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Industrial Waste Water Treatment Notes pdf Details Unit-1 Sources of Industrial Waste, Characteristics of the Industrial Wastes, Inorganic salts, Acids and Alkalis, Organic matter, Suspended solids, Floating Solids and liquids, Heated Water, Colour, Toxic chemicals, Microorganisms, Industrial wastewater means used up water from industries. Unit-2 Waste Reduction Alternatives, Volume Reduction, Classification of Wastes, Conservation Of wastewater, Changing Production to Decrease Wastes, Re-Using Both Industrial and Municipal Effluents for Raw Water supplies, Elimination of Batch or Slug Discharge Of Process Wastes. In general Industrial Waste Water Treatment Notes pdf – IWWT notes pdf Details Unit-3 Sludge Lagooning, Removal of Organic Dissolved Solid, Lagooning, Phosphorus Removal, Phosphorus in wastewater, Orthophosphates, Enhanced biological phosphorus removal, Physical Treatment, Membrane technologies. Unit 4&5 Comparison of Disposal Methods, Tanning Process, Sources of waste water and their characteristics, Effects of waste on receiving water and sewers, Woolen Textile Mills waste, Treatment of Cotton and Woolen Textile Mill Waste. Follow us on Facebook and Support us with your Like 1. Important Contaminants Of Concern In Wastewater Treatment Suspended solids ● Lead to the development of sludge pollutants and anaerobic conditions when untreated wastewater is discharged into the aquatic environment. Nutrients (P, N2&C) ● When discharged into the aquatic environment, these nutrients can lead to the growth of undesirable aquatic life. When discharged in excessive amounts on land, they can also lead to the pollution of groundwater. Priority pollutants ● Organic and inorganic compounds selected on the basis of their known or suspected carcinogenicity, or high acute toxicity. Many of these compounds are found in wastewater. 2. Refractory organics ● These organics tend to resist conventional methods of wastewater treatment. It shows poor degradation. Typical examples include phenols and agricultural pesticides. Heavy metals ● Heavy metals are usually discharged to wastewater from commercial and industrial activities and have to be removed if the wastewater is to be reused. Eg. mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl), and lead (Pb) Dissolved Inorganics ● Inorganic constituents such as calcium, sodium, and sulfate are added to the original domestic water supply as a result of water use and may have to be removed if the wastewater is to be reused. 3. Characteristics Of Industrial Wastewater 1 Physical Characteristics 1.1 Total Solids ● Analytically the total solids content of a wastewater is defined as all the matter that remains as residue upon evaporation at 103 to 105°C. ● Composed of: 1. Floating matter. 2. Settleable matter. 3. Colloidal matter. 4. Matter in solution. Classification of total solids 4. 1.2 Odors ● Industrial wastewater may contain either odorous compounds or compounds that produce odor during the process of wastewater treatment. 1.3 Temperature ● The temperature of water is a very important parameter because of its effect on - Chemical reactions and reaction rates in treatment process. - Aquatic life. 1.4 Color ● Color of industrial wastewater varies according to the type of industry. ● Most colored matter is in a dissolved state. 5. 1.5 Turbidity ● Turbidity, a measure of the light-transmitting properties of water, is another test used to indicate the quality of wastewater discharges and natural waters with respect to colloidal and residual suspended matter. 2. Chemical Characteristics 2.1 Organic Matter ● The presence of these substances has complicated industrial wastewater treatment because many of them either cannot be or are very slowly decomposed biologically. ● Typical examples include - Fats, Oils, and Grease. - Phenols. - Volatile Organic Compounds (VOCs). - Pesticides & Agricultural Chemicals. 6. 2.1.1 Parameters Of Organic Content 2.1.1.1 Biochemical Oxygen Demand (BOD5) ● The determination of the BOD5 involves the measurement of the dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter. ● BOD is a chemical procedure for determining the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. ● It is widely used as an indication of the organic quality of water. ● It is most commonly expressed in milligrams of oxygen consumed per liter of sample during 5 days 7. 2.1.1.2 Chemical Oxygen Demand (COD) ● It oxidizes organic matter through a reaction with a mixture of chromic and sulfuric acid at high temperatures. ● The COD of wastewater is, in general, higher than that of the BOD5 because more compounds can be chemically oxidized than can be biologically oxidized. ● This can be very useful because COD can be determined in 3 hours, compared with 5 days for the BOD5. 8. 2.2 Inorganic Matter ● Nitrogen & Phosphorus. ● Sulfur ● Heavy Metals. 9 Biological Characteristics ● Some industries have certain pathogenic organisms like slaughterhouses others have molds and fungi as starch and yeast factories. ● Biological information is needed to assess the degree of treatment of the wastewater before its discharge to the environment. 9. Common Types Of Wastewater Treatment Methods 1 Physical Unit Operations ● Treatment methods in which the application of physical forces predominates. ● Screening, mixing, flocculation, sedimentation, flotation, filtration, and gas transfer are typical unit operations. 2 Chemical Unit Processes ● Treatment methods in which the removal or conversion of contaminants is brought about by the addition of chemicals or by other chemical reactions. ● Precipitation, adsorption, and disinfection are the most common examples used in wastewater treatment. 10. 3 Biological Unit Processes ● Treatment methods in which the removal of contaminants is brought about by biological activity. ● Biological treatment is used primarily to remove the biodegradable organic substances (colloidal or dissolved) and nutrients (nitrogen & phosphorus) from wastewater. ● Basically, these substances are converted into gases that can escape to the atmosphere and into biological cell tissue that can be removed by settling. 11. Description Of MAIN TREATMENT TECHNOLOGIES 12. Mechanical Processes 1 Screening ● The first unit operation encountered in wastewater-treatment plants is screening. A screen is a device with openings, generally of uniform size that is used to retain the coarse solids found in wastewater. ● According to the method of cleaning, screens are designated as hand cleaned or mechanically cleaned. ● According to the size of openings, screens are designated as coarse or fine. Coarse screens have openings of ¼ inch or more, and fine screens have openings of less than ¼ inch. 13. Mechanical Screen 14. 2 Oil Separation ● It is a process in which floatables, namely non-emulsified oil and organics separate from wastewater. 2.1 API (American Petroleum Institute) Separators ● The design of the separator is based on the specific gravity difference between the oil and the wastewater and between the suspended solids and wastewater. ● In general, this separator can handle very large flow. However, its disadvantage is the long retention time required for efficient oil separation. 15. 2.2 CPI (Circular Rugged Plate Interceptors) Units ● They consist of stacks of plates or bundles of slanted tubes, usually at 60 degrees, in a vessel or tank. It has been found that if the plates are tilted at 60 degrees, the solids will slide down the plates and be collected at the bottom. ● A CPI units can be placed in a small space but cannot take shock loads and high flows. ● They are usually more efficient than API separators and primary clarifiers in removing oil and solids, as more surface area can be provided. 16. 3 Flow Equalization ● Flow equalization is used to overcome the operational problems caused by flow variations, to improve the performance of the downstream processes, and is also used as an emergency tank to equalize wastewater effluent in case of any process failure in the treatment process. ● The design must provide for sufficient mixing to prevent solids deposition and concentration variations and also to provide aeration to prevent odor problems. ● The best location for equalization facilities to be at existing and proposed treatment plant sites. In some cases, equalization after primary treatment and before biological treatment may be appropriate. 17. Physical Treatment 1 Sedimentation ● Sedimentation is the separation from water, by gravitational settling, of suspended particles that are heavier than water. ● Sedimentation is used for separation of grit and particulate matter in the primary settling basin, separation of biological-floc in the activated-sludge settling basin, and separation of chemical-floc when the chemical coagulation process is used. It is also used for solids concentration in sludge thickeners. ● Sedimentation basins are constructed in a variety of shapes and sizes, circular tanks or rectangular tanks. ● The basin is comprised of four zones according to function: 1-The inlet zone. 2-The settling zone. 3-The sludge zone. 4-The outlet zone. 18. ● The inlet zone is a region where the incoming suspension is distributed uniformly over the cross-section of the tank. ● In the settling zone, the particles settle at the same rate as they would in a quiescent. ● In the outlet zone, the clarified liquid is collected uniformly over the basin. ● The solids collect in a sludge zone at the bottom of the tank. Rectangular basin Circular basin 19. Rectangular basin Circular basin 20. 2 Flotation ● Flotation is a unit operation used to separate solid or liquid particles from a liquid phase. ● Separation is brought by introducing fine gas (usually air bubbles) into the liquid phase. The bubbles attach to the particulate matter, and the buoyant force of the combined particle and gas bubble is great enough to cause the particle to rise to the surface to form a scum blanket, which is removed by a skimming mechanism. Grit and other heavy solids that settle to the bottom are raked to a central sludge for removal. ● Principal advantage of flotation over sedimentation is that very small or light particles that settle slowly can be removed more completely and in a shorter time. 21. Air Flotation ● In this system, air bubbles are formed by introducing the gas phase directly into the liquid phase through a revolving impeller through diffusers. Air Flotation 22. Chemical Treatment 1 Neutralization ● Industrial wastes often contain acidic or alkaline components which require neutralization before discharge or treatment. ● For wastes that are discharged to receiving waters, a pH between 6 and 9 is frequently specified by regulatory agencies. For wastes entering biological treatment processes, the pH should be maintained between 6.5 and 9 for optimum growth of the microorganisms. ● Acidic wastes are commonly neutralized with waste alkaline streams, lime, dolomite, ammonia, caustic soda, or soda ash. ● Lime is the most widely used alkaline material for neutralization acid wastes because of its low cost. Lime may be slow to react and may form insoluble precipitates. ● alkaline wastes usually require treatment with a waste acidic stream, sulfuric acid or hydrochloric acid. 23. 2 Oxidation/Reduction ● Oxidants are used in wastewater treatment as a first step in the removal of heavy metals to oxidize organics or as a last step in a treatment process, to oxidize odiferous compounds such as hydrogen sulphide or to oxidize inorganics such as cyanide and for disinfection. ● Common oxidation agents used in wastewater treatment - Oxygen(O2). - Chlorine (Cl2). - Sodium hypochlorite (NaClO). - Calcium hypochlorite (Ca(ClO)2). - Potassium permanganate(KMnO4). - Hydrogen peroxide(H2O2). 24. 3 Chemical Precipitation ● Chemical precipitation in wastewater treatment involves the addition of chemicals to alter the physical state of dissolved and suspended solids and facilitate their removal by sedimentation. Chemical Precipitation 25. 3.1 Coagulation ● It takes place in rapid mix, or flash mix basins which are very rapid. The primary function of rapid mix basin is to disperse the coagulant so that it contacts all of the wastewater. ● Over the years a number of different substances have been used as precipitants. The most common ones -Alum(Al2(SO4)3.18H2O). -Ferrous Sulfate(FeSO4.7H2O). -Lime Ca(OH)2. -Ferric Chloride (FeCl3). -Ferric Sulfate (Fe2(SO4)3). 3.2 Flocculation ● The purpose of flocculation is to form aggregates or flocs from the finely divided matter. The flocculation of wastewater by mechanical or air agitation. 26. Coagulation & Flocculation Process **Chemical Precipitation for Improving Plant Performance ● From 80 to 90 percent of total suspended matter, 50 to 80 percent of BOD5 and 80 to 90 percent of bacteria can be removed by chemical precipitation. In comparison, when plain sedimentation is used, only 50 to 70 percent of total suspended matter, 25 to 40 percent of BOD5 and 25 to 75 percent of bacteria can be removed. 27. Physio-Chemical Treatment Dissolved Air Flotation (DAF) System ● In dissolved air flotation (DAF), air is intimately contacted with an aqueous stream at high pressure, dissolving the air. The pressure on the liquid is reduced through a back pressure valve, thereby releasing micron-sized bubbles that sweep suspended solids and oil from the polluted stream to the surface of the air-flotation unit. ● Solids having a specific gravity greater than water tend to settle to the bottom and are removed by a rotating scraper arm. Attached to the same shaft is a rotating skimmer blade that removes the floating matter from the surface of the vessel into a skimming hopper. ● Clean water passes underneath a skirt and then must leave the vessel through a launder, which is located in the peripheral region. 28. DAF system without recycling Chemical Treatment Physical Treatment 29. Biological Treatment 1 Aerobic Biological Treatment 1.1 Activated-Sludge Process 1.1.1 Conventional Activated Sludge ● The conventional activated sludge system contains a tank for wastewater aeration followed by a settler and a solids recycle line. ● The wastewater flows through under constant aeration in the presence of activated sludge and exits at the end of the tank after 4-8 hours of residence time. The oxygen concentration in the reactor should be 0.5-2 mg/l throughout, where values over 2 mg/l are considered lost energy. 30. Conventional Activated Sludge 31. 1.2 Sequential Batch Reactor “SBR” ● The unit processes involved in the SBR and conventional activated-sludge systems are identical. Aeration and sedimentation/clarification are carried out in both systems. However, there is one important difference. In conventional plants, the processes are carried out simultaneously in separate tanks, whereas in SBR operation the processes are carried out sequentially in the same tank. ● As currently used, all SBR systems have five steps are commonly carried out in sequence as follows: 1- fill. 2- react (aeration). 3- settle (sedimentation/clarification). 4-draw (decant). 5- idle. 32. ● A unique feature of the SBR system is that there is no need for a return activated-sludge (RAS) system. Because both aeration and settling occur in the same chamber, no sludge is lost in the react step, and none has to be returned from the clarifier to maintain the sludge content in the aeration chamber. Sequential Batch Reactor 33. 1.3 Trickling Filter “ Biological Air Filters” ● The trickling filter consists of a bed of a highly permeable medium to which microorganisms are attached and through which wastewater is percolated or trickled. ● The filter media usually consist of either rock (slag is also used) or a variety of plastic packing materials. ● Rock filter beds are usually circular and the liquid wastewater is distributed over the top of the bed by a rotary distributor, and the wastewater was allowed to contact the media for a short time. ● The collected liquid is passed to a settling tank where the solids are separated from the treated wastewater. In practice, portion of the liquid collected in the under-drain system or the settled effluent is recycled, usually to dilute the strength of the incoming wastewater and to maintain the biological slime layer in a moist condition. 34. ● The limitations of the trickling filter include a relatively high incidence of clogging, the long rest period required, and the relatively low loading rate that could be used. Tricking Filter 35. 2 Anaerobic Biological Treatment ● The anaerobic process has been developed for the treatment of sludge and high strength organic load. ● The disadvantage of the anaerobic treatment as compared to aerobic treatment is that the slow growth rates require a relatively long detention time in the digester for adequate waste stabilization to occur. ● On the other hand, most of the organic waste is converted to methane gas, which is combustible and therefore a useful end product. ● The high temperature necessary to achieve adequate treatment are often listed as disadvantages of the anaerobic treatment process; however, high temperatures are necessary only when sufficiently long mean cell-residence time cannot be obtained at nominal temperatures. 36. ● In the anaerobic process, untreated wastes are mixed with recycled sludge and then digested in a reactor sealed off from the entry of air. ● After digestion, the mixture is separated in a clarifier or vacuum flotation unit, and the supernatant is discharged as effluent, usually for further treatment. ● Settled anaerobic sludge is then recycled to seed the incoming wastewater. Anaerobic Biological Treatment 37. Auxiliary Operations 1 Disinfection ● Disinfection refers to the selective destruction of disease-causing organisms. All the organisms are not destroyed during the process. This differentiates disinfection from sterilization, which is the destruction of all organisms. ● Disinfection is most commonly accomplished by the use of the following agents: 1- Chemical Agents. 2- Physical Agents. 3- Radiation. 38. 2 Reuse of Treated Effluent ● Reuse of treated wastewater in various industries is becoming very popular being a cheaper source of water supply where the industrial plant can reuse its own wastewater through recycling or after treatment or it can be used for irrigation. ● There are many possibilities that some of hazardous and toxic chemicals may pass to the treated effluents. In order to eliminate health hazards several advanced methods of tertiary treatment for industrial effluents with disinfection are available world wide to meet the standards for effluent reuse for several purposes 39. 2.1 Advanced Treatment Techniques “Tertiary Treatment” 2.1.1 Filtration 2.1.1.1 Granular Media Filters ● Granular media filters are widely used in wastewater treatment for the removal of both organic and inorganic suspended solids. ● Granular media filters can operate either by gravity flow (gravity filters) or by pressure (pressure filters). ● The most common types of filters are two and three media filters. A common design for a two media filter would have a bed of 0.5 mm sand layer below a 0.9 mm anthracite layer. A common design for a three media filter would have a 30 to 40 mesh garnet layer below the sand layer. Specialty filters could use different media with different effective sizes. 40. ● Solids are captured by the bed and eventually have to be removed by scouring and backwashing. Granular Media Filter 41. 2.1.1.2 Carbon Adsorption ● Carbon adsorption is used to remove certain types of organic contaminants that are resistant to primary and secondary treatment when their removal is required. ● There are some cases where an organic stream contains contaminants that are valuable enough to recover with carbon adsorption. ● Another use of carbon columns is to remove Volatile Organic Compounds (VOCs) from wastewater. All VOCs can be adsorbed onto activated carbon to a greater or lesser extent. Fix-bed Carbon Adsorption system. 42. 2.1.2 Membrane Separation ● Membrane separation techniques are used to remove very fine particles from water, to desalinate water, and recently, membranes have been developed to remove organics from water, such as oil and other organics that have clogged and degraded membranes in the past. ● Membranes are made of various materials but all have a consistent pore size that will permit particles or molecules of a given size to pass through the membrane and will prevent molecules or particles of a size larger than the pore size from passing through. ● Membrane Separation include ultrafiltration (UF) and reverse osmosis (RO). 43. Ultrafiltration (UF) Reverse Osmosis (RO) 44. Sludge treatment and disposal 45. ● The sludge resulting from wastewater treatment operations and processes is usually in the form of a liquid or semisolid liquid that typically contains from 0.25 to 12 percent solids by weight, depending on the operations and processes used. ● Sludge is by far the largest in volume, and its processing and disposal is perhaps the most complex problem facing the engineer in the filed of wastewater treatment. ● The problems of dealing with sludge are complex because it is composed largely of the substances responsible for the offensive character of untreated wastewater. The portion of sludge produced from biological treatment requiring disposal is composed of the organic matter contained in the wastewater but in another form which can also decompose and become offensive; and only a small part of the sludge is solid matter. 46. Preliminary Operations ● Preliminary Operations are used to provide a relatively constant, homogenous feed to sludge-processing facilities. 1 Sludge Grinding ● Sludge grinding is a process in which large and string material contained in sludge is cut or sheared into small particles to prevent the clogging of or wrapping around rotating equipment. 2 Sludge Degritting ● In some plants where separate grit removal facilities are not used ahead of the primary sedimentation tanks or where the grit removal facilities are not adequate to handle peak flows and peak grit loads, it maybe necessary to remove the grit before further processing of the sludge. 47. 3 Sludge Blending ● Sludge from primary, secondary, and advanced processes are blended to produce a uniform mixture to enhance plant operability and performance. ● Blending tanks are usually equipped with mechanical mixers and baffles to ensure good mixing. 4 Sludge Storage ● Sludge storage is particularly important in providing a uniform feed rate ahead of the following processes: lime stabilization, heat treatment, mechanical dewatering, drying, and thermal reduction. ● If sludge is stored longer than two or three days, it will deteriorate and will be more difficult to dewater. 48. Sludge Thickening ● Thickening is a procedure used to increase the solids content of sludge by removing a portion of the liquid fraction. 1 Gravity Thickening ● Gravity thickening is accomplished in a tank similar in design to conventional sedimentation tank. Normally, a circular tank is used. ● The supernatant flow that results is returned to the primary settling tank or to the head works of the treatment plant. Filter Press 54. 2 Sludge Drying Beds 2.1 Conventional sand Drying Beds ● In a typical sand drying bed, sludge is placed on the bed in a 8 to 12in (200 to 300 mm) layer and allowed to dry. Sludge is dewatered by drainage through the sludge mass and supporting sand and by evaporation from the surface exposed to the air. Most of the water leaves the sludge by drainage. ● The moisture content is approximately 60 percent after 10 to 15 days under favorable conditions. Sludge removal is accomplished by manual shoveling into wheelbarrows or trucks or by a scraper or front-end loader. Conventional sand Drying Beds 55. Sludge Disposal and Utilization 1 Beneficial Uses of Sludge ● The fertilizer value of biological sludge, which should be evaluated where the sludge is to be used as a soil conditioner, is based primarily on the content of nitrogen, phosphorus, and potassium. 2 Sludge Disposal 2.1 Landfilling ● There are two types of landfills for industrial sludge: those which accept non-hazardous wastes and those that accept hazardous wastes. ● Landfills are designed to prevent the contamination of ground water and to prevent the migration of the wastes from the landfill. 56. ● For this reason, landfills usually have thick, 3 to 10 feet covers of clean impermeable clay or dirt on top. ● Landfill bottom and sides are also made of impermeable clays or dirt. The sump collects leachate from the landfill and is pumped to a wastewater treatment plant. ● Hazardous landfills must meet very stringent requirements. The bottoms and sides must be double contained, which is usually accomplished by installing two liquid barriers, usually plastic. ● The top of a hazardous waste landfill must be impermeable, which is usually accomplished by installing a plastic water barrier in the dirt cover. ● Liquid is collected from the space between the barriers in a leachate collection system and is properly disposed of. 57. Model For Industrial Wastewater Treatment Plant 58. Short Notes About Wastewater For Textile Industry ● wastewater generated from textile industries characterized as follows: -High level of PH. -Increase in total suspended solid (TSS). -Increase in biological oxygen demand (BOD5). -Increase in chemical oxygen demand (COD). 59. Sampling analysis ● Assume that the wastewater sample analysis for Textile industry was as the following: ResultAnalysis 1300 mg/lCOD 900 mg/lBOD 1250 mg/lTSS 1300 mg/lTDS 10pH 60. Wastewater Discharge ● Assume that Textile industry will discharge the wastewater after treatment to Sewer System, so the target now is achieve Egyptian Law 93/62 (as modified by Decree 44/2000). Max. value according to law 44/2000 Parameters (mg/l unless otherwise noted) 1100 mg/lCOD 600 mg/lBOD 800 mg/lTSS -TDS 6.5-9pH 61. Unit Processes For Textile Industry ● All treatment technologies described earlier in chapter (2) can be used to develop a model for sequential treatment of industrial wastewater which can be described as follows and shown in the following Figure. ● According to wastewater analysis for textile industry propose the following unit processes. -Screening (as a preliminary treatment). - Coagulation and Flocculation Process (as a primary treatment). - Sedimentation (as a primary treatment). - Activated Sludge Process (as a secondary treatment). - Sedimentation (as a secondary treatment). - Sludge drying beds (Sludge treatment). 62. Possible Choice For Wastewater Treatment And Their Sequence. 63. Block Diagram For Textile Industry 64. Flow Chart For Textile Industry

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