

INDUSTRIAL WASTEWATER MANAGEMENT IN DEVELOPING COUNTRIES

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ABSTRACT

Most developing countries around the globe are striving hard for a fast economic growth and associated industrialization. As a result, numerous industries are emerging mostly in the urban areas of developing countries. The wastewater, which is an obvious by-product of all industries, receives lower priority in developing countries. The plant designer and supplier normally provide an in-built pollution control system for new industries. The peripheral facilities, like wastewater treatment, suffer due to limited financial resources. In addition, other factors such as lack of experience in operation, management and plant repairs, lack of spare parts, frequent shortage of power/fuel, lack of end products disposal facilities, social and political reasons contribute to inadequate wastewater management in developing countries. Absence of industrial effluent standards and corresponding legislation for enforcing them are common in developing countries. Environmental impact assessment studies for the industrial growth are commonly not carried out in developing countries. Public awareness against pollution is also at a low profile in developing countries. The industrial wastewater problems in developing countries are discussed in this paper with some typical examples. The critical appraisal of the industrial wastewater management situation in developing countries is concluded by recommendations for the course of action.

KEYWORDS

Industrial wastewater; developing countries; treatment plant; effluent standards; disposal; environmental impact; public awareness.

INTRODUCTION

In the present era of industrialization, the national economies are shifting from the agricultural base to the industrial base. The extent of industrialization has become in fact a measure of economic prosperity and standard of living of a country. Thus, the developing countries, struggling for fast development and achieving self sufficiency, have industrial growth at top priority in their national planning. The pattern of industrial growth in developing countries depends on a number of factors viz., local demands, climatic conditions, economics of the project, availability of resources, hinterland, social background and governmental policies.

The industrial wastewater is generally industry specific and vary widely both in quality and characteristics. Normally it is concentrated and may sometimes contain toxic matters as well. Therefore, management of industrial wastewater is difficult and requires careful consideration and planning. The industries may be classified as cottage industries, small-scale industries, medium industries and major industries according to their size and product range. General characteristics of industries

and their wastewater management in developing countries are presented in Table 1.

TABLE 1 General Characteristics of Industries in Developing Countries

S No	Type of Industry	Site	Industrial Wastewater		
			Collection	In-plant Treatment	Disposal
1.	Cottage Industries	Residential & Commercial area	Unorganized	None	In municipal sewers if available or on-site
2.	Small scale	As above or in Industrial estates	Inadequate	None to preliminary	As above
3.	Medium size	Industrial estates	Organized	Preliminary to Primary	In Industrial sewer or on-site
4.	Major Industries	Special site	Organized	Complete Treatment	Water/Land disposal or reuse.

Unorganized collection and disposal of industrial wastewater is a common feature in most developing countries. As they are in their early stage of industrialization, the impact of industrial pollution is not widespread. However, severe local pollution problems due to industrial wastewater do exist in the vicinity of most of the industrial sites.

WASTEWATER CHARACTERISTICS

The industrial wastewater flow rates and quality depend on the type of industry, size of industry and the processes involved in the production. The quality also depends on the in-plant recirculation of the wastewater and other water conservation measures adopted by the industry. The industrialized countries tend to conserve on water use by in-plant recycle of some streams. However, to achieve this recycle potential, the industry has to provide for plant/process modification and in-plant wastewater treatment. In many cases, these plant modifications work out economically viable, but the initial capital out-lay required for them deter the industries in developing countries to carry them out. At the same time, the technology required for plant/process modifications is not available locally in most cases which also retards their implementation. It is observed that the industrial wastewaters of similar industries from developing countries and industrialized countries show a characteristic difference. The industrial wastewater from industrialized countries normally has higher pollution concentration than that of the developing countries. The average industrial wastewater characteristics for a few types of industries from India and USA are comparatively presented in Fig.1 to illustrate this point. The treatment and disposal of industrial wastewater, which depend on its characteristics, should be specific for the developing countries.

WASTEWATER TREATMENT

The industrial wastewater from cottage and small-scale industries in developing countries normally receives very little in-plant treatment. In some cases, preliminary treatment of wastewater in form of pH adjustment and sedimentation is carried out. The wastewater treatment, being off the main stream of production process, receives low priority in fund allocation. The industries would incur minimum cost on treatment of wastewater for economic reasons. In absence of proper maintenance and operation of the plant, the wastewater treatment is also very inefficient.

The wastewater treatment is considered as an integral part of the process in large industries. The plant designer and suppliers which are normally from the developed world, provide complex wastewater treatment plant along with the industrial process. Such industrial wastewater treatment plants, in spite of expensive layout, do not remain functional over long periods in developing countries. The shut-downs of the treatment plants may be attributed to the following factors:

- a. plant design criteria do not match with the local conditions

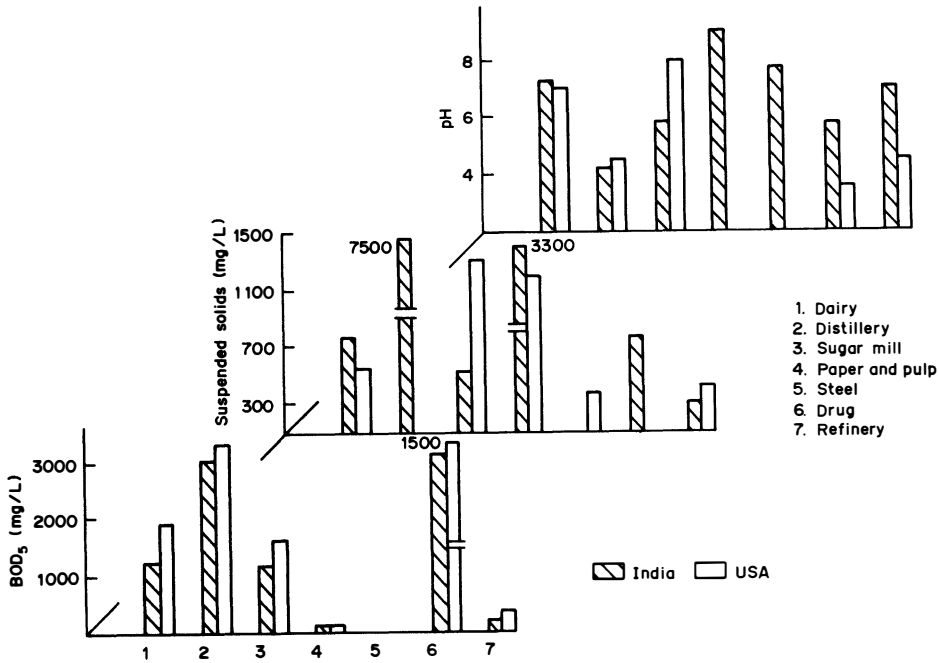


FIG. 1 COMPARATIVE INDUSTRIAL WASTEWATER CHARACTERISTICS

- b. plants require skilled operators which are not available locally
- c. sophisticated plant systems are difficult to maintain with local resources
- d. high cost of operation.

Additionally, Table 2 presents some common problems faced by industrial wastewater treatment plants in developing countries.

Simple and low-cost technologies like lagoons and ditches may provide adequate answers to industrial wastewater requirements in developing countries. High space requirements of low-cost technologies normally do not pose problems in developing countries. A number of industries in India have successfully demonstrated the benefits of low-cost technologies for industrial uses, and these experiences could be exploited by other developing countries as well.

DISPOSAL

The industrial wastewater of cottage and small-scale industries is either discharged into municipal sewers or disposed directly into water bodies or on land. The sewage treatment plant authorities prefer to collect and dispose of industrial wastewater separately for obvious reasons of its characteristics. The pretreatment facilities for industrial waste water are generally not provided in municipal sewage treatment plants. Thus, the combined wastewater characteristics may create stress conditions on sewage treatment plants. Table 3 presents characteristics of wastewater from two adjacent towns in India, one having extensive textile industries and the other is a normal town. The effect of industrial wastewater discharge in municipal sewers is very evident from the characteristics. The shock loading due to industrial discharge many times upsets the municipal treatment process, which requires a lengthy recovery period. In cases where large water bodies like sea or large streams are available for wastewater disposal, the sewer industrial wastewater from industrial area is directly disposed of in water bodies through regulated outfalls. This practice, as adopted in coastal towns in developing countries, saves municipal sewage treatment plants from complex situations, but creates long-term impacts on the receiving waters.

TABLE 2 Common Problems Faced by Industrial Wastewater Treatment Plants in Developing Countries

S No	Source/Cause	Problem
	<u>Operation & Maintenance</u>	
1.	Material resource	Shortage of chemicals/fuel Shortage of spare parts Disruption of power supply Lack of laboratory facilities Inadequate maintenance equipment
2.	Human resource	Shortage of local technical staff Lack of adequate experience and training Interest and motivation in plant staff Lack of specialist/ Advisers
3.	Technical	Inadequate preventive maintenance of plant Malfunctioning of control systems Problems with plant inlets and outlets
	<u>Wastewater</u>	
4.	Intermittent discharge	Very long or too short sedimentation periods Septic primary effluent Insufficient gas transfer Odor/insect problems Difficulties in maintaining biomass Sludge bulking Varying effluent quality
5.	Varying influent characteristics	System overloading Shock load may upset the process Toxics inactivate biomass.
6.	Disposal/reuse of effluent and side streams	Lack of proper disposal sites Environmental pollution No in-plant modifications for reuse of effluent

TABLE 3 Effect of Untreated Industrial Wastewater Discharged into Municipal sewers

S No	Parameter	Jodhpur (Normal town)	Pali (Industrial town)
1.	pH	8.5	12.5
2.	Solids (mg/L)		
	Dissolved, fixed	1050	6500
	volatile	300	1550
	Suspended, fixed	200	200
	volatile	300	385
3.	BOD ₅ (mg/L)	500	800
4.	COD (mg/L)	850	1550
5.	Chloride (mg/L)	850	2900
6.	Sulfate (mg/L)	400	550

The large industries normally have their own wastewater treatment plants and the treated effluent is either disposed of according to convenience or reused for in-plant processes or for irrigation. However, the efficiency of the treatment which is mostly very low for reasons discussed earlier, reduces the reuse potential of the treated

effluent. The extent of disposal sites in relation to the number of industries is generally favourable in developing countries, therefore, serious efforts for improving industrial wastewater treatment plants are not coming forth. Long-term uncontrolled disposal of industrial wastewater on land causes serious problems of land and groundwater pollution and this is a common feature of industrial towns of developing countries.

LEGISLATION AND ENFORCEMENT

The pollution control measures cost a sizeable amount of funds to the industry, which unfortunately is considered as unproductive. In absence of adequate laws and enforcing infra-structure, the industries tend to save on this unproductive cost by disposing of untreated or partially treated industrial wastewater into the receiving environment. To control this situation, the government has to enact pollution control laws that provide penalties and punishments for offenders, create organizations for monitoring the industrial effluents and enforcement of pollution control laws. These pollution control bodies should devise effluent quality standards based on the conditions of the receiving environment. The developing countries, being late starters in industrialization, mostly lack in all these aspects of industrial pollution control. In some countries, like Nigeria and Libya, effluent standards are laid down, but the lack of efficient enforcement infrastructure makes life easy for the industries. In India, Water (Prevention and Control of Pollutions) Act was enacted in 1974. Under this Act, the State Governments created State Water Pollution Control Boards. The activities of these Boards are coordinated by Central Board for Prevention and Control of Water Pollution. However, wide powers to enforce the pollution control measures were delegated only in 1986 under Environment (Protection) Act, 1986. Due to a number of constraints, the State Pollution Control Boards are still far from being perfect in enforcement of the provisions of these Acts. Some of the constraints are shortage of experienced staff, lack of sampling and testing facilities, lack of cooperation from the industries and shortcomings in the legislation.

ENVIRONMENTAL IMPACT ASSESSMENT

Overall picture of the state of pollution of the environment subjected to the process of industrial growth should be assessed by conducting environmental impact studies. Environmental impact may be assessed through detailed study of receiving environment viz., stream quality, marine quality and groundwater quality. These studies not only provide the factual picture of pollution, but also provide guidance for preventive and corrective measures for environmental protection. The developing countries hardly embark on such studies due to lack of resources and planning. Moreover, infancy of the industrialization and availability of large effluent disposal sites in most developing countries still do not warrant urgency of such studies. In India, the State Pollution Control Boards have investigated some of the main rivers in the country for stream quality and this information is beneficially utilized for judicious waste load allocation to different stream reaches. However, a large portion of the receiving environment is still uninvestigated, which would require large further input of resources.

Public awareness is a vital factor that significantly contributes in the pollution control activities. Public protests can force the industries to adopt adequate pollution control measures. In developing countries, people still lack in pollution awareness and many industries do take advantage of this unhappy situation. Gross pollution of the Lagos Lagoon in Nigeria shows pollution tolerance of the public at large.

CONCLUSIONS

The developing countries are giving due priority to their fast industrial growth. The problems of management of industrial wastewater are usually side-lined due to various reasons viz.,

- a) initial stages of industrialization
- b) lack of funds, human and material resources
- c) normally ample wastewater disposal sites are available, thus impact of pollution is not severely felt

- d) local appropriate wastewater technologies are not available.
- e) lack of pollution control enforcement infra-structure
- f) lack of social awareness

To prevent the industrial pollution problems growing from difficult to unmanageable in developing countries, serious consideration would be required on part of the governmental agencies responsible for industrial planning and pollution control and the industries. These may include the following :

GOVERNMENT

- a) Planning of industrial estates with due consideration to environmental protection
- b) Exercise control for planned growth of industries
- c) Adopt proper effluent standards
- d) Enact laws for pollution control
- e) Create pollution control enforcement bodies and help in their working
- f) Plan periodic environmental impact assessment studies
- g) Induce and help industries in their wastewater management
- h) Promote industrial wastewater disposal facilities
- i) Create facilities for manpower training and education in the field of pollution control.

INDUSTRIES

- a) Give due priority to wastewater collection and in-plant treatment
- b) Adopt simple and manageable wastewater treatment technologies
- c) Allocate sufficient resources for operation and maintenance of treatment plants
- d) Opt for internal recirculation of water and resource recovery by plant/ process modifications, if required
- e) Adopt safe effluent disposal practices to protect the environment.

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