



NATIONAL PETROCHEMICAL COMPANY
STANDARDS

ENGINEERING STANDARD
FOR
WASTE TREATMENT & DISPOSAL
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INTRODUCTION

Industrial effluents are divided into three categories:

- Solid effluents
- Liquid effluents
- Gas effluents

Herein wastewater effluent specifications are considered.

Con-taminants in wastewater to be removed by physical, chemical or biological means (Means of treatment in which the application of physical forces predominate known as unit operation, such as screening, mixing, sedimentation and so on. Means of treatment in which the removal of contaminants brought by the addition of chemicals or by biological activity known as unit processes. Precipitation, combustion and biological oxidation are examples of unit processes). Unit operations and processes which should be commonly used in wastewater treatment are listed in table 1. Maximum permissible concentration of contaminants in effluents according to Iranian Environment Organization's regulation listed in attachment 1.

TABLE 1:UNIT OPERATIONS, UNIT PROCESSES, AND SYSTEMS FOR WASTEWATER TREATMENT

CONTAMINANT	UNIT OPERATION, UNIT PROCESS, OR TREATMENT SYSTEM
Suspended Solids	Sedimentation
	Screening and comminution
	Filtration
	Flotation
	Chemical-polymer addition
	Coagulation/sedimentation Land treatment systems



TABLE 1: (CONTINUED)

CONTAMINANT	UNIT OPERATION, UNIT PROCESS, OR TREATMENT SYSTEM
Biodegradable organics	Activated-sludge variations Fixed-film: trickling filters Fixed-film: rotating biological contactors Lagoon and oxidation pond variations Intermittent sand filtration Land treatment systems Physical-chemical systems
Pathogens	Chlorination Hypochlorination Ozonation Land treatment systems
Nutrients: Nitrogen	Suspended-growth nitrification and denitrification variations Fixed-film nitrification and denitrification variations Ammonia stripping Ion exchange Breakpoint chlorination Land treatment systems
Phosphorus	Metal-salt addition Lime coagulation/sedimentation Biological-chemical phosphorus removal Land treatment systems
Refractory organics	Carbon adsorption Tertiary ozonation Land treatment systems

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TABLE 1:(CONTINUED)

CONTAMINANT	UNIT OPERATION, UNIT PROCESS, OR TREATMENT SYSTEM
Heavy metals	Chemical precipitation Ion exchange Land treatment systems
Dissolved inorganics solids	Ion exchange Reverse osmosis Electrodialysis

PHYSICAL UNIT OPERATIONS

DRYING

Drying shall be done under the following methods.

Flash Drying

Sludge shall be pulverized in a cage mill or by an atomized suspension technique in the presence of hot gases. The equipment should be designed so that the particles remain in contact with the turbulent hot gases long enough to accomplish mass transfer of moisture from sludge to the gases.

Rotary Dryers

In rotary dryers the material being dried shall be in contact with hot gases, or hot gases shall be separated from the drying material by steel shells or hottest gases shall surround a central shell containing the material.

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2.2 ELUTRIATION

The operation shall consist of' intimately mixing a solid, or a solid-liquid mixture, with a liquid for the purpose of transferring certain component to the liquid.

2.3 FLOCCULATION

After adding chemicals to a chemical precipitation system, stirring or agitation should be performed to increase flocculation. Flocculation should promote by gentle stirring with slow moving paddles. Agitation should be carefully controlled so that the floc particles will be of suitable size and will settle readily.

2.4 FLOTATION

In flotation unit operation, separation should be brought about by introducing fine gas (usually air) bubbles into liquid phase. To remove suspended matter and to concentrate biological sludges, flotation should be used. Once the particles have been flatted to the surface, they should be collected by a skimming operation.

Chemicals shall be used to aid the flotation process. Inorganic chemicals, such as the aluminum and ferric salts and activated silica, shall be used to bind the particulate matter together.

Air bubbles should be added or caused to form in one of the following methods:

2.4.1 Air Flotation

Air bubbles should be formed by introducing the gas phase directly into the liquid phase through a revolving impeller or through diffusers.

2.4.2 Dissolved Air Flotation

Air shall be dissolved in the wastewater under a pressure of several atmospheres, followed by release of the pressure to the atmospheric level. In small pressure systems, pressurizing shall be furnished by means of a pump to 2.5 to 3.5 (kg/cm²)g with compressed air added at the pump suction. In the larger units, a portion of the effluent (15 to 120 percent) shall be recycled, pressurized, and semisaturated with air.

2.4.3 Vacuum Flotation

Wastewater shall be saturated with air either directly in an aeration tank or by permitting air to enter on the suction side of a sewage pump.

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The unit shall consist of a covered cylindrical tank in which a partial vacuum is maintained. The tank shall be equipped with scum- and sludge- removal mechanisms. Auxiliary equipment shall be an aeration tank for saturating the wastewater with air, a short-period detention tank for removal of large air bubbles, vacuum pumps, and sludge and scum pumps.

2.5

SCREENING

Suspended particles greater than 6 mm should be removed by screening. A screen should have openings of uniform size of any shape. The screening element should consist of parallel bars, rods or wires, wire mesh, grating or perforated plate. Coarse screens should have openings of 6 mm or more. Fine screens should have openings of less than 6 mm.

2.6

SEDIMENTATION

The separation of suspended particles heavier than water by gravitational settling shall be used for grit removal, particulate-matter removal in the primary settling basin, biological-floe removal in the activated-sludge settling basin, chemical-floe removal when the chemical coagulation process is used, and for solid concentration in sludge thickeners. In the design of sedimentation basins, due consideration should be given to production of both a clarified effluent and a concentrated sludge.

2.7

MIXING

Chemicals should mix with sludge before vacuum filtration. Liquid mixing can be carried out in the following ways:

- In hydraulic lumps in open channels
- In venturi flumes
- In pipe lines
- In pumps
- In vessels with the aid of mechanical means.

2.8

VACUUM FILTRATION

By vacuum filtration, water content should be reduced so that the proportion of solids increases from 5 to 10 percent to about 30 percent. Vacuum filtration shall be accomplished on cylindrical drum filters. These drums shall have a filter medium, which may be a cloth of natural or synthetic fibers, coil springs, or a wire-mesh fabric.

3 CHEMICAL UNIT OPERATIONS3.1 ACTIVATED CARBON

Organic compounds that cause odor in water should be removed by activated carbon. Size of active carbon can be classified as powdered and granular. The diameter of powdered carbon should be less than 200-mesh. The diameter of granular carbon should be greater than 0.1 mm.

3.2 CHEMICAL PRECIPITATION

Clear effluent should be obtained by chemical precipitation. From 80 to 90 percent of total suspended matter, 50 to 55 percent of the total organic matter, and 80 to 90 percent of the bacteria should be removed by chemical precipitation. The most common chemicals are listed in table 3.1.

TABLE 3.1

CHEMICAL	FORMULA
Alum	$Al_2(SO_4)_3 \cdot 18H_2O$
Ferrous sulfate (copperas)	$FeSO_4 \cdot 7H_2O$
Lime	$Ca(OH)_2$
Sulfuric acid	H_2SO_4
Sulfur dioxide	SO_2
Ferric chloride	$FeCl_3$
Ferric sulfate	$Fe_2(SO_4)_3$

3.3 DISINFECTION

When all of the disease-causing organism are not destroyed during the process, disinfection should be used.

In wastewater treatment, disinfection should be accomplished through the use of : chemical agents, physical agents, mechanical means, and radiation.

3.3.1 Chemical Agents

Chemical agents that should be used as disinfectant include: alcohols, iodine, chlorine and its compounds, bromine, ozone, dyes, soaps and synthetic detergents, quaternary ammonium compounds, hydrogen peroxide and various alkalis and acids.

Characteristics of an ideal chemical disinfectant is shown in table 3.2.

TABLE 3.2: CHARACTERISTICS OF AN IDEAL CHEMICAL
DISINFECTANT

CHARACTERISTIC	REMARKS
Toxicity to micro-organism	Should have a broad spectrum of activity of high dilution:
Solubility	Must be soluble in water or cell tissue
Stability	Loss of germicidal action on standing should be low
Nontoxic -to higher forms of life	Should be toxic to organisms and nontoxic to man and other animals
Homogeneity	Solution must be uniform in composition
Interaction with extraneous material	Should not be absorbed by organic matter
Toxicity at room temperature	Should be effective in environmental temperature range
Penetration	Should have the capacity to penetrate through surfaces
Noncorrosive and nonstaining	Should not disfigure metals or stain clothing
Deodorizing ability	Should deodorize while disinfecting
Detergent capacity	Should have cleansing action to improve effectiveness of disinfectant
Availability	Should be available in large quantities and reasonably priced

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3.3.2

Mechanical Means

Typical removal efficiencies for various treatment processes are listed in table 3.3 .

TABLE 3.3: REMOVAL OR DESTRUCTION OF BACTERIA BY
DIFFERENT TREATMENT PROCESSES

PROCESS	PERCENT REMOVAL
Coarse screens	0-5
Fine screens	10-20
Grit chambers	10-25
Plain sedimentation	25-75
Chemical precipitation	40-80
Trickling filters	90-95
Activated sludge	90-98
Chlorination of treated sewage	98-99

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BIOLOGICAL UNIT OPERATIONS

In biological treatment of waste water the objectives shall be coagulated and remove the nonsettleable colloidal and stabilize the organic matter. For industrial waste water, the objective shall be removed or reduce the concentration of organic and inorganic compounds. Because many of these compounds are toxic to microorganisms, pretreatment may be required.

The sanitary engineer should be familiar with the characteristics of the following microorganisms because of their importance in biological treatment processes:

Bacteria, fungi, algae, protozoa, rotifers, crustaceans and viruses. General classification of microorganisms by sources of energy and Carbon is shown in table 4.1.

TABLE 4.1: GENERAL CLASSIFICATION OF MICROORGANISMS
BY SOURCES OF ENERGY AND CARBON

Classification	Energy source	Carbon source
Autotrophic:		
Photosynthetic	Light	CO ₂
Chemosynthetic	Inorganic oxidation-reduction reaction	CO ₂
Heterotrophic	Organic oxidation-reduction reaction	Organic