
Reports from IUPAC Bodies

Water Pollution Management in India (VI.3)

Introduction

The rapid pace of industrialization and the greater emphasis on agricultural growth for overall development have brought in a host of environmental problems in recent years in India. Financial and technological constraints have led to inefficient conversion processes, thereby leading to generation of larger quantities of waste and resulting pollution. The concentration of industries in certain pockets and the skewed distribution of rainfall have further compounded the scenario. Thus, India encounters water quality problems both on account of water pollution and overexploitation of groundwater.

Government Measures on Water Pollution Control

Major industries in India responsible for water pollution are fertilizers, sugar, textiles and chemicals, mines and minerals, pulp and paper, leather tanneries, and process industries. Pollution problems in India are addressed by a combination of legislative, punitive, and motivational measures. The government of India has enacted a number of pieces of legislation, such as the Water (Prevention and Control of Pollution) Act, 1974 and amended in 1988; the Water (Prevention and Control of Pollution) Cess Act, 1977 and amended in 1991; and the Environment Protection Act, 1986, etc. The problem is compounded by the presence of a large number of small-scale industries. A system of environmental audit has therefore been introduced to enable the production units to evaluate the raw materials, utilities, and operational efficiencies to effect any possible midcourse corrections and minimize environmental pollution. Imposition of cess for water required and wastewater produced represent the punitive measures that would force the industries to reduce the pollution load. At the same time, the government has come out with a number of schemes to encourage setting up of treatment plants to mitigate the pollution load through subsidies and soft loans.

Water Pollution Mitigation by Industries

Initially, the affected industries directed their efforts to treat their effluents so as to meet the discharge norms such as MINAS (minimum allowable standards), usually defined in terms of temperature, pH, BOD, COD, suspended loads, and toxic constituents such as mercury, chromium, cadmium, etc. The norms are differ-

ent for inland and coastal discharges. Large- and medium-scale industries have their own infrastructure and resources, and they have adopted their own effluent treatment schemes so as to render their discharge streams environmentally safe.

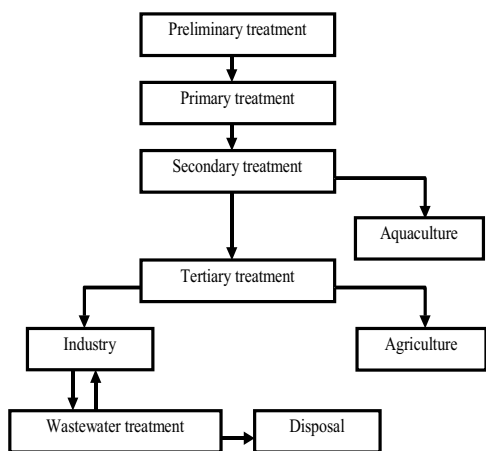
Small-scale industries, because of their limited resources in terms of finance, space, and technology, cannot afford to treat their wastes. The concept of Common Effluent Treatment Plant (CETP) was evolved to provide necessary assistance to this sector, wherein the wastes generated by a number of industries are brought together to a central place and treated. A number of plants are in operation in different parts of India. Significant variations in the composition of the wastewater arising from a cluster of industries has created difficulties in ensuring the efficiency and effectiveness of the CETP. Insisting on a pretreatment system by the individual industries to ensure consistency of the composition of effluents would defeat the very purpose of CETP. With the knowledge that the addition of domestic sewage improves the treatability of industrial wastewater, a new approach, referred to as a Combined Effluent Treatment Plant, has evolved, wherein the domestic sewage of the surrounding community is jointly treated with the industrial wastewater¹.

Water Management in Indian Industries

The migration of population and the clustering of industries around urban centers have escalated the demand for good-quality water, both for industrial and domestic use. Inadequate natural resources and increased generation of sewage have created problems, both in the supply of water and disposal of sewage, forcing the government to increase the water charges and effluent cess. In urban centers, a dual pricing system for water is being adopted, whereby water for domestic consumption is charged less. Furthermore, industries are encouraged to set up water recovery or desalination plants to meet their demands. Consequently, industry has not only started adopting measures to minimize waste, but also has been looking for various means by which they can recover and recycle their wastewater. Some industries, such as Rashtriya Chemicals and Fertilizers Ltd., have successfully experimented to recover and reuse water from their regenerant waste streams using reverse osmosis and are in the process of setting up large-capacity plants.

Role of Membranes in Water Recovery and Reuse

Membrane processes, with their variety and flexibility, are characterized by ambient temperature operation, low energy consumption, and modular nature. The physico-



Schematics of Municipal Wastewater Reuse

chemical mechanism of separation requires only limited use of chemicals, making the process eco-friendly. In some cases, the processes allow the recovery of valuable chemicals for reuse. Membranes are available in the market covering a wide range of characteristics.

Water recycling and reuse, in this context, has assumed greater significance. Thus, industries have resorted to methods whereby they can recover and reuse water. The general scheme² followed, as shown below, consists of preliminary, primary, and secondary treatments for the reduction of suspended matter and bio-contaminants.

A scheme consisting of reverse osmosis at the tertiary treatment stage has been adopted on a trial basis by Madras Fertilizers Ltd. (MFL) and Madras Refineries Ltd. (MRL) to recover good-quality water from sewage. The water thus recovered is being used as a boiler feed after polishing through demineralizers. This process has encouraged the state government to adopt the scheme for Chennai, traditionally a water-starved city in India, for recycling about 30 MGD of water for industrial use.

Management of Drinking Water

The overexploitation of groundwater has particularly affected the availability of good-quality drinking water in remote villages of India. A significant number of villages have problems related to brackishness and contamination by iron, fluoride, arsenic, etc. Rain harvesting and groundwater recharge techniques are being encouraged to make the villages self-sufficient, but they have limited potential. Membrane processes, such as reverse osmosis and electrodialysis, have been widely adopted for the provision of drinking water for salinity-affected villages, but a number of improvements are required in order to simplify the operating features so as to absorb the technology under the rural infrastructural constraints.

Future Scenario

It is expected that in the future all process industries will have water recycling plants and coastal industries may adopt seawater desalination plants either using process waste heat or reverse osmosis membranes. Domestic water requirements would be met with natural resources, while industrial requirements may have to be supplemented by desalination.

Assessment of the Current Technology

Membrane technology, though originally developed for desalination, has made a major impact in a number of industrial separations. With reference to desalination and effluent water treatment for reuse, the technology is considered mature enough for large-scale exploitation. Whether for domestic use or industrial process water requirements, the cost of desalted water, however, continues to be an area of attention. Cost-reduction strategies include reduction in process energy requirements by adopting/integrating energy-recovery systems and enhancing permeate recovery through better feed water pretreatment practices and employing high-salt rejecting membranes. These measures are partially adopted for seawater desalination in India.

Seawater desalination on a large scale is generally considered for industrial process water needs in India rather than for domestic use. For small-capacity brackish water desalination in rural inland areas, membrane technology is at present facing a setback owing to the higher cost of water produced and operational problems such as nonavailability of skilled manpower needed for plant operation and frequent electric power breakdowns. Regarding effluent water treatment for reuse in industries, membrane technology is most suited for Indian conditions and is being rapidly adopted.

References

1. Mehta, G.; Prabhu, S. M.; Kantawala, D. J. *IAEM* **1995**, 22 (3), 276–287.
2. Maudgal, S. C. *J. IAEM* **1995**, 22 (3), 203–208.

B. M. Misra

Final Report on the Design and Field Testing of a Teaching Package for Environmental Chemistry (CTC) (An IUPAC/ICSU Project)

The design of a package for teaching selected aspects of environmental chemistry has been completed. The package has also been field-tested through a series of hands-on workshops. The details of the work, which was carried out in Bangalore and Delhi under the aus-