in the Shuwaikh Industrial Zone and the newly developed Subhan Industrial Estate. These industries include food, chemicals, paper, furniture, fish canning, metal and engineering workshops. The industrial zone is not provided with a sewerage system and effluents are discharged to the sea through a drain or trucked for further dumping in the sea, desert or the city sewer system. In addition, oilfields are spread out in various places, mostly in close proximity to the populated centres south of the capital.

Most industries in SIA are equipped with on-site pre-treatment facilities. However, their performance has yet to meet the stringent effluent criteria of SIA, which has been developed specifically to protect the sea-water quality required for the guaranteed operational reliability of the nearby desalination plants.

More than 95 per cent of the solid industrial wastes are disposed of on land, while the remaining part is discharged to drain, leached into a ground system or burned in the desert. Spent catalysts are stored for potential sale or recovery in the future. In addition to the 2.1 million t/y sludge produced by all industrial activities in Kuwait, the Kuwait Oil Company generates 4.6 million t/y of crude oil suspension with less than 1.1 per cent oil content from its fields in Wafra and Burgan. These wastes are currently disposed of in lagoons in the desert. More oily and toxic wastes are expected to be produced in the future due to the continued industrial expansion in Kuwait.

The strategy developed by the Kuwaiti Environmental Protection Council for long-term environmental management of industry in Kuwait calls for:

- Use of technology appropriate to the local environment to avoid adverse impacts either on the environment or the people.

- Setting standards appropriate for the local environment and to support agencies concerted with the setting and enforcing of the standard related to protection of the environment.

- Development of trained technical staff capable of follow up, to ensure that the set standards are being compiled with.

- Promotion of scientific research to provide technical information related to environmental impact and the effects of the utilization of technologies on man as perceived from health, social and psychological aspects and to evaluate and revise, whenever necessary, those standards and results as the information piles up.

- Follow the standard methods and procedures to study the cost-benefit of the measures applied for the protection of environment and to evaluate the outcome and to encourage measures that yield a higher positive outcome.

- Provision of training opportunities to acquaint officials responsible for development, with the social impact of development and the various reactions of the people and the dangers of imposing any unwanted changes.

Iraq. A comprehensive industrial and economic development programme was launched in Iraq in the early 1970s. A concomitant environmental protection scheme was developed at the same time to alleviate the adverse effects of the extensive industrial and construction activities all over the country. Labour-intensive industries are mainly concentrated in Baghdad, in the north (Mosul) and south (Basra) regions. The concentration of major industries in these areas has placed a tremendous burden on water resources and aggravated environmental pollution problems. The impact of industrial pollution is evident in the deteriorated water quality in the vicinity of direct industrial discharge, problems in sewerage and sewage treatment works, and degradation of air quality, especially in areas close to oil refineries and cement plants. The consensus of government and industry concerning environmental conservation is yet to materialize into concrete actions to alleviate industrial pollution.

Recently, the government has been devising an integrated pollution control programme based on local environmental needs and the technical capabilities of the country.

Oman. Until recently, activity in the manufacturing sector was very low. Visible activities were only in the food processing, power and light industries. However, during the past five years concerted efforts have been made to increase industrial development in the country. With increased foreign exchange earnings from oil, the government has been able to finance new industries such as refining, cement and chemicals.

Zonation of industries has been introduced in Oman in the mid seventies when the country's industry started to expand. The Industrial Estate of El-rously, 90 ha, was established according to a decree which defines, among other things, environmental measures regarding solid, liquid and industrial waste disposal. Monitoring gaseous emission is the responsibility of the Environmental Protection Council. The Ministry of Industry has planned three more industrial estates in Suhar, Salalah and Greater Muscat as proposals for the third five-year national development plan 1986-1991.

The existing industries are mostly located in the capital city of Muscat (power, dairies, grain mill, soft drinks, poultry processing and canning), while new establishments are housed in an industrial centre 40 km west of Muscat. Some small agro-industries and a new cement plant are located in the southern province of Salalah. In general, few or no facilities exist for controllig industrial emissions; effluents are disposed of on land and air emissions are uncontrolled. However, they pose a minor environmental impact since they are released in small amounts.

Qatar. Major industries are located in the Umm Said industrial complex (refining, petrochemicals, power, iron and steel, and fertilizer). A large cement plant is located south of Dukhan on the west coast of Qatar. Light industries are located in the capital city of Doha (soft drinks, dairy, poultry, grain mills, workshops, etc.), and their effluents are discharged to the city sewerage network for combined treatment in the Naijah wastewater purification plant. Most industries in Umm Said have end-of-pipe treatment facilities and the treated effluents are either utilized for landscaping or discharged to the Gulf. At the oil terminal, about 35,000 t/y of oily sludge is produced and incinerated in an open pit, which creates serious air pollution problems in the area.

The Industrial Development Technical Centre (IDTC) of Qatar is according high priority to the environmental impacts of industrialization. The IDTC has established an analytical laboratory at Umm Said for the analysis of air, water and soil samples. In addition, a mobile unit for in-and around factory measurements has been commissioned. In addition, the Occupational Health Division, Ministry of Health, is closely monitoring, occupational health and safety measures of the industrial establishments in the country.

United Arab Emirates. Industry, including oil and gas section constitutes about 70 per cent of the country's GDP ($US 585 million). The Government's intention is to expand and diversify industry aiming at diminishing the great dependence on oil revenues.

Several industrial plants are dispersed in major cities: Abu Dhabi (power, refining, dairies, soft drinks, steel), Dubai (refining, power, cement, dairies, soft drink), Sharjah (cement, soap, beverage, dairies), Ras Al-Khaimah (cement, steel) and Al-Ain (power, cement). In addition, two major industrial complexes are being developed; in Dubai (Jebel Ali, which houses aluminium and natural gas plants) and in Abu Dhabi (Rawaisin). Cement plants are generally equipped with electrostatic precipitators for dust recovery. The aluminium plant recovers most of the emitted fluoride for recycling as a catalyst. Most light industries within the major cities pre-treated their effluents before discharge into the municipal system, while refineries, power and aluminium plants discharge their treated effluents directly to the Gulf. At present about 15,000 t/y of oil sludges from the inverted underwater storage vessels are released to the sea. As this practice causes serious pollution problems, sea disposal should be stopped and replaced by an appropriate disposal method.

The contribution of industrial emissions to air pollution in the ROPME region is shown in figure (3), and pollutants loads dicharged to the Gulf are illustrated in figure (4).

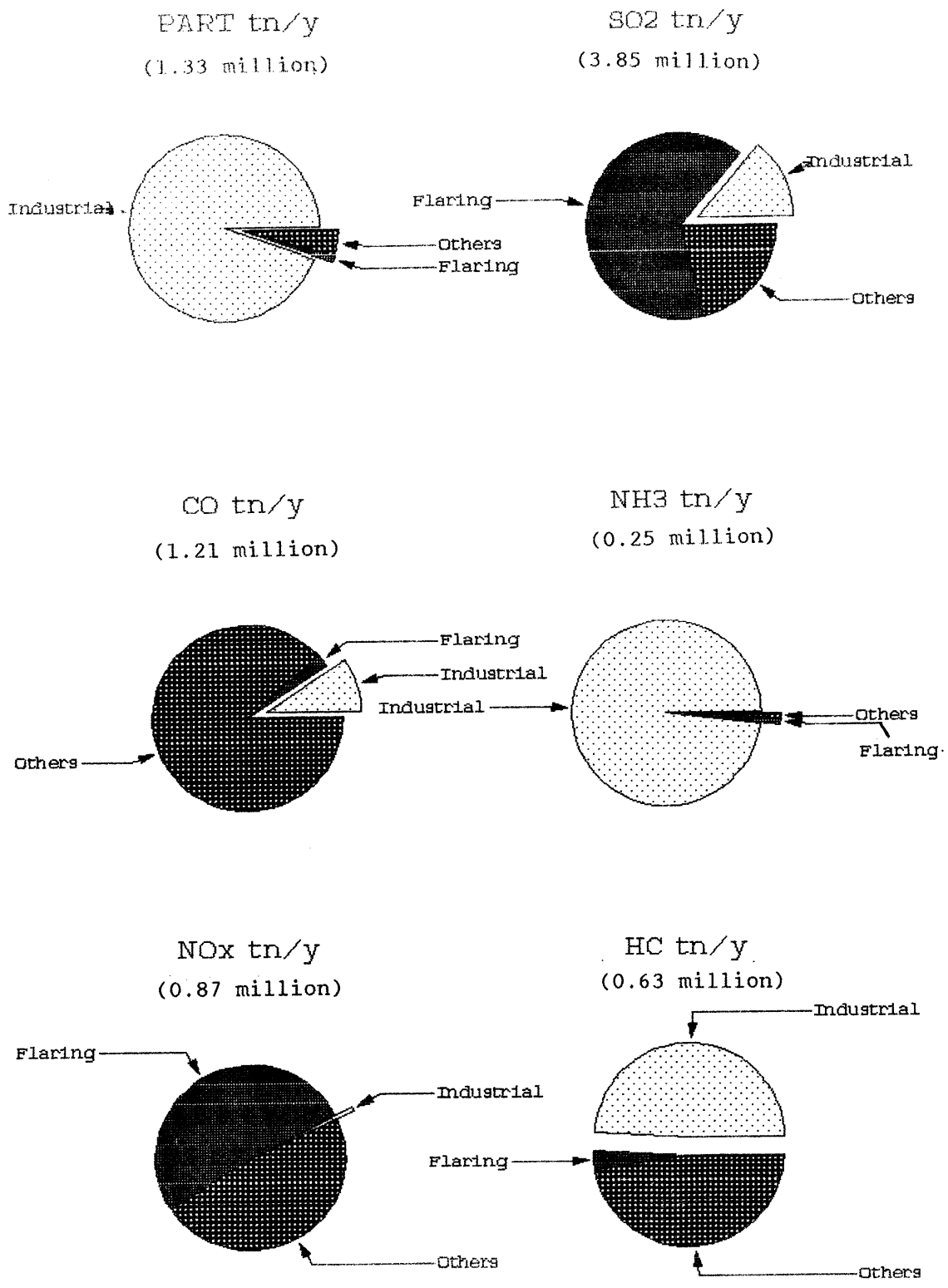
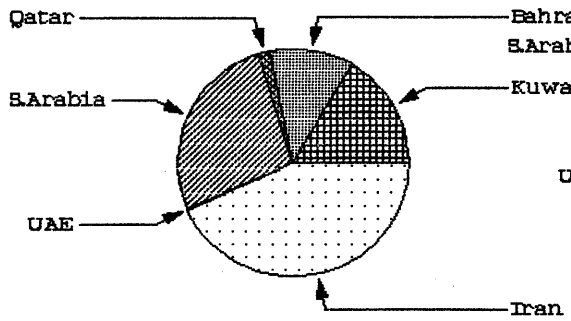
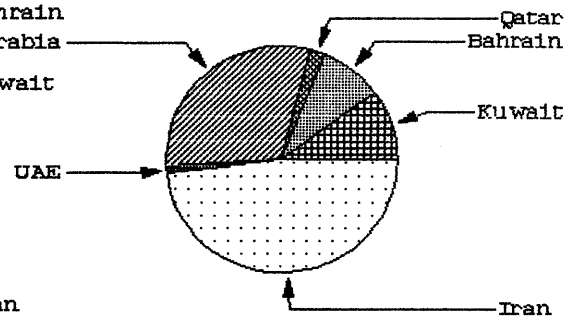


FIGURE 3. CONTRIBUTION OF INDUSTRIAL EMISSIONS TO AIR POLLUTION IN THE GULF

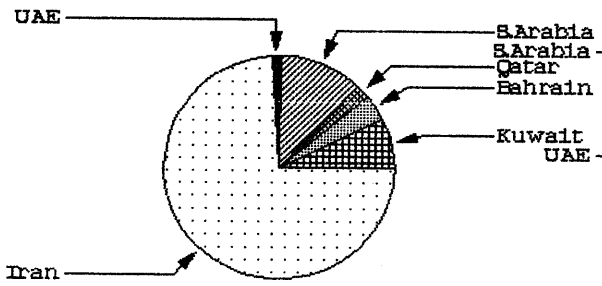
BOD t/Y (50.1x10 3)



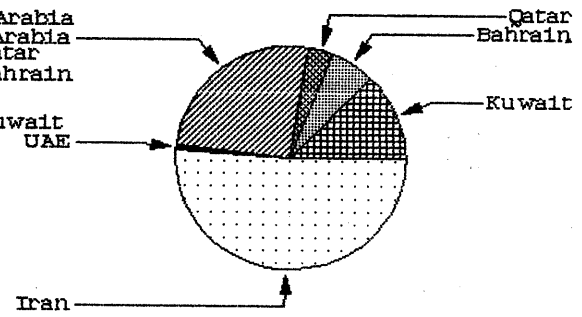
W.V M3/Y (2.49 million)



SS t/Y (67.6x10 3)



N t/Y (18.5x10 3)



Ballast Oil (6 47 million)

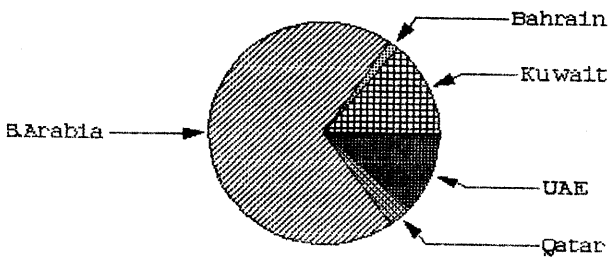


FIGURE 4. ESTIMATES OF LIQUID POLLUTANTS DISCHARGED TO THE GULF

ENVIRONMENTAL MANAGEMENT IN INDUSTRY: A CONCEPTUAL REVIEW

The prospects for attaining appropriate patterns for sustained industrial development in the region are promising. The acquisition of relatively advanced technologies, coupled with growing awareness that development should enhance rather than undermine the resource base, provides enormous opportunities for the future. ROPME countries have distinct advantages in integrating environmental concerns in their industrial development policies. As most of these countries are relative newcomers to industrialization, they can adequately assess the environmental impacts of industrial development and provide for effective protection in their current planning.

The integration of environmental concerns in industrial development requires actions by the member States on a fairly broad front. Some of the major policy areas include industrial location, environmental impact assessment, selection of appropriate technology and effective reutilization of wastes.

These areas should be carefully explored through cost-benefit studies, especially since several States are currently faced with the prospect of long-term decline in their oil revenues.

In selecting industrial activities suitable for the region, the following factors may have to be considered:

1. The quantity and quality of the available natural resources and the anticipated date of their exhaustion;

2. The adequacy of the alternative production technologies and their potential environmental impacts;

3. The suitability of alternative sites;

4. The existing level of air and water pollution;

5. The opportunities for waste disposal and for recycling of by-products;

6. The cost of various alternatives.

While the above does not represent a comprehensive list of issues to be studied for a specific industrial project it nevertheless demonstrates the complexity of the subjects involved in appraising a new industrial activity.

In this context, it is also important to consider the "social conditions" in addition to the "physical factors" discussed above. Population growth, density of settlement and level of urbanization should be incorporated in industrial development plans.

Environmental impacts of industrial pollution are complex and cumulative. In the large industrial complexes presently operating along the Gulf coast, it is irrelevant to assess the impact of individual discharge on the environment as it should be assessed with other industrial discharges from

the same location while considering the prevailing climate, wind velocity, stream flow, and the capacity of the receiving environment to absorb or assimulate the pollutants.

The quality of the surrounding environment must always be regarded as a combined effect of all sources of disruption which are directly or indirectly induced by industrial development in a certain locality. This goes far beyond the mere pollution of the environment to include other nuisances such as excessive noise, urban congestion, creation of slum communities, progressive absorption of free space and chaotic traffic. In several industrial areas in the ROPME region additional "unique" conditions expose the community to more environmental dangers than those encountered in the neighbouring countries. These include vulnerability and depletion of ground-water resources, the greater complexity and potential hazards of most oil-based industries, the inadequate infrastructure in the rapidly growing urban agglomerations and the tropical climate which intensifies pollution problems.

For these reasons, it is essential for the ROPME countries to view the process of industrial development from the very outset as a multi-purpose undertaking which not only affects the physical and economic environment but also affects individual and social well-being as well.

In this regard, it is worth mentioning that ROPME countries should benefit from the lessons gained by the developed countries during the course of their industrial development over the past two centuries. Most ROPME countries have a better chance and more room for manoeuvre so as to avoid the mistakes of spontaneous industrial expansion and the uncontrolled pollution emissions which may cause irreparable environmental damage. The countries of region as well as other industrialized developing countries are in a clearly advantageous position from which they can accurately anticipate the damage and appropriately counteract by "built-in" measures, while the developed countries have to rebuild or "add on" at an extensive cost. In addition, the ROPME countries can make more rational choices for their long-term strategies for industrial development compared with the developed countries which are forced to formulate their future development strategies while accounting for the negative environmental impact of the various manufacturing operations already in operation.

This apparently favourable situation is counteracted by the tendency to adopt patterns of industrial development copied from the industrialized world without due regard to the environmental consequences or even the basic developmental long-term interests. A typical example is the tendency to install the most advanced technologies and highly automated processing equipment without adequate experience and manpower for operation and maintenance. It is therefore indispensable for the ROPME countries to make the best use of the experience, both good and bad, of the industrialized world. A case in point is the widely accepted concept of locating the industry first and building the supporting infrastructure around it. In this area, this approach should be challenged, if not completely avoided, as polycentric rather than monocentric spatial industrial development seems

appropriate to the Gulf in view of its unique environmental, physical and social conditions. Further, polycentric industrial development may encourage spreading of urban development versus the present excessive expansion of metropolitan centres.

The emergence of huge industrial complexes in the already concentrated urban centres along the Gulf coast has created major pollution problems and further complicated the acute problems of public services. The highly polarized industrialization which brought about "pockets" of environmental pollution in several locations in the region could be corrected by decentralization to spread the burden of environmental impact and to generate balanced growth in more manageable smaller areas, thus avoiding spots of "heavy pollution" which requires expensive remedial actions.

It may be argued here that large industrial complexes are in a better position to manage a combined waste treatment system; however, the advent of new waste control technologies, makes it possible in several cases effectively to reduce the waste of the small size industries through on-site treatment at a reasonable cost.

ENVIRONMENTAL STRESSES OF INDUSTRIALIZATION IN THE REGION

Industrial development imposes inevitable stresses in the form of health hazards, economic loss and esthetic nuisances. During the last decade, ROPME countries accelerated their environmental concerns and passed legislation to control their environment. Unfortunately, most of that legislation was conceived theoretically and was brought about without due regard for the socio-economic conditions of the region. In addition, legislation was enacted to control "end-of-pipe" emissions without considering the environmental impacts of products when used by consumers and residues from products when released without control into the receiving environment. There are also indications that high-risk industries which face public opposition and stringent pollution control laws in the industrialized countries are moving to the region. Exportation of these high-risk industries may have long-term devastating environmental consequences, no matter how attractive the short-term economic gains seem to the community. For all these reasons, industrial pollution cannot be regarded merely as a techno-economic problems, but should be dealth with as priority national concern, and as such deserving of much broader in-depth consideration by all member States.

Health hazards of industrial emissions include exposure to high concentrations of toxic chemicals causing poisoning and burns, or exposure to low doses for long periods which induces chronic diseases, cancers, sterility and reproductive problems. Arsenic from pesticides and glass manufacturing ties up active sites of cellular substituents and may also cause hyper-pigmentation and skin cancer. Boron is toxic for many organisms in concentrations as low as 1 part per million. Cadmium emitted from metal-finishing and ceramic industries causes serious cardiovascular diseases. Nitrate reacts with an oxygen-carrying pigment in the blood and leads to harmful physiological effects. Cyanides are extremely toxic as they inhibit the phosphorylative oxidation reactions which permit cellular

respiration. Mercury and its compounds, especially methl-mercury, have been associated with a number of poisoning episodes characterized by impaired hearing, vision and muscular co-ordiantion and, in some outbreaks, by high mortality. Lead, which is considered a global pollutant, can produce a variety of serious effects, including neurological disorders.

Particulates such as dust, smoke and aerosols may have both acute and long-term health and environmental effects. These effects range from irritating the eyes and throat and reducing resistance to infection, to causing chronic respiratory diseases. Carbon monoxide released from incinerators and other industrial proceses replaces oxygen in the bolood stream and may impair vision, alertness and other mental capacities. Several crippling diseases are linked to asbestos exposure such as asbestosis and lung cancer, which has a 15 to 40 years latency. The exhaust from motor vehicles constitutes a serious health hazard as it forms photochemical oxidents responsible for smarting eyes, throat irritations and impairment of lung functions. Industrial air pollution also causes severe damage to monuments and works of art in areas close to sources of emission.

Uncontrolled disposal of hazardous residues from industrial complexes in the region may present serious environmental and health problems in the near future. Rain seeps through the land, carrying chemicals that contaminate underground waters and nearby streams and lakes, while toxic vapours released from evaporating liquids or uncontrolled chemical reactions cause air pollution problems. Recent studies in the region have indicated that workers exposed to chemical agents at levels lower than the internationally recognized threshold limits had some health impairments. This has been attributed to unfavourable climate, low socio-economic standards and hypersensitivity. Atmospheric chemical pollution (oxides of sulphur and particulates including heavy metals) also represents an emerging industrial pollution problem in the region.

Measurable economic losses created by industrial pollution are estimated when they represent direct costs such as loss of materials, cost of treatment or decreased value of marketable fish. However, intangible costs such as impact on health, loss to tourism and esthetic damages are extremely difficult to quantify in monetary terms. The damage done by noise pollution, such as people moving away from noisy areas and the loss in property values, is not usually included as economic loss in the cost-benefit analysis.

Expanding population and industrial growth are influencing current environmental problems in the region and presenting new challenges. In metropolitan centres which accommodate intensive, relatively high-technology operations, there is the potential for discharges of residual hazardous chemicals in the environment. This represents a serious problem for the existing water treatment works which are not designed to handle these persistent residues. These problems will loom larger as continued population and industrial growth will place more pressures on the limited natural resources and further limit the capacity of the environment to assimilate wastes.

PERSPECTIVE ON ENVIRONMENTALLY SOUND TECHNOLOGY IN THE REGION

The concerns for a careful hasbandry and utilization of natural resources, reduction of waste generation and recyling of secondary materials should not be regarded as a matter of environmental interest only but rather basic elements of the industrial development plans in the region. As economic considerations inevitably influence decisions concerning the best mangement startegy, the optimum solution in any locality may not necessarily be the most suitable for another place. The aim should always be to select appropriate management options to conserve environmental quality while employing suitable technologies without imposing excessive costs to the industry.

Within the context of environmentally sound technology, the various alternatives available through the implementation of low and non-waste technology LNWT have received credence in recent years. These alternatives include, inter alia: the design and operation of production processes to reduce generation of wastes; residuals' handling to maximize the utilization of energy and raw materials and energy requirements during use; and extending the lifetime and facilitating the recovery and recycling of material after use.

Technologically, various options can be employed to achieve a specific level of industrial pollution control to satisfy certain criteria with regard to environmental quality; however, economics often is the major determinant for the selection of a control strategy. Unfortunately, little consistent information is available in this region regarding the costs of pollution control in industry; this is attributed to: (a) lack of consensus about what constitutes comparable levels of control across technology alternatives; (b) the dynamic nature of costs as new technologies are continuously developed for better control of industrial pllution and (c) specificity of information to application of a particular technology to a particular waste.

Decisions concerning the proper waste control strategy cannot be made rationally on an economic basis only as ecological, social and public health factors should also be considered in selecting an appropriate control programme. Toxic wastes when generated in significant quantities are particuarly dangerous and require adequate precautions for their collection, deactivation and disposal and should be handled without endangering human health or the environment regardless of the costs incurred.

There is uncontrolled use of chemicals and hazardous matter in several industrial complexes in the region which poses serious risks to the public health and the environment. In view of the trans-boundary nature of most of these hazardous matters, the highest level of attention must be directed towards developing a regional scheme for preventive and control strategies designed to take full account of all environmental concerns related to production and use of hazardous matter.

Looking at the industrial scene through the ROPME region, it is evident that major industrial complexes have not been designed in a way that a waste generated in a given industrial facility becomes a raw materials for another neighbouring facility producing a different product. Further, national and regional waste exchange has not been used, effectively to transfer the wastes among industrial sectors, particularly when the wastes produced do not constitute an economic potential. The lack of advanced treatment of secondary products, and the inefficiency of the collection and storage systems are other problems which hinder effective reutilization of wastes in the region.

On a related issue, the major constraints to adoption of LNWT arise from lack of complementarity within the production processes, inadequacy of industrial infrastructures, lack of expertise and prevailing attitudes by management against expenditures on pollution control. Present government policies concerning supply of cheap water and energy and offering subsidies for raw materials to industries may implicity induce resource wastage and apathy towards polluting technologies.

As no single method of waste disposal will suffice for the wide variety of wastes presently generated in the region, various alternatives should be carefully assessed to select the most practical and cost-effective scheme. Available options comprise: (a) in-plant measures to reduce generation of wastes; (b) measures to control wastes after generation; (c) permanent disposal and (d) methods of enhancing the assimilative capacity of the receiving bodies. These measures substitute for one another depending upon the particular waste load, capacity of the receiving environment on available technology and economic resources. The range of technologies employed for waste reduction in selected ROPME countries is described below:

A. Source segregation

The contamination of large volumes of non-polluted effluents can be avoided by separation of concentrated streams which contain hazardous or polluting constituents.

- Grease traps are commonly found in food-processing plants and new regulations are enforced in several countries to limit oil pollution from service stations through on-site treatment.

- Tanneries and electroplating plants in Iraq, Iran and Saudi Arabia are being involved in programmes to segregate the highly toxic wastes for the purpose of metal recovery and detoxification before mixing with other processing effluents.

B. Process modifications

Process modifications aim at increasing production efficiency and reducing wastes thus decreasing manufacturing costs. Usually environmental protection has not been a primary motive of the modifications although this is eventually achieved as an end result.

- The modification of the electrolysis cells in the choloralkali industry was intended to increase process efficiency and reduce losses of the costly mercury and brought along a substantial decrease in the mercury discharged with the processing effluents.

- In the steel industry, a particularly difficult waste problem is the disposal of waste pickle liquor when pickling with sulphuric acid. A shift to hydrochloric acid is being experimented with in some plants which could reduce the acid loss from about 6 kg/ton steel in the case of sulphuric acid to less than 0.1 kg/ton in the case of hydrochloric acid.

- Extensive retrofitting and upgrading of the pollution control gear have been recently completed in the cement plants of Riyadh and Qasim in order to comply with the Saudi Arabian air emission standards; the Jeddah plant was forced to cease operations and was moved to Rabigh as retrofitting the old plant proved uneconomical.

- In a large integrated rayon factory in Iraq, saleable by-products are currently recovered form liquid effluents and the overall waste management system was not only able to abate pollution but to show a net cash profit.

C. End-product substitution

Replacing the hazardous products with new products to eliminate or reduce the generation of hazardous wastes has been speeded up recently by evolving changes in technology and the rising concern about health.

- Bans on some pesticides such as DDT in most member States have resulted in switching production to less hazardous and more effective chemicals.

- Most member States are currently replacing asbestos pipes in the water distribution networks with those fabricated from steel or poly-vinyl chloride. However, this could increase the level of cyanides and the hazardous vinyl choride monomer in the environment.

- Substituties of the hazardous dyes and auxiliaries with less polluting chemicals has been gradually introduced in the textile finishing industry.

D. Recovery and recycling

Recovery involves the separation of a substance from a mixture; recycling involves the use of materials that has been recovered. Some recoverable components are recyclable where as others have to be discarded if they have little or no market value.

The amount of material that could be recovered within the ROPME member countries is very difficult to estimate because neither the total volume of waste nor its composition is known with an accuracy. Based on the limited

available information, the GCC countries have an estimated 200,000 tons of scrapped vehicles annually which could be efficiently used as input to the steel plants in the region. However, the costs of collection, scrapping and transportation of the pressed scrap seem uneconomical at present. About 10,000 tons of lead could be recovered from the scrapped batteries to be used as a substitute for imported lead. This practice is being employed by several factories in the region. Effective recovery of plastics, glass, catalysts, etc.. is being hampered owing to improper collection and reprocessing, and absence of charges levied against waste generators and non-recyclable containers.

A recovery system may involve simple operations such as reprocessing of steel-pickling liquors which involves precipitation gravity settling and flotation, or complex processes such as reverse osmosis, ion-exchange and other advanced treatments; these technologies are often expensive and may have limited application unless operated as a central enterprise to serve several establishments.

Wastes produced in relatively small amounts could be retained in a regional recycling centre that can centralize the collection of wastes thus reducing costs of transportation and treatment; added benefits include decreased dependency on imported resources, saving in energy requirements for production, and reducing environmental and health hazards.

In our region, industrial wastes by and large are not recognized as recoverable resources so information is not readily available whereby reclaimers can determine the volume and suitability of particular secondary product that might be available for reuse. However, it is anticipated that rising prices of raw materials, concern for energy conservation and increased interest in environment protection will encourage industries to expand the use of the recyclable components of their waste materials. At present, waste generators and users even within the same locality are not often in a position to exchange materials among themselves; thus a "clearing house concept" may be established to enable manufactureres and waste processors to increase the efficiency of waste utilization.

MANPOWER DEVELOPMENT FOR INDUSTRIAL ENVIRONMENTAL MANAGEMENT

The problems associated with environmental management in modern industry require a multidisciplinary approach in their resolution, with planners, officials responsible for monitoring and administration as well as industrial managers contributing to decisions concerning environmental management in industry. In particular, industrial managers and technical staff must have a comprehensive knowledge of the einvironmetally sound operation of their industries and the technical and economic implications of pollution control as well as its effect on workers' health and the well-being of the community.

Training should not be limited to regorous instruction. Trainees are not just recipients of information; they should be encouraged to share their experience and knowledge for better understanding of the problems and the best ways to solve them. Currently, training activities for industrial personnel

in the field of environmental management in the ROPME region are carried out with sporadic short courses and seminars by universities and research institutions. A quick review of the technical content of the reference materials reveals a somewhat theoretical approach with subjects not directly related to plant operation and management needs.

The vocational training carried out by the intermediate technical colleges hardly touches upon the problems of industrial wastes and most technical personnel have a limited knowledge of the problem of emissions and the various alternatives for combatting pollution.

While chemists and engineers are exposed to the general concepts of environmental protection during the course of their undergraduate studies, curricula rarely contain specific courses on industrial waste control.

Universities and technical colleges can provide the much needed theoretical and technical background to the problems of industrial pollution, and provide the linkage between those going into advisory and enforcement positions and those opting for industry.

On-the-Job training, off-site educational programmes, regional seminars and other training activities provide vital tools for manpower development. The responsibility of training industrial personnel should be promoted as a collaborative effort of learning institutions, government organizations and industry. Industry should also contribute to the training of government officials and decision makers on specific industrial environmental management problems; this would eventually lead to development of practical and meaningful programmes for abatement of industrial pollution. While the development of technical manpower is essential for the success of industrial environmental management, equally important is the development of expertise for planning, monitoring and enforcement. At present, institutional capabilities of the concerned government agenceis are rather limited, hence the need to provide adequate training for officials to become aware of the environmental impact of industrialization and to use the knowledge and experience gained to curb industrial pollution through the institution of appropriate regulations.

In this connection, the following briefly outlines the scope and contents of training programmes for government officials:

- Review of Environemntal Impact statements (authority and responsibility; impact identification, evaluation and aggregation; data source: methodologies including ranking, score allocation and quantification: economic implications).

- Procedures for setting standards (industrial discharges; in-plant controls; environmental dispersion; effects on man and the environment; monitoring facilities; impact on industrial development; institutional requirements).

- Review of pollution control programmes (technology evaluation; indigenous capabilities; long-term sustenance; cost-effectiveness; by-product recovery).

- Monitoring and administration (sample collection; preservation and analysis; environment monitoring including health surveys and surveillance of the receiving environment; data interpretation and reporting; enforcement including legal procedures and penalties).

- Information mangement systems (data processing, storage and retrieval, system analysis, dissemination of information).

Industrial personnel should be regarded as a prime partner in the development and implementation of environmental protection programmes. If they are well trained, they will better understand the basis of government actions, offer proper advice on practical control measures, share responsibility and will be ready to comply with regualtions and emission limitations. Their training should involve the following basic components:

- Environmental management (the anticipation and assessment of pollution control, centralized pollution control schemes, environmental planning, public awareness). An emphasis should be placed on the newly developed "integrated approaches to pollution control, such as (a) the bubble concept which allows a group of plants to "under-control" one or more emissions sources. in exchange for compensating controls on other sources less costly to control, and (b) the emission trading programme which allows pollution sources to avoid mandate control of specified discharge points by paying other generators of the same pollutant to reduce emissions by an equal or greater amount).

- Industrial siting and environmental impact assessment.

- Water pollution (sources, analysis, water-borne diseases, criteria for water quality, primary treatment, biological treatment, advanced treatment, LNWT).

- Air pollution (sources, analytical procedures, emission control technologies, health effects).

- Solid and hazardous wastes, (management of solid wastes, laboratory and waste management for safety and regulatory compliance, environmental and health impacts).

- Noise (source, measurements, control methods).

- Legal and adminstrative issues (policy and administration, notification procedures, regulations and emission standards, penalties and riparian rights).

REGULATORY AND ECONOMIC INSTRUMENTS: AN APPRAISAL

A review of environmental legislation in the region reveals the diversity of breadth and scope of regulatory instruments either enacted or under development. However, the effective enforcement of laws and pollutants' limitations have been hampered owing to (a) the presence of several administrative organs responsible for monitoring and control of industrial pollution outside a co-ordinated system; (b) neligent enforcement of pollution control regulations and emission standards', and (c) hesitancy to invest in pollution control programmes and waste-treatment facilities.

The present deficiencies of industrial pollution control legislation are attributed to inappropriateness of the standards which are often unachievable, inflexible and inconsistent, the lack of an effective and unified enforcement mechanism, splintered responsibilities among monitoring agencies and misconceptions on the part of the industrial management of the pollution problems and their environmental consequences.

During the past decade, legisltion concerning control of industrial emissions has been revised and updated in some member States; however, in most instances governments are not providing adequate solutions to the perceived inadequacies of the regulatory instruments. Some standards still use vague and confusing terminology such as "no toxic matter should be emitted from industrial establishments into the receiving environment". Such standards are not enforceable as they do not specify types and concerntrations of potential harmful toxicants. Further, the concept of zero telerance of any material is unachievable, especially for materials that occur naturally in the environment. Recognizing that toxicity involves concentration and exposure time, emission standards of toxicants such as mercury, molybdenun, selenium, etc., should specify maximum concentration of each potential toxicant which is not harmful under conditions of continuous discharge.

There is widespread recognition in the region of serious health and environmental problems associated with expanding industrial production and the inevitable generation of pollutants, particularly hazardous and toxic matter. Most governments have recently moved to reconcile the conflict between industrial development and environmental conservation. The operation of industrial installations representing a potential hazard is presently subjected to through review before official approval. On the one hand, approval procedures grant that the legally prescribed impact thresholds are not exceeded when new plants continuously operate. On the other hand, the procedures require the application of appropriate technology in the new establishments.

In this connection, governments are encouraged to develop practical emission standards which should be laid down and periodically adapted to new technological developments. The administrative policy must reflect the needs of all concerned parties: the community, industry, environmental agencies, public services, etc. At one end, industry demands that environment should be used to dilute pollutants as long as its assimilative capacity can absorb the generated waste. The other extreme represented by conservationists requests

maintenance of the environment in its natureal state with practically no release of pollutants. However, in the end, environmental legislation should reflect a practical approach to ensure continued industrial expansion based on rational use of resoruces and minimum adverse impact on the environment (see figure 5).

Within the past decade, and as a consequence of the establishment of government organs for environmental protection in all member States and the passage of comprehensive environmental legislation, public and industry understanding of the environment and the preconceptions of the means to conserve it have evolved considerably. In the early 1970s, the oil boom and its vast revenues led to the assumption that the overall cost of environmental control had little impact on the gross national product, industrial investments, inflation and unemployment in the ROPME region. However, the accumulated experience has shown that compliance with environmental regulations can be costly and may affect industrial development in some cases. In addition, developing credible means to quantify benefits and damages has proven to be far more complex than originally believed.

Very recently, the pursuit of environmental policies in the member States had been restrained by various degrees due to insufficient budgetary allocations and austerity measures dictated by the unexpected decline in oil revenues. In some cases, revision of development plans and drastic reductions of industrial investments impeded the expenditure on equipment and facilities to control industrial pollution.

Because of these economic constraints, greater attention has been paid through the region to the assessment of costs and benefits of industrial pollution control and to the evaluation of the impact of environmental expenditures on production costs. Conclusions from the limited studies to date have shown that, though there is greater uncertainty in quantifying cost-benefit relations, there is no strong evidence to suggest that expenditures on pollution control programmes have a significant impact on production costs if considered on a nation-wide basis rather than on a sectoral basis.

While the norms and standards as well as various economic measures for pollution control are steadily being imposed on industry in the region, it is evident that the role of regulatory and economic instruments in stemming to the tide of industrial pollution is still hampered by the lack of effective monitoring and enforcement mechansims, the slowness of legal proceedings, the trivial penalties imposed on violators in most countries, and the practices of granting unjustified exceptions to public industries.

The application of the "Polluters Pay Principle - 3Ps" is not widely used in the region. The 3Ps implies that costs for the prevention or control of pollution caused by industry must be paid by the individual concerns responsible for the emission of pollutants. Putting 3Ps to practice finds its expression in particular in the use of pollution charges which represent a payment by industry for use of the assimilative capacity of the environment. Evidence from the industrialized countries indicates that economic sanctions or incentives, and regulatory instruments such as standards limiting maximum emissions can complement each other for effective control of industrial pollution.

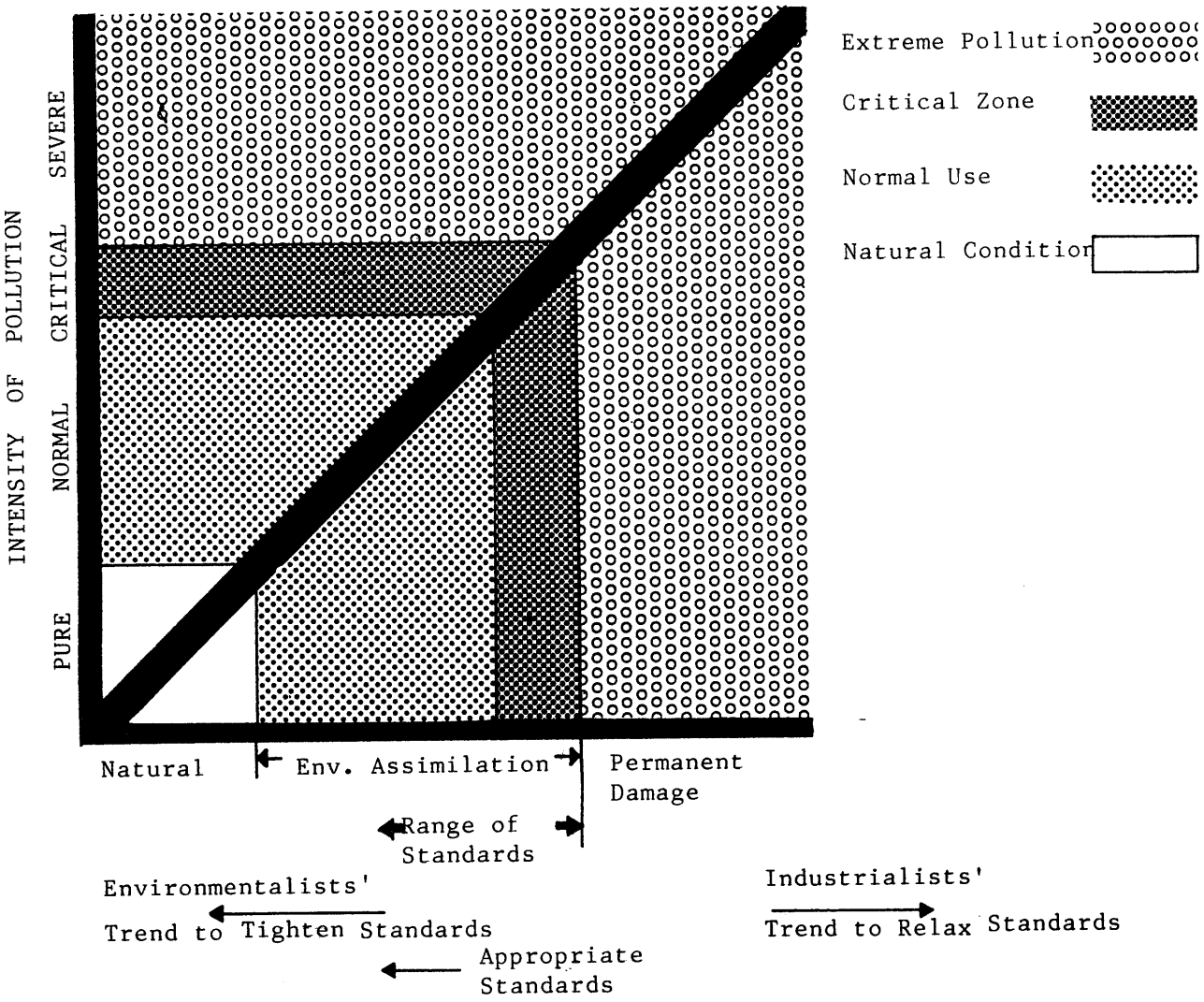


FIGURE (5): DEVELOPMENT OF ENVIRONMENTAL STANDARDS

A pollution charge is conceived as an economic incentive to promote waste control. However, its deterrent effect will diminish if the rates are not set high enough to encourage introduction of LNWT and reduction of discharges. If the charge is less than the marginal costs of abating pollution, there will be little or no incentive for industry to reduce wastes and the charge simpley becomes a tool of raising revenue to supplement governmental budgets.

A pollution charge depends on effluent flow and pollutants' content which generally includes biochemical oxygen demand, suspended matter, and possibly nitorgen, phosphorus, grease and toxic constituents. Once costs are apportioned among the waste-loading parameters, they can be allocated to individuals or groups of users according to waste loads. Methods of cost allocation and recovery include:

- Users charge: The system is based on the use of or benefit from the public waste treatment works where municipal and industrial wastes are combined and treated together. The unit-user charge is expressed as cost/unit waste. The total charge for a given contributor is the sum of the unit-user charges multiplied by their corresponding loads.

- Negotiated contracts: In cases where there are few major industrial contributors to the municipal system, the sewerage authority can negotiate individual contracts taking into account the special nature of each effluent. Contracts are particularly useful in planning of a new industry, as it may be charged the capital costs for that portion of the design capacity allocated to its use. Also an industry anticipating expansion can easily contract for the excess capacity.

- Property taxes: Though this system of taxation is convenient and commonly applied in the region for other purposes, it is considered infficient and inequitable for paying pollution charges. The system encourage excessive generation of waste loads as there is no incentive for industry to reduce pollution. Inequities would occur as non-pollutors are forced to bear a share of the total cost which should be paid by the polluting industries only.

It is of paramount importance in view of the current economic constraints in the region to consider the impact of a pollution charge on the total production costs. Conceptually the imposition of a pollution charge will have two different effects on the cost of production: a general rise in product price to absorb this new cost and a change in the relative prices of both products and resources inputs. The increase in particular final product prices will not be only related to the pollution charge embodied in the product, but any pollution charges imposed on the primary and intermediate materials used in processing of the final product. It is expected that such charges will not be easily absorbed by industry, especially in countries which apply restrictive pricing policies for the locally produced essential goods. However, the change in relative resources prices may induce substitution of these resource inputs because the pollution charge may ultimately lead to introduction of LNWT and other control measures.

CONCLUSIONS

It is believed that industrialization is vital for sustainable development in the region, however, more emphasis should be placed on the promotion of cleaner technology, conservation of resources and application of appropriate measures for abatement of pollution at its sources. The following actions deserve prompt consideration and close attention by the member States:

1. ROPME should work with the member countries to establish industrial development priorities, co-ordinate measures for abatement of industrial pollution and waste reutilization, and to promote "show-how" for appropriate environmental mangement in industry.

2. Decision-makers and industrial mangers must give atmost priority to environmental protection. They should promote incorporation of LNWT in all future industrial projects.

3. Industrial decentralization is a viable option to ease the burden on the overloaded urban centres along the Gulf coast and to avoid creation of pockets of heavy pollution associated with large industrial complexes.

4. Research funding for industrial pollution control should be increased substantially to encourage development of indigenous solutions to the local problems.

5. Collaboration between industry, local authorities and central administration is essential for proper planning and siting of new manufacturing operations.

6. Combined treatment of industrial and domestic wastes should be considered carfully whenever feasible; as should co-fuelling technologies.

7. Manpower development for environmental managment in industry is crucial for achieving the objectives of combatting industrial pollution.

8. The dumping of wastes at sea, and the transboundary movement of hazardous matter must be prohibited.

9. Governments must consider the proper reflection of external costs of pollution in the allocation of resources for industry. Economic disincentives would compel the manufacturers to curb pollution to minimize the cost burden of taxation.

10. Regulations and enforcement mechanisms should be strengthened to ensure clear working directive for effective enforcement and to enable compliance by industry.

11. Monitoring methodologies and techniques for the analysis of industrial wastes should be unified throughout the region to avoid discrepancies in data collection and interpretation.

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