2. It is often unnecessary to carry the oxidation of a compound to completion since, depending on the oxidant and oxidizing conditions, the intermediate oxidation products which may be formed will be of much lower toxicity or less objectionable characteristic than the original materials.
3. Complete oxidation may not only be impractible from a treatment standpoint, but also represents a non-justified economical outlay.
4. Subsequently, chemical oxidation might be considered as a selective modification or elimination of objectionable or toxic substances, including :
5. Inorganic constituents, such as Mn(II), Fe(II), S^{2-}, CN^{-}, SO_3^{2-} and
6. Organic compounds, such as phenols, amines, humic acids, other taste, odor, or color producing or toxic compounds, bacteria and algae

Module IV

Industries Poliution Control

SOURCES AND CHARACTERISTICS

1. Air pollution is the presence of substances in air in sufficient concentration and for sufficient time, injurious to human, plant or animal life, or to property.
2. Air pollutants arise from both man-made and natural processes.
3. Pollutants are also defined as primary pollutants resulting from combustion of fuels and industrial operations and secondary pollutants, those which are produced due to reaction of primary pollutants in the atmosphere.
4. The ambient air quality may be defined by the concentration of a set of pollutants which may be present in the ambient air we breathe in.
5. These pollutants may be called criteria pollutants.
6. Emission standards express the allowable concentrations of a contaminant at the point of discharge before any mixing with the surrounding air

Combustion sources

1. By combustion sources is meant operations where primarily fossil fuels, coal, natural gas, petrol, diesel and furnace oil are burnt to obtain energy.
2. This includes power plants, industrial boilers, domestic heating and automobiles.

Automobiles

1. In urban areas automobiles form a significant source of a number of air pollutants, namely, particulates, NOx, hydrocarbons, carbon monoxide and lead.
2. These pollutants are produced when fuel is burnt under less than ideal conditions
3. Non-uniform oxygen supply within the combustion chamber and lower flame temperature leads to incomplete combustion releasing CO, HC and unburnt particles in the exhaust.
4. Tetraethyl lead is added to petrol as anti-knock additive.
5. Where such petrol is used lead is emitted in the exhaust fumes as inorganic particulates

Industrial sources - Only two sources are discussed here

Cement manufacture

1. Raw materials include lime, silica, aluminum and iron. Lime is obtained from calcium carbonate.
2. Other raw materials are introduced as sand, clay, shale, iron are and blast furnace slag.
3. The process consists of mining, crushing, grinding, and calcining in a long cylindrically shaped oven or kiln

Sulphuric acid manufacture

1. Sulphuric acid is produced from Sulphur, which is burnt to obtain SO_2.
2. Sulphur dioxide is converted to trioxide in presence of vanadium pentaoxide catalyst.

3. The Sulphur trioxide is absorbed in recycling concentrated sulfuric acid.
4. Unreacted SO2 escapes with the flue gas.
5. New large plants now a days use double conversion double absorption (DCDA) process realizing above 99 percent efficiency

WASTE TREATMENT FLOW SHEET FOR TEXTILES

1. Textile industry can be classified into three categories cotton, woolen, and synthetic fibers depending upon the used raw materials.
2. The cotton textile industry is one of the oldest industries in China.
3. The textile dyeing industry consumes large quantities of water and produces large volumes of wastewater from different steps in the dyeing and finishing processes.
4. Wastewater from printing and dyeing units is often rich in color, containing residues of reactive dyes and chemicals, such as complex components, many aerosols, high Chroma, high COD and BOD concentration
5. In the textile dyeing industry, bleaching is an important process.
6. It has three technologies

i. sodium hypochlorite bleaching
ii. hydrogen peroxide bleaching and sodium chlorite bleaching
iii. Sodium hypochlorite bleaching and sodium chlorite bleaching are the most commonly used processes

Textile dyeing wastewater risk

1. Discharged wastewater by some industries under uncontrolled and unsuitable conditions is causing significant environmental problems.
2. High values of COD and BOD, presence of particulate matter and sediments, and oil and grease in the effluent causes depletion of dissolved oxygen, which has an adverse effect on the aquatic ecological system.

The textile industry standards for water pollutants

1. As the wastewater is harmful to the environment and people, there are strict requirements for the emission of the wastewater.
2. Due to the difference in the raw materials, products, dyes, technology and equipment, the standards of the wastewater emission have too much items.
3. It is developed by the national environmental protection department according to the local conditions and environmental protection requirements which is not fixed.

WASTE TREATMENT FLOW SHEET FOR TANNERIES

1. Treatment of various wastewaters is become more important due to diminishing water resources, increasing wastewater disposal costs, and stricter discharge regulations that have lowered permissible contaminant levels in waste streams.
2. Tannery industry is the significant contributor to the economy and provides large scale employment opportunity for people of economically weaker part of the society.
3. Tanning involves a complex combination of mechanical and chemical processes.
4. The preservation and processing of raw hides and skins for tanning process cause severe pollution problem towards environment and mankind, rather than being important from economic and employment consideration
5. The tanning operation in which organic or inorganic materials become more chemically bound to the available substance and preserve it from deterioration.
6. The substances generally used to accomplish the tanning process are chromium or extracts from bark of trees, such as chestnut.
7. Two types of tanning operations based on tanning agents are chrome and vegetable tanning.
8. The general process oftanneries are vegetable tanning employs the use of extracts from the bark of various trees as the tanning agent.
9. Mostly leathers are produced by chrome tanning compare to vegetable tanning.

10. Chrome tanning produces leather better suited for certain applications, particularly for the upper parts of boots and shoes, and requires less processing time than traditional vegetable tanning.

Treatment process

1. The treatment of tannery wastewater by different oxidation and combined process.
2. The application of solar technologies to these processes could help to diminish that problem by reducing the energy consumption required for generating UV radiation.
3. The maximum reduce content by mineralization of the organic compounds using combined UV and the Fenton's oxidation processes for the treatment of tannery wastewater.
4. Calcium hypochlorite was the most efficient oxidant while compared to other oxidant for removal of chromium pollutant from tannery wastewater.

Waste Treatment For Distilleries

Origin And Characteristics of Distilleries Waste

The beverage alcohol industries utilize different grains, malted barley and molasses as raw materials. on the other hand the molasses (black strap type) are exclusively used as raw materials in the industrial alcohol industry.

In beverage alcohol industry, the preparation of mash consists of:

1. Preparation of green malt
2. Preparation of cooked slurries of the grains
3. Mixing of the above two followed by ph adjustment and nutrient (ammonium salts and phosphates) supplementation.

On the other hand in molasses distilleries, the preparation of mash consists of:

1. Dilution by water to a sugar content of about 15%
2. pH adjustment to 4.0 - 4.5 to prohibit bacterial activities and
3. Nutrient addition. The yeast suspension is prepared separately in the laboratory with art of the diluted molasses and then inoculated into the mash for fermentation under controlled conditions.

Refineries Waste

Manufacturing Process :

Crude oils are complex mixtures of hydrocarbons of varying molecular weight and structure. These hydrocarbons range from simply highly volatile substances to complex waxes and asphaltic compounds. The final petroleum products are obtained from the crude oil through a series of operations viz. topping , thermal cracking , catalytic cracking , catalytic reforming etc. In general , the crude oil is first subjected to fractional distillation in the process known as " topping " . The products obtained are called raw products and include raw gasoline, raw naptha , raw kerosene , gas oil, fuel oil etc.

Now these intermediate refinery products are again treated to yield various finished market products as per the requirements. The operations practiced include "catalytic cracking" or "thermal cracking" and further purification processes like "acid treatment" , "sweetening treatment" , "hydrodesulphurization" etc.

The decomposition of heavy or high boiling petroleum distillates like gas oil and fuel oil to lighter products like gasoline is called cracking. These operations take place practically at the atmospheric pressure and at a high temperature. In catalytic cracking, however, an acid type solid catalyst (such as synthetic silica alumina) is introduced into the reactor.

A residue of heavy black material known as coke, is obtained out of the process of cracking. In the catalytic cracking process, however , the asphaltic or tar-like products get adsorbed on to the surface of the catalysts in the form of coke.

When "high octane" fuels are in demand ,much of the naphtha is "catalytically reformed" into high octane gasoline; the process involved is another form of cracking.

The wax distillates of the crude oil may be used as raw material for the manufacture of light lubricating oils. The process of their manufacture consists of chilling the distillates and filtering the wax from the oil.

The products thus obtained either as final product or as feedstock for further processing may contain certain undesirable constituents which must be either removed or converted into less harmful compounds by further refining processes.

Such refining processes include (i) removal of hydrogen sulfide gas and mercaptans by washing with strong caustic soda solution , or (ii) absorption of hydrogen sulfide gas in an alkaline absorber liquid followed by the recovery of the hydrogen sulfide gas , in the process known as regenerative process (iii) conversion of mercaptans to less harmful desulphide, employing solutions like lead oxide in caustic soda together with sulphur, or sodium hypochlorite or copper chloride , in a process known as "sweatening" and (iv) conversion of alkylsulphides and thiophenes and practically all other sulphur compounds into hydrogen sulfide in a catalytic in the process known as "hydrodesulphurization" - hydrogen sulfide thus formed is recovered by the regenerative process.

Fertilizer Plant Waste

Introduction :

Fertilizer industry can be divided into three main categories depending upon

1.Fertilizer raw materials

2. Fertilizer intermediates

3. Fertilizer products

Fertilizer Intermediates:

1. Sulphuric acid
2. Phosphoric acid
3. Nitric acid

Fertilizer products: **(SOLID)**

N - Fertilizers

1. Ammonium nitrate
2. Urea
3. Ammonium sulfate

P - Fertilizers

1. Super phosphates NPK fertilizers

LIQUID:

Ammonia fertilizers produced in India can be classified broadly into two groups viz., nitrogens fertilizers, and phosphatic fertilizer. Plants may be producing only nitrogenous fertilizers like urea, Ammonium sulphate, Ammonium Nitrate, Ammonium chloride or only phosphatic fertilizers like super phosphates; there are plants where complex fertilizers containing both nitrogen and phosphates like Ammonium phosphate and Ammonium sulphate phosphate are produced

Manufacturing Process :

Ammonia is the principal intermediate in the manufacture of all nitrogenous fertilizers. So, except when the byproduct ammonia will be available from a coke oven, raw materials for nitrogenous fertilizer production is the carbonaceous materials, which are required for making ammonia. So all the nitrogenous fertilizer plants will have essentially an Ammonia production unit and a reactor where the synthetic ammonia will be reacted with other chemicals to produce the final product. The plant may have auxiliary units to produce the reacting chemicals also. Basic process steps in the manufacture of urea, from carbonaceous raw materials like naphtha are as follows:

(i) reaction of the carbonaceous materials with steam and air to form a mixture of hydrogen and carbon monoxide, known as synthesis gas.

(ii) Reaction of the carbon monoxide with steam over a catalyst to form more hydrogen and carbon dioxide.

(iii) Separation and purification of carbon dioxide.

(iv) Removal of residual carbon monoxide from gas mixture

(v) Synthesis of ammonia by reacting hydrogen and nitrogen over a catalyst (Nitrogen is supplied as air in an earlier step) and

(vi)Synthesis of urea by treating ammonia with carbon dioxide in a reactor at higher temperature and pressure

Treatment of Fertilizer Waste Water :

Major pollutants in the fertilizers waste water for which the treatment is necessary include oil, arsenic, ammonia, urea, phosphate and fluoride. The effluent streams can be characterized as either a phosphoric

known as 'Ammonia-liquor' containing mainly ammonia and various other compounds is subjected to distillation for the recovery of ammonia; the waste is sent for further treatment or other chemical recovery. After the second stage of cooling i.e in the third stage, the gas is compressed and cooled for further recovery of chemicals. Besides the arrangement for separation of tar and ammonia, this stage may include a benzol washer for the recovery of light oils. The remaining gas may be used or sold as fuel. The coal after being carbonized is removed from the oven and quenched by cold water

. Treatment of Coke Owen Waste

All the pollutants of the spent ammonical liquor, affect the ecology of the waste receiving water course, the phenol is considered to be the most objectionable pollutant. The other objectionable substances include thio-cynate, thio-sulphate, cyanide etc. In some plants spent ammonical liquor is utilised for quenching of hot coke, this practice destroys the toxic matters like phenols in the liquor, But as this causes heavy corrosion in the quenching cars and in other quenching equipments , the method is not generally favoured. Phenol being a valuable chemical by-product, may be recovered instead of destroying it. Several techniques have been developed for the recovery of phenol by liquid extraction methods.

Most of these processes use Benzene as solvent, to extract phenol from the crude ammonical liquor , before it enters the Ammonia still for ammonia stripping . Other solvents used include light oil, petroleum oil etc. The extracted phenols from all absorption process can be recovered by washing with sodium hydroxide solution; the phenol reacts with the caustic solution to produce sodium phenolate. The crude phenol is then liberated from it using gases containing carbon dioxide.

Treatment of Coal Washery Waste

The major pollutant of the coal washery is the suspended solids. AS such this waste is usually treated in a Clarifier with or without coagulation. However the addition of Coagulant reduces both the detention time and surface area of the tank. Several coagulants like lime, starch and indigenous coagulants like Nirmali seed extracts can be used effectively for the clarification of coal washery wastes. The clarified effluent is either recycled or discharged as waste.

Blast Furnace and its Wastewater

Blast furnace is a basic unit in an integrated steel plant. Essentially the blast furnace process consists of charging iron ore and coke as fuel limestone and dolomite as fluxing material into the
top of the furnace and blowing heated air (blast) into the bottom. Pig iron is the metallic product of this unit. Appreciable quantity of water is used in blast furnace for the purpose of cooling and gas cleaning operations. However, the cooling water normally remains un-contaminated and is reused after cooling.

Pulp and Paper Mill Waste

The paper mills use the 'pulp' as the raw material , which is again produced utilizing different cellulosic materials like wood , bamboo,jute, straw mainly of rice and wheat, waste paper, bagasse etc in the pulp mills.

Manufacturing Process :

The Process of manufacturing of paper may be divided into two phases - Pulp making and then making of final product of paper. The major portion of the pollution from papermaking originates in the pulping processes. Raw materials are reduced to a fibrous pulp by either mechanical or chemical means. The bark is mechanically or hydraulically removed from wood before it is reduced to chips for cooking. Mechanically prepared (groundwood) pulp is made by grinding the wood on large emery(very hard mineral) or sand stone wheels and then carrying it by water through screens.

This type of pulp is low-grade , usually highly colored, and contains relatively short fibers, it is mainly used to manufacture non durable paper products such as newspaper. The screened bark effluent contains fine particles of bark and wood and some dissolved solids. Chemically prepared pulps, as compared with mechanically prepared ones, are made by the soda, sulfate (Kraft) or sulfite process. In all these methods the wood is prepared, as in the making of groundwood, by reduction to chips and screening to remove dust. The chemical processes differ from one another only in the chemical used to digest the chips. Pulping is the process in which wood or other cellulosic raw materials are digested with chemicals under high temperature and pressure so that cellulosic fibres of wood are relieved from its binders such as lignin, resin etc

effluent or an ammonia effluent. The phosphoric acid effluent is high in fluoride concentration, low in pH, High in phosphate and high in suspended solids. Standard practice has been contain the water for reuse, allowing enough time for solids sedimentation.

- Oil is removed in a gravity separator
- - Arsenic containing waste is segregated and after its concentration the solid waste is disposed off in a safe place.
- Phosphate and fluoride bearing wastes are also segregated and chemically coagulated by lime; clarified effluent which still contains some amount of phosphate and fluoride is diluted by mixing with other wastes.

The other effluent type is characteristic of ammonia production and ammonia containing products. Most of the contamination comes from ammonia production itself. It is characteristically high in ammonia from effluent gas scrubbing and gas cleaning operations and high in sodium hydroxide or carbonate from gas cleaning process. Several alternatives are there for the treatment of Ammonia bearing wastes

1. Steam stripping
2. Air stripping in towers
3. Lagooning after pH adjustment
4. Biological nitrification and denitrification

Waste Water from Fertilizer Plant:

A variety of wastes are discharged from the Fertilizer plant as water pollutants in the form of

1. Processing chemicals like Sulphuric acid
2. Process intermediate like Ammonium, Phosphoric and etc.
3. Final products like urea, Ammonium sulphate, Ammonium phosphate etc.

In addition to the above, oil bearing wastes from compressor houses of ammonia and urea plants, some portion of the cooling water and the wash water from the scrubbing towers, for the purification of gases, also come as waste. Wash water from the scrubbing towers may contain toxic substances like Arsenic, Monoethanolamine, Potassium carbonate etc. in a Nitrogenous fertilizer plant, while that in a phosphatic fertilizer plant may contain a mixture of carbonic acid, hydrofluoric acid. Both alkaline and acidic wastes are also expected from the boiler feed water treatment plant, the wastes being generated during the regeneration of anion and cat ion exchanger units. Additional pollutants like phenol and cyanide will be introduced in the list of pollutants in the fertilizer plant where ammonia is derived from the waste ammonia cal liquor of the coke ovens

Steel Plant Wastes

Introduction

Integrated steel plants usually consist of five main units, Viz; Coal washery, Coke oven blast furnace, steel melting shop and rolling mills. In addition to the above the plants may have auxiliary units like oxygen plant and power plant for their own uses.

Coal washery and its wastewater:

The coal needs some processing to make it suitable for use in coke ovens. The main objective of such treatment is the removal of solid foreign matter present in the coal. Generally the process in a coal washery include crushing, screening and wet washing of coal In the wet process the coal is separated from the impurities using the principal of differential settling.Water used for washing is recycled and reused after sedimentation. But in spite of all care taken to ensure maximum reuse, appreciable quantity of wash water containing coal fines, and other impurities like clay and small amounts of other minerals like calcite, gypsum, pyrite etc, comes out as waste, normally in a thickened form as the under- flow of the sedimentation tank.

Coke Ovens and their Water Waste

The production of coke involves the carbonization of bituminous coal by heating in the absence of air at a temperature range of 900 - 1100 degrees centigrade in an oven, which drives off all volatile portions in the coal. The gas which is evolved containing the volatile matters is collected through the stand pipes and is cooled in stages. In the first stage the gas is cooled to about 80 degrees centigrade by spraying cold liquor over the gas, there by producing mainly tar as condensate. In the second stage by a further cooling to about 30 degrees centigrade, condensate containing additional tar and ammonia liquor is produced. These two condensate liquors after the separation of tar in a tar-decanter are recycled as sprays in the first stage. The excess liquor