EXECUTIVE SUMMARY

Rapid population and Industrial growth is posing challenges in Water and Effluent management. The study provides indepth water quality standards National and International, Status of raw and potable water treatment plants and gaps in the same, International Scenario, Industrywise Effluent treatment system, present state of plant and machinery manufacturers, export status , thrust area for water and effluent management.

STANDARDS

Water

India has set up standards vide IS-2296-1982, for 5 classes of inland surface waters. These are in general conformity to WHO standards specially as regards drinking water.

Treated Effluent

India has set up MINIMAL NATIONAL STANDARDS (MINAS) Industry wise.

Developed countries have made progressive improvements in their standards for effluent as the treatment technologies are updated.

Technology Status of Raw Water Treatment Plants in India

The equipment used for raw water treatment can be classified into

(i) Potable water treatment plants.
(ii) Industrial raw water treatment plants.

The details of the equipment manufactured/used in India for potable water treatment can be summarised as follows :

a) Household Appliances

- Filtration through candles, activated carbon,
- Disinfection through Ultraviolet treatment, chlorination treatment with potassium permanganate.
- Use of zero-B, Aqua Guard.

b) Small Community Villages

- Package units for clarification, filtration, chlorination, pack-

age iron removal unit, package R.O. units for desalination package defluoridation, package electrodialysis unit.

Use of these technologies is slowly coming in India.

c) *Municipal Water Supply*

The technologies in use in India are the following :

- clarifications
- filtration
- ultra filtration
- flocculation
- reverse osmosis
- electrodialysis
- water softening
- fluoride removal.

National technology mission has taken the initiative to provide safe drinking water in villages by the installation of desalination plants.

More emphasis should be given to equipments like lamella clarifier which requires 1/10th the area required by conventional clarifier. These clarifiers are used for removal of suspended particles from water and waste streams.

Filtration media is another area where upgradation of technology is required.

The technologies used abroad include advanced microfiltration which has a very high efficiency in terms of removal of suspended solids and bacteria from surface water. Microfiltration technology is now used abroad and has eliminated treatment technologies like - sand filtration, coagulation and flocculation, filter beds and cartridges. Microfiltration is more efficient than the conventional techniques and produces high quality potable water to standards which have been accepted world wide.

Status of Industrial Raw Water Treatment in India

It is seen that all the equipments used for the treatment of Industrial raw water are available in India

Indigenous technology used for raw water treatment in Industries is able to satisfy the needs both in terms of quality and quantity of treated water.

New technologies like Reverse Osmosis have surfaced in India, but not widely used. Microfiltration technology is used abroad for treat-

ing Industrial Raw Water.

The country is self sufficient in treating raw water for industries.

RECOMMENDATIONS

Reverse Osmosis and Microfiltration technologies for treatment of industrial raw water may be adopted by the industries as these are better, both in terms of quality and quantity of treated water, when compared to indigenous technology being currently employed.

Technology Status of Effluent Treatment Plants (ETP) in Various Industries

India has very few Industries which are able to meet the effluent quality requirements. The status of ETP's in various industries are as follows :

INDUSTRY	% of units which do not have ETPs
1. Synthetic fibres	50
2. Distilleries	6
3. Sugar	29.4
4. Pulp & Paper	22.4
5. Fertilizer	32.4

Almost all the oil refineries have ETPs or are in the process of acquiring them. Generally all oil refineries have primary treatment facilities.

Organised sector like steel have ETPs system but are not being maintained properly.

Petrochemical industry has a good system of ETPs.

The status of technology of ETPs is different for each industry, hence it is discussed industry wise.

1. Pulp and Paper Mill Industry

The effluent generated in this industry contains very high raw cellulosic material resulting in high levels of COD and colour. The pollutant load by small and medium paper mills is very high due to lack of commercially viable chemical recovery system. The paper making process calls for heavy use of water, which ultimately finds its way into the effluent.

In majority of the paper mills, the plant and machinery is very old and efforts for modernisation are totally lacking. This also causes the increase in the level of pollutants.

Recommendations

i) It is suggested that the following production process control technologies may be adopted in the Indian Pulp and Paper Industries to reduce effluent volume and pollutant load discharge.

- Cooling water segregation and recycle.
- Vacuum pump seal water collection and reuse.
- Evaporator surface condenser to replace barometric condenser to facilitate reuse of condensates.
- Evaporator boil-out tank for collection of weak black liquor for recycle to chemical recovery.
- Caustic area spill collections for recovery and recycle.
- Spill collection in the evaporator, recovery, causticising, liquor storage, brown stock, paper machine and bleach plant areas for recycle.
- Lime mud pond to reduce total suspended solid discharges in white liquor clarification and mud washing area.
- High pressure showers for wire and felt cleaning save 90 percent of the water used in conventional shower applications.
- Improvement in savealls by installing new vacuum disc savealls.
- White water storage for wire cleaning showers, pulp dilution and bleach plant washing.
- Rejects separation using sidehill screen from pulp and paper mill cleaners, pressure and centrifugal screens eliminates up to 40 percent of solids to the treatment plant from these sources separated, rejects fit for landfill disposal
- Oxygen bleach before caustic extraction in bleaching sequence, facilitates caustic extraction effluent recycle for chemical recovery. (Oxygen bleaching results in a BOD reduction of 81 percent and a colour reduction of 89-92 percent in bleach plant effluent and a BOD and colour reduction of 30 and 50 percent, respectively, in total mill effluent).

All the above technologies are being used in many of pulp and

paper industries abroad and have resulted in reducing the effluent volume and pollutant load discharge.

ii) In order to have a reasonable annual burden vis-a-vis the annual turnover by enhancing the economics of physico-chemical processes for colour removal, it is felt that :

   a) Technology gap may be bridged for better solid-liquid separation and recovery of chemicals from sludge produced during colour removal.

   b) R&D efforts for improving biodegradability of lignin through ozone or ultraviolet treatment or through genetically engineered micro organisms may be considered.

iii) Comprehensive assistance plan may be prepared to enable the paper mills, specially small and medium units to modernise their plant and machinery so as to minimise the effluent generation at various stages of production.

2. Pharmaceutical Industries

The problems of effluent treatment are generated mainly by the manufacturers of bulk drugs. The scale of pollution caused by the formulators is of less serious nature. The effluent treatment carried out by the manufacturers of bulk drugs becomes ineffective because of the following reasons :

a) The plant does not give desired results because of poor operation; maintenance and negligent attitude of the manufacturer.

b) The capacity and production of the bulk drugs has increased after installation of the ETP but the ETP has not been adequately expanded as required.

c) The characteristics of effluents have changed because of change in product line. However, ETP has not been modified for the changed effluent characteristics.

d) Inappropriate treatment is adopted for the nature of effluent proposed.

e) Effluent disposal is connected to storm water drainage system which ultimately pollutes the water bodies and ground water sources far away from the manufacturing unit.

Recommendations

i) Modification of outdated technology may be to achieve the pollution control standards.

sii) Proper treatment scheme may be adopted in the industry as it is specific to each plant and product. Government should make sure that the industries adopt these schemes.

iii) Any change in the product line and expansion may be linked with desired changes in ETP.

iv) The disposal of effluent discharge may be delinked from storm water drainage system.

v) The sedimentation tanks and evaporation beds should be properly lined to avoid the penetration of effluent in groundwater.

3. Steel Industry

Although the technology available in India for treatment of major pollutants from the industry namely, phenol, cyanide, ammoniacal nitrogen, BOD, COD, SS, Oil and Grease appears to be adequate to meet the MINAS standards, the improvements in technology to meet the developments in other countries is lacking specially in case of removal of cyanides and phenol.

Recommendation

i) Production process technology may be upgraded for reduction in volume of effluent generated and recycle of the effluent.

ii) R&D efforts may be required in the following areas:

a) Removal of cyanides by processes like
- Wet air oxidation.
- Ion exchange.
- Reverse osmosis.
- Biological methods by developing suitable cultures.

b) Removal of phenol by process like
- Biological methods by developing suitable cultures.
- Activated carbon treatment

4. Oil Refineries

The main components of effluent from oil refineries are sulphides, free and emulsified oils, chlorides, phenols, suspended solids and BOD. The existing refineries using once through cooling system are meeting MINAS more by dilution of effluent than treatment of the same

Only three refineries are at present having three stage treatment (Primary Oil Separation, Secondary Oil Separation and Biological

Treatment). The remaining nine refineries have only partial treatment facilities.

Recommendations

i) All the three stages of effluent treatment facilities may be adopted by all the refineries in the country.

ii) Indigenous technology may be upgraded in following areas:

   a) Free oil removal by corrugated plate interceptor (CPI) or better methods.

   b) Emulsified oil removal technology.

   c) Powdered activated carbon treatment (PACT) biological treatment.

   d) Wet air regeneration (WAR) technology for sludge treatment.

   This will also enable recycling of effluent.

5. Petrochemical Industry

The raw materials used, the processes adopted and the finished product range varies widely from unit to unit as also the character of the effluents in this sector. However, cooling tower blowdown may be considered as the major part of the effluent volume. At present chromate-phosphate method is adopted for cooling water treatment and disposal of chromium sludge formed in the process is creating problems. In addition to it, many units are not segregating water stream from effluent stream.

Recommendations

i) Technology utilisation and upgradation may be carried out in the following areas which may be applied alongwith waste stream segregation and recycle of water :

   a) Use of phosphinate/polymeric dispersant system for treatment of cooling water.

   b) Waste strength reduction through recovery of chemicals using modern technologies like

      - ultra filtration,
      - solvent extraction system,
      - absorption techniques employing polymeric adsorbants (XAD resins),
      - use of pure cultures and enzymes and development of micro-organisms for specific applications through Biotechnology and Genetic Engineering.

ii) Special R&D efforts may be taken in the field of Rotating Biological Reactors, Anearobic Reactors, Diffused Aeration process, etc. R&D centres may concentrate on applications of Biotechnology, develop them indigenously and build up the manufacturing capabilities.

6. Distilleries

In India, sugar is produced by using techniques not used elsewhere in the world. The characteristics of the molasses produced in India therefore are different in nature and the foreign technology cannot be directly adopted for effluent treatment in distilleries.

Spent wash, the main pollutant from distilleries, results in effluents having very high BOD (40000 - 50000 mg/l) and COD (8000 - 10000 mg/l). Though multiple stage treatment can reduce these levels, the commercially viable technology is not available to meet the standards laid down by pollution control boards.

Wherever biomethanation ETPs exist, the proper method of disposal of sludge generated is not taken care of.

Recommendations

The technology upgradation and R&D efforts are required in the following treatment methodologies:

i) Anaerobic biological treatment of spent wash with methane (biogas) generation employing one of the following technologies:
   - Diphasic fixed film anaerobic filter system.
   - Upflow anaerobic sludge blanket (UASB) process.
   - Anaerobic fluidised and expanded bed reactors.

ii) Incineration and potash recovery.

iii) Continuous alcohol fermentation technology may be given more prominence.

7. Sugar Industry

The sugar industries effluent is characterised by oil and grease, BOD, COD, suspended solids and pH requiring treatment. Unlike distilleries, the BOD level is not high and is about 1000-1500 mg/l. The effluent treatment technology is available in India to achieve MINAS standards.

Recommendations

i) Useful by-products may be recovered for enabling waste reduction at source:

   a) Baggase - used for fuel, paper, fibre particle boards and general purposes (like plastics, furfural etc.)

   b) Molasses - used for export, fertilizer, cattle feed , distillery and fermentation products (acetic acid, acetone, citric acid, yeast, glycerin etc.)

ii) R&D efforts may be carried out to select the most appropriate treatment technology considering environmental risks, institutional requirements, land requirements and process reliability to achieve MINAS based on capacity of unit. Options are the following :

   - Activated sludge process.
   - Extended aeration.
   - Aerobic lagoon.
   - Anaerobic treatment alone e.g. upflow or anaerobic sludge blanket (UASB) or diphasic anaerobic reactor or UASB followed by aerobic lagoon.

iii) It may be necessary to lay emphasis, give incentive and fix responsibility for proper working of Effluent Treatment Plant in sugar mills. Presently ETPs working depend mainly on initiative and drive of management of sugar mill, which may change quite often its interest towards working of ETP.

iv) The pollution control boards and suitable agricultural agencies may co-ordinate to judge the feasibility and PCB's may accordingly reverse standards for treated effluents, thus eliminating the need for putting costly ETP's and saving electric power.

8. Fertilizer Industry

The fertiliser industries use a wide spectrum of feedstock and produce a vast array of products. Thus, the effluent treatment scheme is specific to the products of the plant. The major pollutants are amongst ammonia, urea, phosphates, methanol, flourides, oil, cyanides, metals like vanadium, nickel, arsenic and chromium depending upon type of feedstock and product of the plant. The wastewater generated are in large quantities as large quantities of water is used for processes, steam production and cooling.

The technology is available for thermal hydrolyser stripper (removal of ammonia, urea), API oil separators and Biological chemical treatment of remaining pollutants to treat the effluents to MINAS standards

The problems related to control of pollution are more severe in case of old plants.

Recommendations

i) Efforts may be made to maximize tapping of the potential for recycling of process waters & cooling water by all the plants.

ii) The old fertiliser units, may be compelled to install the proper ETPs irrespective of the cost involved, and operate them efficiently. The cost may be subsidised after studying individual case for payback period.

9. Dyes and Dye-Intermediate Industry

Majority of the units manufacturing dyes and dye-intermediates are in the small and medium scale sectors, mostly in sheds created by various Industrial Development Corporations. They neither have independent space nor money for installation of ETPs

In addition to it, the treatability of the dyestuff effluents is difficult due to the presence of non-biodegradable components (inorganic salts, soluble azodyes) which contribute colour.

Recommendation

i) Primary treatment may be enforced in all manufacturing units.

ii) Common Secondary Effluent Treatment Plants may be developed. This may be financed either by the industries themselves or State Industrial Development Corporations aided suitably by State Governments.

iii) R&D centres may focus their efforts on the various options mentioned below for treating non-biodegradable components

a) *Chemical pretreatment to make the waste amenable to biological treatment :*

- Reduction of azo compounds with iron borings or sodium hydrosulphite.
- Oxidation of dyestuffs in the effluent by using sodium

hypochlorite, potassium permanganate and wet air oxidation.

b) *Bio-physical treatment:*

This primarily enables biological treatment for removal of organics and biodegradable substances in combination with adsorbants for trace color removal :

- aerobic biological treatment systems are well known and proven.
- powdered activated carbon treatment (PACT) technology (to be employed with above) needs to be studied, possibly with development of adsorbants other carbo.

c) *Membrane Technology*

This will require the development of specific membranes enabling segregation of dyestuff molecules characterised by large size and weights. However this will only segregate and concentrate the colour component which will require further treatment (e.g. incineration).

d) *Electrochemical treatment*

Generation of nascent chlorine as decolorising agent or use of iron electrodes to generate ferrous and ferric ions to precipitate the dyestuff is possible.

10. Tannery Industry

Like Dyes and Dye Intermediates, the Tanneries are also located mainly in small and medium scale sector. These units are having limited space for processing and limited funds. The multiplicity of the treatments involved makes the effluent complex in nature for the treatment

Recommendations

i) Primary treatment may be enforced in all manufacturing units.

ii) Common Secondary Effluent Treatment Plants may be developed. This may be financed either by the industries themselves or State Industrial Development Corporations aided suitably by State Governments

iii) R&D efforts may be directed towards recovery of useful by-products in Common Effluent Treatment Plants which will also

result in reducing pollution load thereby reducing the cost of treatment and generating extra revenue to compensate the operational cost in a limited way.

11. Pesticide Industry

Pesticide manufacturing and formulation involves a variety of chemicals and complex chemical processes, requiring installation of ETPs after study of likely effluents involved on case to case basis. However, the technologies indigenously available and those provided by the foreign collaborators are adequately meeting the standards set by PCBs.

There appears to be, however, scope for further development of biotechnology which is considered more environment friendly. There is also scope for updating the existing technologies which will help in reduction of raw materials consumed and minimise waste generation.

Recommendations

Transfer of technology may be considered in the following areas :

i) Pure culture for biological treatment.

ii) Process control technologies which might further effect waste minimization as it is expected to lead to lower waste generation.

12. Domestic Effluent Treatment in Class -I Cities

Sewage generation, collection and treatment are the major parameters to be considered for the assessment of pollution from the domestic sector. 45 cities generating more than 50 million litres of effluent per day and contributing 78% of total effluent generated from 212 class -I cities have been identified as major domestic pollution generating cities. Out of 48 cities who responded on the existence of effluent treatment facilities, 20 have only primary treatment facilities, 15 have partial primary and partial secondary facilities and 13 have secondary treatment facilities.

Recommendation

i) Adequate collection, treatment and disposal of municipal wastewaters may be provided for class-I cities.

ii) Major wastewater generating Class-I cities may be taken up on priority basis to treat their wastewaters before discharging into the rivers and water bodies.

iii) The other Class-I cities irrespective of size which are discharging

directly or indirectly in the water coarse may be taken up at second stage.

iv) Use of treated municipal wastewater may be encopuraged for irrigation.

13. Equipment Manufacturers

Majority of the equipments required for effluent treatment can be manufactured in India. In keeping with the market requriements the manufacturers on their own seek to import technology. Approximately 56% (14 out of 25 manufacturers contacted) have foreign collaborations. Following are the areas where import of state of art technology may be required:

a) Solid-liquid separation including ultrafiltration especially for paper and petrochemical industries.

b) Free and emulsified oil separation especially for oil refineries.

c) Reverse Osmosis and membranes especially for paper and pulp, steel, dyestuff industries.

d) Polymeric adborsants especially for petrochemical industries.

e) Ozoniser for oxidation or disinfection purposes especially water treatment, dyestuff, pharmaceuticals, petrochemical industries etc.

f) Ultraviolet treatment for breaking chemical bonds and disinfection

g) Solvent extraction in petrochemical industries.

h) Phosphonate or polymeric dispersants in cooling water treatment.

i) Electrochemical treatment for dyestuff degradation.

j) Powdered activated carbon treatment (PACT) as concurrent treatment with biological systems especially in oil refineries, dyestuff industries etc.

k) Anaerobic biological treatment technologies like diphasic reactors, upflow anaerobic sludge blank (USAB) reactors etc.

l) Wet air oxidation especially for making certain compounds amenable to biological treatment as in steel, dyestuff, oil refineries.

m) Genetically engineered cultures viz biotechnology for treatment of specific pollutants like oil, phenol, pesticides, lignin, cyanides, etc.

n) Incineration for hazardous waste or very strong wastes.

Recommendations

i) The effluent treatment equipment manufacturers may be encouraged to import the state of art technology in the fields where sufficient know-how does not exist.

ii) Added to above it is also desired that in order to provide incentives to user industries to obtain state-of-art technology for pollution control, some financial benefits could be provided, set-up information dissemination centres, and make available commercially the R&D progress of national institutions.

iii) A databank of all the good/bad ETP's industrywise may be set up so that the equipment manufacturers can rectify the faults which occur in their equipments when operating under different loadings and throughput conditions.

iv) Since in the design of effluent treatment plants, variation in the form of waste characteristics and flow results in demand of equipment of various capacities and sizes, equipment manufacturers need to make an effort for manufacturing versatile equipments with wide capacity ranges.

R&D ORGANISATIONS

The role of R&D organisation, both government institutions as well as in-house set-ups, has to play a continuing role to achieve the following :

- Upgradation of production process control technology.
- Innovation in effluent treatment system design especially biotechnology.
- Development of indigenous self reliance for imported technology by way of absorbing the state-of-art technology and building up of manufacturing capabilities.

The upgradation of production process control technology has the most vital role because it results in efficiency in production with concurrent waste reduction at source (reuse, recycle, reduced losses etc).

CONSULTANCY ORGANISATIONS

The role of consultancy organisations perhaps has an equally crucial role due to the far reaching influence it can have on the developments. Information availability being the most crucial input, the consultancy organisations can play a pivotal role to

- Assimilate state-of-art knowledge through personnel development, world wide contacts developed through seminars, conferences, product and technology information exchange etc.
- Provide a link between user industries with both, manufactures and R&D organisations.
- Identify need for improvements in process technologies, treatment technologies, equipment performance.
- Advise government on policy and planning matters.

It is further recommended that consultancy organisations may develop data base regarding technologies and results achieved during operations and maintenance of Effluent Treatment Plants.