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Optimizing The Industrial Wastewater Treatment and Management.

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Optimize your treatment system, minimize your costs, maintain compliance

Advanced Cost Effective technology and practices to treat toxic wastewater pollutants

Advanced treatment processes are normally applied to industrial wastewater only, for removal of specific contaminants. Advanced treatment is commonly preceded by physicochemical coagulation and flocculation. Where a high quality effluent may be required for protection of public sewerage system containing sensitive biological treatment plants, wastewater reuse options and sludge used as fertilizer where the occurrence of toxic materials should not be present.

Advanced treatment steps may also be added to the conventional treatment plant.

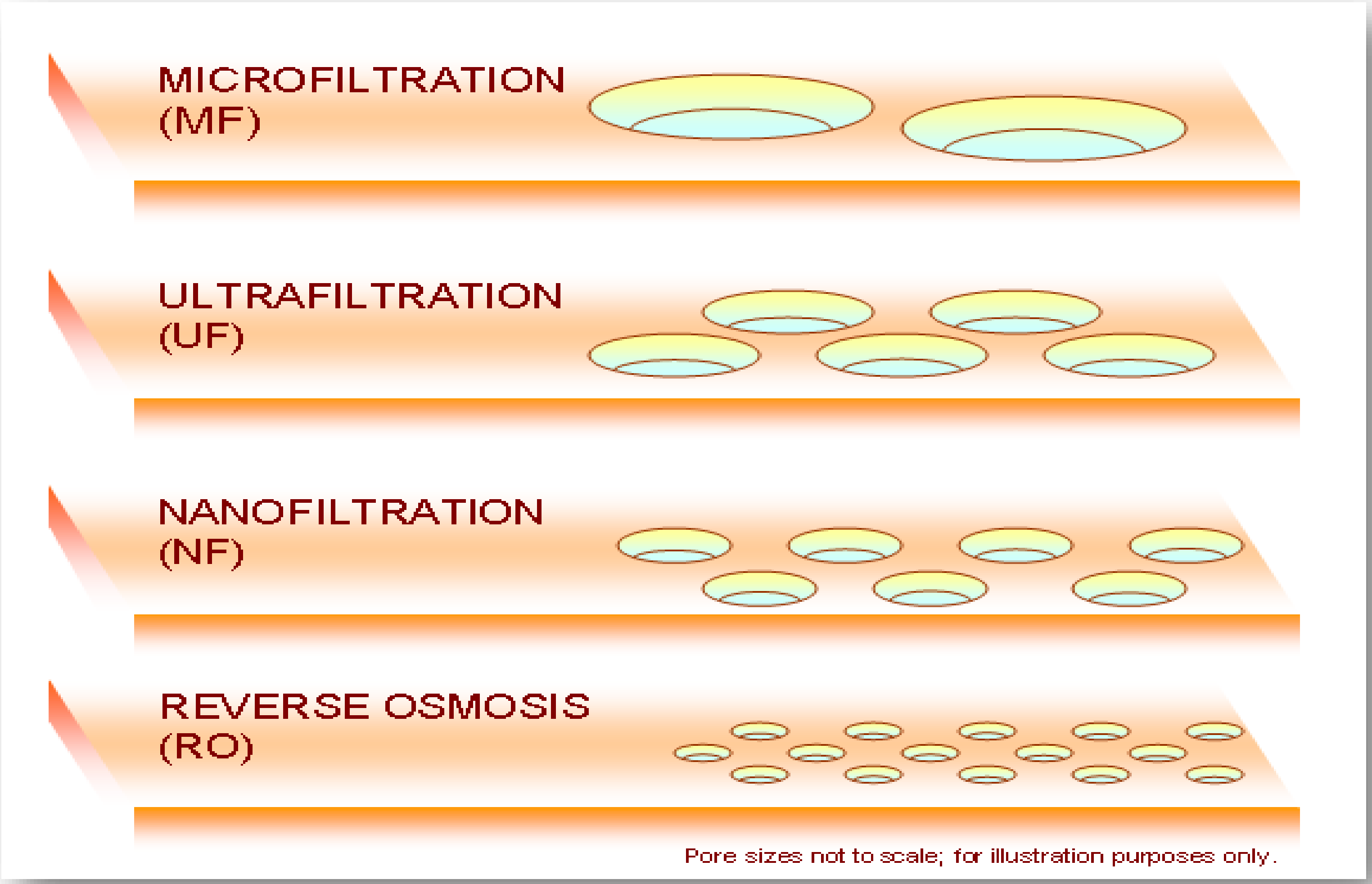
ADVANCED COST EFFECTIVE TECHNOLOGIES

1. Membrane filtration technologies

Membrane filtration can be broadly defined as a separation process that uses semi permeable membrane to divide the feed stream into two portions: a permeate that contains the material passing through the membranes, and a retentive consisting of the species being left behind.

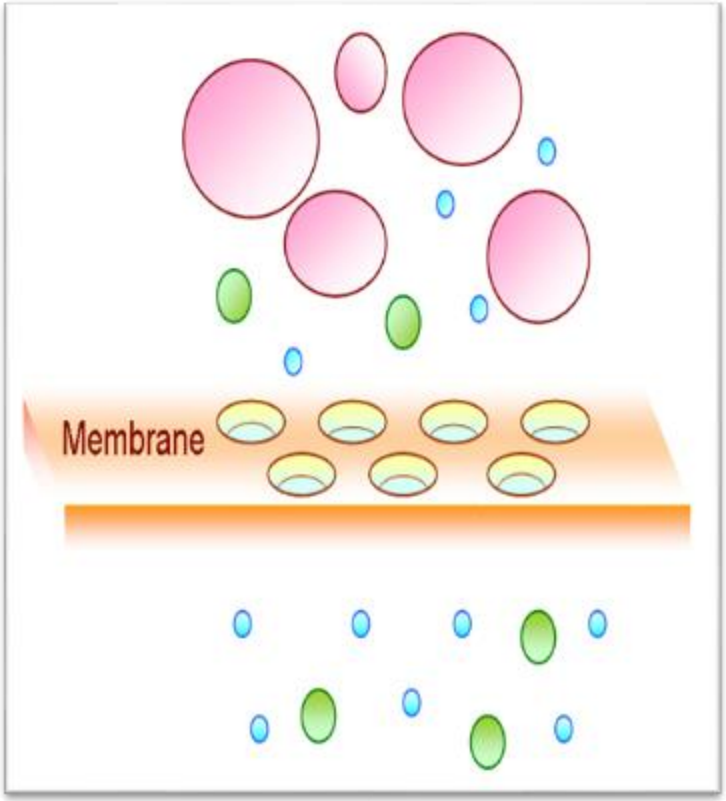
More specifically, membrane filtration can be further classified in terms of the size range of permeating species, the mechanisms of rejection, the driving forces employed, the chemical structure and composition of membranes, and the geometry of construction.

The most important types of membrane filtration are pressure driven processes including **microfiltration (MF)**, **ultrafiltration (UF)**, **nanofiltration (NF),** and **reverse osmosis (RO).**


MICROFILTRATION (MF)
ULTRAFILTRATION (UF)
NANOFILTRATION (NF)
REVERSE OSMOSIS (RO)
Pore sizes not to scale; for illustration purposes only.

1.a. Ultra filtration/Nanofiltration.

Water is forced through semi permeable membranes that filter out very small particulates (ultra filtration) and dissolved molecules (nanofiltration). Nanofiltration retains these compounds on the membrane both through hydrophobic adsorption and size exclusion, while ultra filtration retention is typically due to hydrophobic adsorption. However, these systems foul quickly when used on wastewater systems, and are reserved for use in drinking water treatment. These techniques are also highly effective for the removal of pathogens.

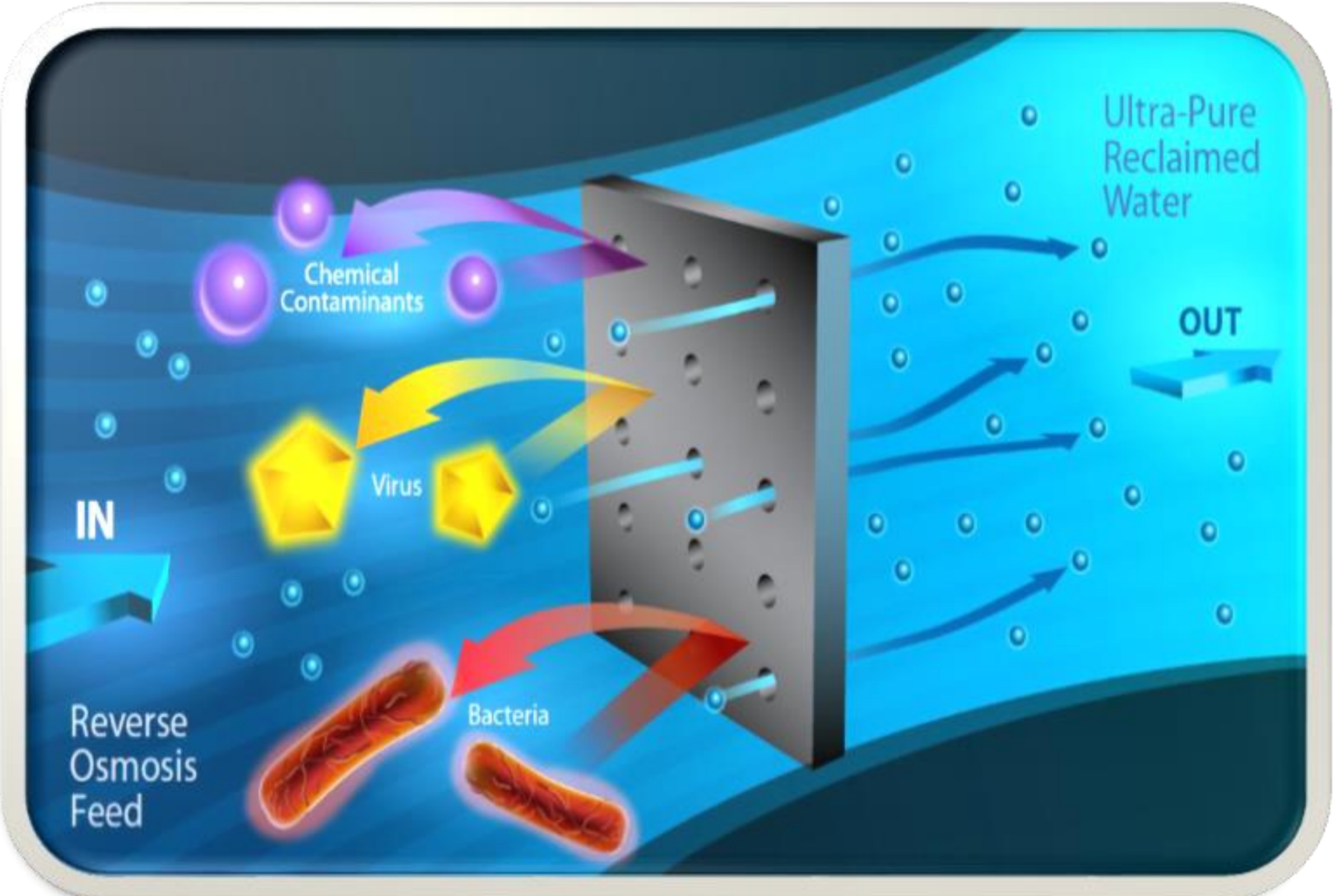


1.b. Reverse Osmosis.

Reverse osmosis is a membrane separation technology used by industrial facilities as an in-process step or as an end-of-pipe treatment.

In an end-of-pipe application, reverse osmosis typically recycles water and reduces discharge volume rather than recovers chemicals. The effluent from a conventional treatment system generally has a TDS concentration unacceptable for most rinsing operations, and cannot be recycled.

Reverse osmosis with or without some pretreatment can replace TDS concentrations, and the resulting effluent stream can be used for most rinsing operations.


Ultra-Pure
Reclaimed
Water
Chemical
Contaminants
OUT
Virus
IN
Bacteria
Reverse
Osmosis
Feed

2. Granulated Activated Carbon (GAC).

Water is passed through a bed of activated carbon granules that adsorb contaminants. GAC has been shown to be very effective at removing many pharmaceuticals, except for clofibric acid.

Competition with organic matter in WWTP effluent for sorption sites can reduce EDC and PPCP removal rates. EDC and PPCP removal depends on the solubility of the compounds – more soluble, polar compounds are not removed efficiently.

Powdered activated carbon has greater efficiencies of removal for some pharmaceuticals, but is typically used in episodically to treat a specific situation.

3. Advanced oxidation technologies

Advanced oxidation processes (AOPs) have been broadly defined as near ambient temperature treatment processes based on highly reactive radicals, especially the hydroxyl radical (·OH), as the primary oxidant.

The ·OH radical is among the strongest oxidizing species used in water and wastewater treatment and offers the potential to greatly accelerate the rates of contaminant oxidation.

AOPs can be broadly defined as redox methods which are based on the intermediacy ofreactive oxygen species, such as hydroxyl radicals, •OH, superoxide radical anions, O2 •-, and perhydroxyl radicals HO2 •, to convert harmful organic and inorganic pollutants found in air, water and soil to less hazardous compounds. The most widely used AOPs include ozonation, electrochemical oxidation, Fenton's and photo-Fenton's reagent, heterogeneous semiconductor photocatalysis, wet air oxidation, and sonolysis, among others2. A brief description of these technologies is given below.

a. Ozonation

Is an attractive and a well established technology for wastewater reuse purposes. We studied the ozonation of pharmaceuticals in wastewater from the secondary clarifier of urban and domestic STPs by using alkaline ozone and a combination of ozone and hydrogen peroxide.

Alkaline ozonation achieved only a moderate degree of mineralization essentially concentrated during the first few minutes; but the addition of hydrogen peroxide eventually led to a complete mineralization

b. Electrodialysis

Electrodialysis is a process in which dissolved colloidal species are exchanged between two liquids through selective semipermeable membranes (11). The technology applies a direct current across a series of alternating anion and cation exchange membranes to remove dissolved metal salts and other ionic constituents from solutions.

By using the electrodialysis cell, facilities remove impurities from the process bath, extending its life. Facilities can treat the removed concentrate stream on-site, or haul it off-site for disposal, treatment, or metals reclamation.

c. Electrolytic Recovery

Electrolytic recovery is an electrochemical process used to recover metal contaminants from many types of process solutions and rinses, such as electroplating rinse waters and baths.

Electrolytic recovery removes metal ions from a waste stream by processing the stream in an electrolytic cell, which consists of a closely spaced anode and cathode. Equipment consists of one or more cells, a transfer pump, and a rectifier.

Current is applied across the cell and metal cations are deposited on the cathodes. The waste stream is usually recirculated through the cell from a separate tank, such as a drag-out recovery rinse.

d. Ion Exchange (in-process)

Ion exchange is a reversible chemical reaction that exchanges ions in a feed stream for ions of like charge on the surface of an ion-exchange resin. Resins are broadly divided into cationic or anionic types. Typical cation resins exchange H^+ for other cations, while anion resins exchange OH^- for other anions (10).

Choosing the right technology for the industry to meet discharge limits of the local sewer

Technology selection eventually depends upon industrial wastewater characteristics and on the treatment objectives as translated into desired effluent quality.

Criteria that influence selection of the wastewater treatment process:

- Reliability
- Resistance to hydraulic shocks
- Resistance to organic loading shocks
- Coordination with local climate

Criteria that influence selection of the wastewater treatment process:

- Flexibility in operation
- Simple in operation and maintenance
- Capital cost
- Land requirement

Criteria that influence selection of the wastewater treatment process:

- Operation and maintenance cost
- Sludge disposal cost
- Reach to treatment degree requirement

Criteria that influence selection of the wastewater treatment process:

- Odor generation
- Risk
- Amount of sludge generation
- Environment impacts

Final choice in technology selection is usually dictated by that technology capable of achieving compliance with regulatory codes at the lowest uniform annual cost (amortized capital investment plus operation and maintenance costs).

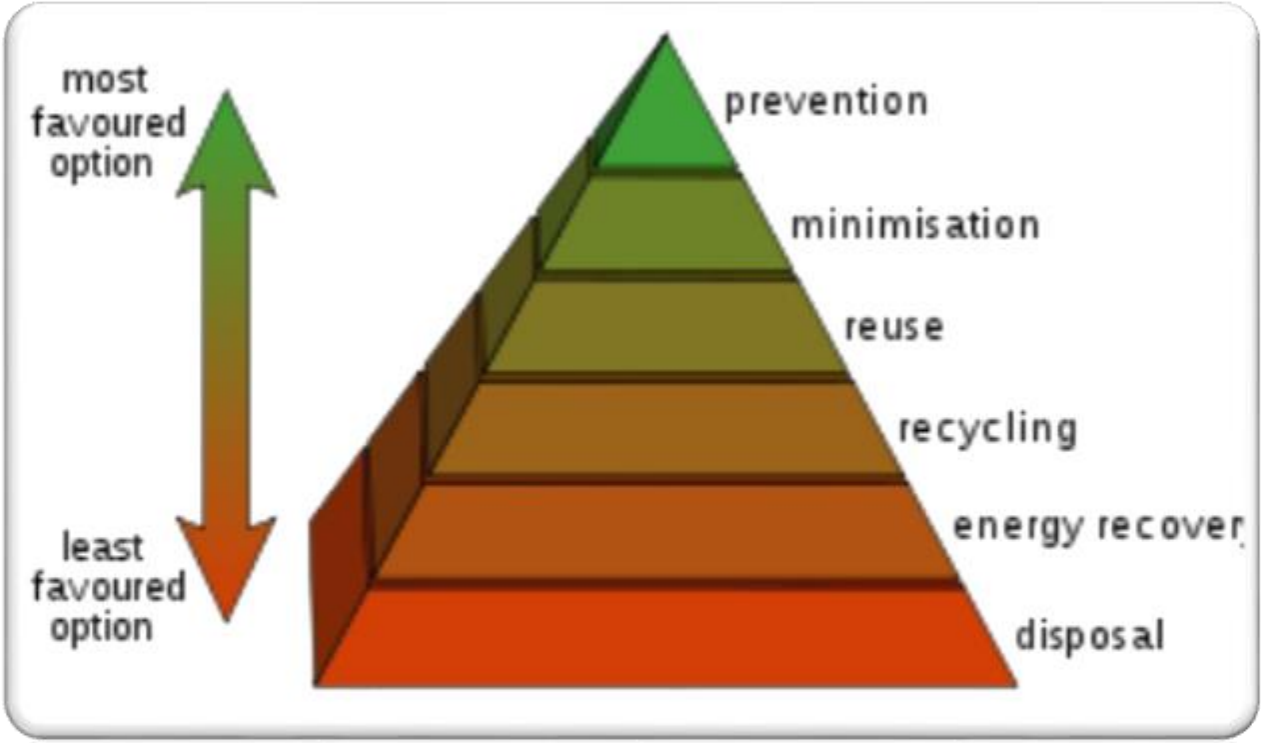
Using environment-friendly technology to minimize the amount and toxicity of the industrial waste generated.

The suitable environment-friendly technology selection to minimize the amount and toxicity of the industrial waste generated depends on the manufacturing operations generating the wastewater

WASTE WATER MANAGEMENT HIERARCHY

A logical waste management hierarchy would be based on the principal that pollution should be prevented or reduced at the source wherever feasible, while pollutants that cannot be prevented should be recycled in an environmentally safe manner. In the absence of feasible prevention or recycling opportunities, pollution should be treated. Disposal or other release into the environment should be used as a last resort.

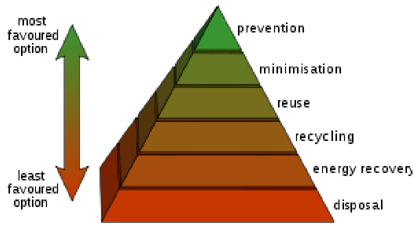
Waste Water hierarchy



Recent and Preferable friendly options the most economical, feasible and environmental sound for industries minimizing toxicity of the industrial waste

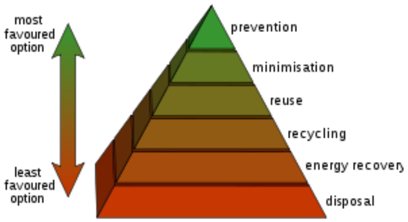
1. Pollution prevention

The pollution prevention practices and wastewater treatment technologies are used to prevent the generation of wastewater pollutants and reduce the discharge of wastewater pollutants.



Pollution Prevention is generally defined as any in-plant process that reduces, avoids, or eliminates the use of toxic materials and/or the generation of pollutants and wastes so as to reduce risks to human health and the environment and to preserve natural resources through greater efficiency and conservation. The goal of pollution prevention is to minimize environmental risks by reducing or eliminating the source of risk (rather than reactively through treatment and disposal of wastes generated).

There are significant opportunities for industry to reduce or prevent pollution at the source through cost-effective changes in production, operation, and raw materials use. The opportunities for source reduction are not often realized because existing environmental regulations, and the industrial resources they require for compliance focus upon treatment and disposal, rather than source reduction. Source reduction is different and more desirable than waste management and pollution control.



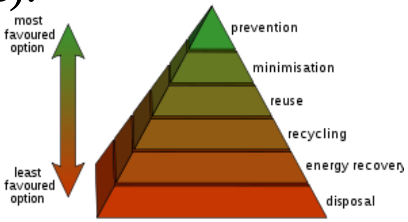
pollution prevention measures include the following:

a. Training and Supervision

Training and supervision ensure that employees are aware of, understand, and support the company's pollution prevention goals. Effective training programs translate these goals into practical information that enables employees to minimize waste generation by properly and efficiently using tools, supplies, equipment, and materials.

b. Production Planning

Production planning can minimize the number of process operation steps and eliminate unnecessary procedures (e.g., production planning can eliminate additional cleaning steps between process operations).



c. Process or Equipment Modification

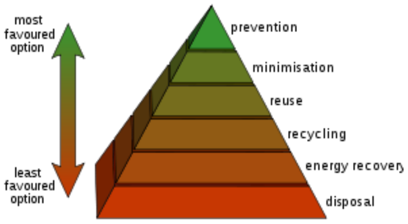
Facilities can modify processes and equipment to minimize the amount of waste generated (e.g., changing rack configuration to reduce drag-out).

d. Raw Material and Product Substitution or Elimination

Where possible, facilities should replace toxic or hazardous raw materials or products with other materials that produce less waste and less toxic waste (e.g., replacing chromium-bearing solutions with non-chromium-bearing and less toxic solutions, or consolidating types of cleaning solutions and machining coolants).

e. Loss Prevention and Housekeeping

Loss prevention and housekeeping includes performing preventive maintenance and managing equipment and materials to minimize leaks, spills, evaporative losses, and other releases (e.g., inspecting the integrity of tanks on a regular basis; using chemical analyses instead of elapsed time or number of parts processed as the basis for disposal of a solution).

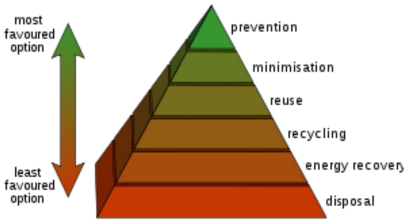


f. Waste Segregation and Separation

Facilities should avoid mixing different types of wastes or mixing hazardous wastes with nonhazardous wastes. Similarly, facilities should not mix recyclable materials with noncompatible materials or wastes. For example, facilities can segregate scrap metal by metal type, separate cyanide-bearing wastewater for preliminary treatment, and segregate coolants for recycling or treatment.

g. Closed-Loop Recycling

Facilities can recover and reuse some process streams. For example, some facilities can use ion exchange to recover metal from electroplating rinse water, reuse the rinse water, and reuse the regenerant solution as process solution make-up.



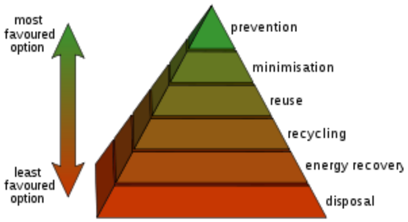
2. Source Reduction

Source reduction is defined as any method that reduces or eliminates the source of pollution entirely. This includes any practice that:

. Reduces the amount of hazardous substances, pollutants, or contaminants entering a waste stream or otherwise released into the environment prior to recycling, treatment, or disposal; and

. Reduces hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

The term source reduction includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control.



Advantages of Source reduction

Instituting management and personnel programs such as employee training or employee incentive programs that encourage employees to reduce waste.

Performing good material handling and inventory control practices that reduce loss of materials due to mishandling, expired shelf life, or improper storage.

Preventing loss of materials from equipment leaks and spills. Segregating hazardous waste from non-hazardous waste to reduce the volume of hazardous waste disposed.

Advantages of Source reduction

Using standard operating procedures for process operation and maintenance tasks

Performing preventative maintenance checks to avoid unexpected problems with equipment.

Turning off equipment when not in use.

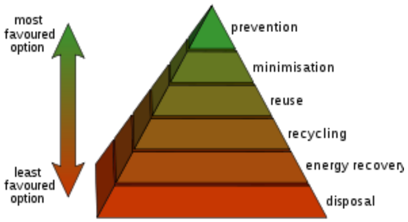
Improving or increasing insulation on heating or cooling lines.

Using drip pans and splash guards.

Environmentally Sound Reuse and Recycling

SOURCE CONTROL METHODS

1. Process Changes
2. Material Substitution
3. Material Inventory and Storage
4. Waste segregation
5. Good housekeeping/Preventive Maintenance/Employee Education
6. Product changes
7. Water and energy conservation
8. Recycling/waste exchange



Preferable technologies

1. Zero Exhaust Technology

Zero waste is an integrated system approach that aims to eliminate rather than only manage waste.

- **Zero waste is an Targeting the whole system means striving for:**

- **Zero waste of resources: Energy, Materials, Human;**

-

- **Zero emissions: Air, Soil, Water;**

Zero waste is an Targeting the whole system means striving for:

- **Zero waste in activities: Administration, Production;**
- **Zero waste in product life: Transportation, Use, End of Life; and**
- **Zero use of toxics: Processes and Products.**

2. Clean Production Technology

‘Cleaner Production is the continuous application of an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency, and reduce risks to humans and the environment. Cleaner Production can be applied to the processes used in any industry, to products themselves and to various services provided in society.

Implementation of cleaner production measures to reduce the quantity and quality of the generated toxic and industrial waste water

Good housekeeping

Input substitution with less toxic materials or renewable materials

Better process control

Equipment modification

Technology change

On site recovery/re-use

Production of useful by-products

Product modifications

Cleaner Production results from one or a combination of conserving raw materials, water and energy; eliminating toxic and dangerous raw materials; and reducing the quantity and toxicity of all emissions and wastes at source during the production process.

Cleaner Production aims to reduce the environmental, health and safety impacts of products over their entire life cycles, from raw materials extraction, through manufacturing and use, to the 'ultimate‘ disposal of the product.

Where practical, waste should be minimized (using cleaner production protocols and recycling techniques to a maximum practical extent) before consideration is given to allowing any discharge into the environment/disposal in the most environmentally acceptable manner. Some waste may require disposal at an authorized disposal site.

Some of the benefits for adopting cleaner production practices include a reduction in expenditure for packaging, energy, waste treatment or disposal, water and materials, increased employee environmental awareness and an improved public perception of the business.

Improving chemical wastewater treatment plant efficiency and environmental compliance

In most of the time, waste water treatment plants are operated without optimization. It is normally thought that optimization is unnecessary as the system is already designed to meet our requirements. However, this is not the case. Design always has some operating margin for taking care of performance degradation.

Further, waste water treatment plant design is based on the results obtained for a set of samples collected for a short time duration. The quality of waste water being treated may be significantly different from the design, and it is always essential that any waste water treatment facility is optimized after successful commissioning of the plant.

This ensures that all the machines do perform well so that the treated water quality is to the expected level.

Optimization of Existing Chemical Precipitation Treatment System

Facilities can optimize the performance of an existing chemical precipitation and clarification system using a variety of techniques such as adding equalization prior to treatment, conducting jar testing to optimize treatment chemistry, upgrading control systems, and providing operator training.

1. Equalization

Equalization is simply the damping of flow and concentration variations to achieve a constant or nearly constant wastewater treatment system loading (8). Equalization improves treatment performance by providing a uniform hydraulic loading to clarification equipment, and by damping mass loadings, which improves chemical feed control and process reliability. MP&M facilities implement equalization by placing a large collection tank ahead of the treatment system. All process water and rinse water entering this tank are mixed mechanically and then pumped or allowed to gravity flow to the treatment system at a constant rate. The size (volume) of the tank depends on the facility flow variations throughout the day. Operating data collected during MP&M sampling episodes indicate hydraulic residence times for equalization tanks average 4 to 6 hours.

2. Jar Testing

The purpose of jar testing is to optimize treatment pH, flocculent type and dosage, the need for co precipitants such as iron or polymers , and solids removal characteristics. Facilities should conduct jar testing on a sample of their actual wastewater to provide reliable information.

3. Control System Upgrades

Typical treatment system controls at MP&M facilities includes pH and ORP controllers on alkaline chlorination systems for cyanide destruction, pH controllers on chemical precipitation systems, flow and level monitoring equipment on equalization tanks, and solonoid valves and metering pumps on chemical feed systems to provide accurate treatment chemical dosing. A number of MP&M facilities have computer hardware and software to monitor and change treatment system operating parameters. For a number of MP&M facilities, upgrading control equipment may reduce both pH and ORP swings caused by excess chemical dosing, resulting in consistent effluent metals concentrations.

4. Operator Training

Having operators trained in both the theory and practical application of wastewater treatment is key to ensuring the systems are operating at their best. Many MP&M facilities send their operators to off-site training centers while others bring consultants familiar with their facility's operations and wastewater treatment system to the facility to train operators. Some of the basic elements of an operator training course should include (1):

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