Online tutorials

I M.Sc. CHEMISTRY(2 YEAR) SEM: II

19CHEE206-1: SELECTIVE MATERIALS, TECHNIQUES AND ENVIRONMENTAL CHEMISTRY

UNIT – V- ENVIRONMENTAL TOXICOLOGY

SYLLUBUS: Chemical solution to environmental problems, biodegradability, principles of decomposition, better industrial processes. Bhopal gas tragedy, Chernobyl, Three mile island, Sewazo and Minamata disasters. Industrial Pollution: Cement, sugar, distillery, drug paper and pulp, thermal power plants, nuclear power plants, metallurgy polymers drugs etc., radionuclide analysis, disposal of wastes and their management

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Environmental toxicology: Study of harmful effects of chemical and biological agents as toxicants from pollutants, insecticides, pesticides and fertilizers can affect an organism and its community by reducing its species diversity and abundance. Such changes in population dynamics affect the ecosystem by reducing its productivity and stability.

Toxins and Toxicants: Toxins are natural products such as the ones found in poisonous mushrooms, or in a snakes' venom. **Toxicants** are man-made products, artificial products introduced into the environment due to human activity; examples are industrial waste products and pesticides

BIO DEGRADATION

Definition: process by which organic substances are broken down by the environmental effects and by the Living organisms.

Biodegradable products-: Examples; There are many biodegradable products which are decomposed by bacteria, fungi and other microorganisms are many new eco-friendly materials and natural and biodegradable products. 1.Biodegradable detergent and soap 2.Lemon batteries 3.Beeswax 4. Stationary such as pencils, folders and erasers 5.Plant pesticides 6. Plant stakes 7. Flower pots 8.Jute curtains 9. Diapers 10Waste bags 11. Cups, plates and other utensils 12. Glue and paint 13 Hair care products 14. Cosmetic products

Principles of Decomposition-: In nature biodegradable products decompose by microorganism, fungi, and bacteria. Decomposition is process in which organic substances are broken down into simple material or useful material. Decomposition takes place in many natural or artificial substances.

Animal decomposition-: There are general five stages by which animals are decomposed;
Fresh-: This stage is the immediate stage in which first heart stops beating. Subsequently, blood is not pumped and finally death is caused. After death the muscular tissues becomes incapable and rigid within 5 to 6 hours. Body release heat in atmosphere and become cool after death.

Bloat-: microorganism reaction takes place on body. In this stage gases like methane, hydrogen sulfide, carbon dioxide, released. Due to the accumulation of gases within the body bloated appearance and also liquids and liquefied tissues become frothy. It is also called anaerobic stage. In these stage bacteria converts hemoglobin into sulfa hemoglobin.

Active decay-: Active decay causes greatest mass losses.
Advanced decay-: this stage is also called inhibitor stages because decomposition of animal inhibited in this stage. It is due to the availability of cadaveric material.

Remains-: This stage is characterized by loss of everything on the body except bones and dry skin

Better industrial processes: To reduce the toxicants let into the environment, the following points need to be focused by the industries.

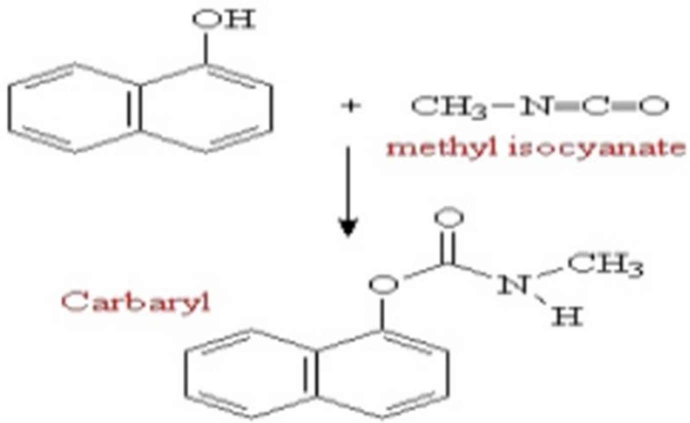
1. need to comply with regulatory mandates,
2. the desire to achieve or strengthen competitive advantage, and
3. the desire to improve corporate stewardship practices and reputation.
4. Making more efficient use of materials and energy can significantly lower production costs in many industries. As the price of scarce input materials rises and the cost of hazardous and nonhazardous waste disposal increases, better process metrics allow managers to analyze the cost-benefit trade-offs of improving overall materials efficiency.
5. The development of tools for evaluating environmental metrics, while in an early stage, will accelerate as businesses and stakeholders seek greater value from the information they already generate. For now, those who report and those who attempt to interpret environmental metrics must take great care to distinguish qualitative differences underlying quantitative metrics. That is, they must separate what is "big" from what is "important.“
6. Progress in devising and using industrial environmental performance metrics continues to be made. Many companies are in the process of experimenting with and developing new metrics.
7. Better methods for reducing the impact of industrial activities on the environment will require better measures by which to gauge performance.

Bhopal Gas Tragedy

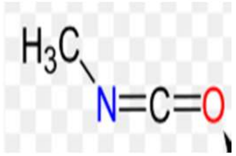
- Occurrence: 3rd December 1984.
- Place of occurrence: Bhopal, Madhya Pradesh, India.
- Company: Union Carbide Corporation.
- Chemical: Methyl Isocyanate (45 tons)
- **What happened:** 45 tons of Methyl Isocyanate (MIC) gas escaped from two underground storage tanks at a Union Carbide pesticide plant.

The Union carbide India limited(UCIL) factory was built in 1969 to produce the pesticide carbaryl (Insecticide commercial name Sevin)using methyl isocyanate (MIC) as an intermediate.

Preparation of Carbaryl from 1- napthaol



- Clear, colorless, sharp smelling liquid
- Highly flammable
- Extremely toxic
- Volatile reaction with water in about 10 minutes
- Union Carbide used MIC to produce a insecticide called **Carbaryl.**

MIC-Effects on Human Health 

- Respiratory Disorders – Irritation to the lungs, causing coughing and/or shortness of breathing. Higher exposure caused build up of fluids (pulmonary edema). Caused Asthama.

- Cancer Hazard – Caused mutation (genetic changes). It caused cancer.

- Reproductive Hazard – Association between exposure to Methyl Isocyanate and miscarriages. It may damage the growing fetus. May also affect fertility in men and women.

- Traces of many toxins were found in the Brest Milk of mothers and were inturn transmitted to the recepient babies.

40, 000 kg was released in Bhopal on 3rd December 1984

By early December 1984, most of the plant's MIC related safety systems were malfunctioning and many valves and lines were in poor condition. In addition, several vent gas scrubbers had been out of service as well as the steam boiler, intended to clean the pipes. During the late evening hours of 2 December 1984, water was believed to have entered a side pipe and into Tank E610 whilst trying to unclog it, which contained 42 tons of MIC that had been there since late October. The introduction of water into the tank subsequently resulted in a runaway exothermic reaction, which was accelerated by contaminants, high ambient temperatures and various other factors, such as the presence of iron from corroding non-stainless steel pipelines.The pressure in tank E610, although initially nominal at 2 psi at 10:30 p.m., it had reached 10 psi by 11 p.m. Two different senior refinery employees assumed the reading was instrumentation malfunction. By 11:30 p.m., workers in the MIC area were feeling the effects of minor exposure to MIC gas, and began to look for a leak.

About 30 tonnes of MIC escaped from the tank into the atmosphere in 45 to 60 minutes. This would increase to 40 tonnes within two hours. The gases were blown in a southeasterly direction over Bhopal.

Acute Effects:

1. coughing, severe eye irritation and a feeling of suffocation, burning in the respiratory tract, breathlessness, stomach pains and vomiting.
2. Thousands of people had died by the following morning. Primary causes of deaths were choking, reflexogenic circulatory collapse and pulmonary oedema.
3. The gas cloud, composed mainly of materials denser than air, stayed close to the ground and spread in the southeasterly direction affecting the nearby communities.
4. The health care system immediately became overloaded. In the severely affected areas, nearly 70 percent were under-qualified doctors. Medical staff were unprepared for the thousands of casualties. Doctors and hospitals were not aware of proper treatment methods for MIC gas inhalation.

Among the 500,000 people exposed to the gas:

- 20,000 have died till date
- 120,000 continue to suffer **(15-20 die each month)**

Out of every **3 children** born after the Bhopal disaster, only **1 survived.**

7000 animals killed and 7000 injured

What compounded the tragedy was that the victims failed to get adequate compensation and the generation that followed continued to suffer from health complications.

Lapses: By Union Carbide

- Improper design of chimneys (without consideration of weather conditions in all seasons)
- Improper design and maintenance of safety equipment.
- Not following safety regulations as that followed by **UCC plants in USA.**
- Inadequate **emergency planning** and community awareness.
- **Lack of awareness** of the potential impact of MIC on the community by the people operating the plant.
- **Inadequate community planning,** allowing a large population to live near a hazardous manufacturing plant.

Chernobyl Accident 1986

The April 1986 disaster at the Chernobyl-nuclear power plant in Ukraine was the product of a flawed Soviet reactor design coupled with serious mistakes made by the plant operators. It was a direct consequence of Cold War isolation and the resulting lack of any safety culture.

The Chernobyl accident in 1986 was the result of a flawed reactor design that was operated with inadequately trained personnel.

The resulting steam explosion and fires released at least 5% of the radioactive reactor core into the atmosphere and downwind – some 5200 PBq (I-131 eq).

Two Chernobyl plant workers died on the night of the accident, and a further 28 people died within a few weeks as a result of acute radiation poisoning.

The United Nations Scientific Committee on the Effects of Atomic Radiation said that, apart from increased thyroid cancers, "there is no evidence of a major public health impact attributable to radiation exposure 20 years after the accident.“

Resettlement of areas from which people were relocated is ongoing. In 2011 Chernobyl was officially declared a tourist attraction.

The 1986 Chernobyl accident

On 25 April, prior to a routine shutdown, the reactor crew at Chernobyl 4 began preparing for a test to determine how long turbines would spin and supply power to the main circulating pumps following a loss of main electrical power supply.

A series of operator actions, including the disabling of automatic shutdown mechanisms, preceded the attempted test early on 26 April. By the time that the operator moved to shut down the reactor, the reactor was in an extremely unstable condition. A peculiarity of the design of the control rods caused a dramatic power surge as they were inserted into the reactor.

The interaction of very hot fuel with the cooling water led to fuel fragmentation along with rapid steam production and an increase in pressure. The design characteristics of the reactor were such that substantial damage to even three or four fuel assemblies would – and did – result in the destruction of the reactor. The overpressure caused the 1000 t cover plate of the reactor to become partially detached, rupturing the fuel channels and jamming all the control rods, which by that time were only halfway down. Intense steam generation then spread throughout the whole core (fed by water dumped into the core due to the rupture of the emergency cooling circuit) causing a steam explosion and releasing fission products to the atmosphere.

About two to three seconds later, a second explosion threw out fragments from the fuel channels and hot graphite. There is some dispute among experts about the character of this second explosion, but it is likely to have been caused by the production of hydrogen from zirconium-steam reactions.

About 200-300 tonnes of water per hour was injected into the intact half of the reactor using the auxiliary feed water pumps but this was stopped after half a day owing to the danger of it flowing into and flooding units 1 and 2. From the second to tenth day after the accident, some 5000 tonnes of boron, dolomite, sand, clay, and lead were dropped on to the burning core by helicopter in an effort to extinguish the blaze and limit the release of radioactive particles.

Immediate impact of the Chernobyl accident

The accident caused the largest uncontrolled radioactive release into the environment ever recorded for any civilian operation, and large quantities of radioactive substances were released into the air for about 10 days. This caused serious social and economic disruption for large populations in Belarus, Russia, and Ukraine. Two radionuclides, the short-lived iodine-131 and the long-lived caesium-137, were particularly significant for the radiation dose they delivered to members of the public.

It is estimated that all of the xenon gas, about half of the iodine and caesium, and at least 5% of the remaining radioactive material in the Chernobyl 4 reactor core (which had 192 tonnes of fuel) was released in the accident. Most of the released material was deposited close by as dust and debris, but the lighter material was carried by wind over Ukraine, Belarus, Russia, and to some extent over Scandinavia and Europe.

The casualties included firefighters who attended the initial fires on the roof of the turbine building. All these were put out in a few hours, but radiation doses on the first day caused 28 deaths – six of which were firemen – by the end of July 1986. The doses received by the firefighters and power plant workers were high enough to result in deterministic effects, in the form of acute radiation syndrome (ARS). These effects occur if a person is exposed to more than 700 milligrays (mGy; doses which are large enough to produce deterministic effects are measured in grays) within a short time frame (usually minutes), and common ARS symptoms include gastrointestinal problems (*e.g.* nausea, vomiting), headaches, burns and fever.

Three Mile Island Accident

The three mile island(a city) Unit 2 reactor, near Middletown, Pa., partially melted down on March 28, 1979. This was the most serious accident in U.S. commercial nuclear power plant operating history, although its small radioactive releases had no detectable health effects on plant workers or the public. Its aftermath brought about sweeping changes involving emergency response planning, reactor operator training, human factors engineering, radiation protection, and many other areas of nuclear power plant operations. It also caused the NRC to tighten and heighten its regulatory oversight. All of these changes significantly enhanced U.S. reactor safety.

A combination of equipment malfunctions, design-related problems and worker errors led to TMI-2's partial meltdown and very small off-site releases of radioactivity.

Summary of Events

The accident began about 4 a.m. on Wednesday, March 28, 1979, when the plant experienced a failure in the secondary, non-nuclear section of the plant (one of two reactors on the site). Either a mechanical or electrical failure prevented the main feedwater pumps—component from sending water to the steam generators that remove heat from the reactor core . This caused the plant's turbine-generator and then the reactor itself to automatically shut down. Immediately, the pressure in the primary system (the nuclear piping portion of the plant shown in orange) began to increase. In order to control that pressure, the pilot-operated relief valve opened. It was located at the top of the pressurizer. The valve should have closed when the pressure fell to proper levels, but it became stuck open. Instruments in the control room, however, indicated to the plant staff that the valve was closed.

As a result, the plant staff was unaware that cooling water in the form of steam was pouring out of the stuck-open valve. As alarms rang and warning lights flashed, the operators did not realize that the plant was experiencing a loss-of-coolant accident.

Other instruments available to plant staff provided inadequate or misleading information. During normal operations, the large pressure vessel that held the reactor core was always filled to the top with water. So there was no need for a water-level instrument to show whether water in the vessel covered the core. As a result, plant staff assumed that as long instruments showed that the pressurizer water level was high enough, the core was properly covered with water too. That wasn't the case.
Unaware of the stuck-open relief valve and unable to tell if the core was covered with cooling water, the staff took a series of actions that uncovered the core. The stuck valve reduced primary system pressure so much that the reactor coolant pumps started to vibrate and were turned off. The emergency cooling water being pumped into the primary system threatened to fill up the pressurizer completely—an undesirable condition—and they cut back on the flow of water. Without the reactor coolant pumps circulating water and with the primary system starved of emergency cooling water, the water level in the pressure vessel dropped and the core overheated.

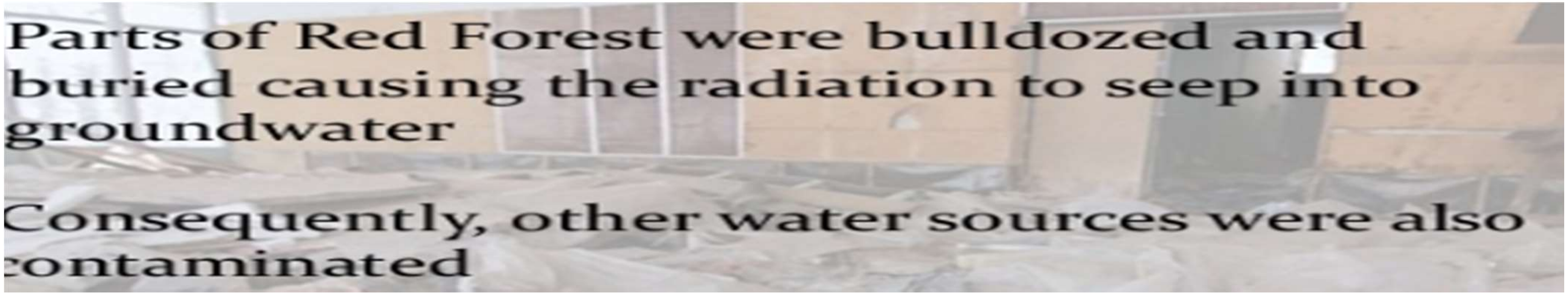
Two Significant types of radionuclides released in the atmosphere

1. Iodine-131 (8 day half-life)
2. Caesium-137(30 year half-life)

Health Effects

The approximately 2 million people around TMI-2 reactor during the accident are estimated to have received an average radiation dose of only about 1 millirem above the usual background dose. To put this into context, exposure from a chest X-ray is about 6 millirem and the area's natural radioactive background dose is about 100-125 millirem per year for the area. The accident's maximum dose to a person at the site boundary would have been less than 100 millirem above background.

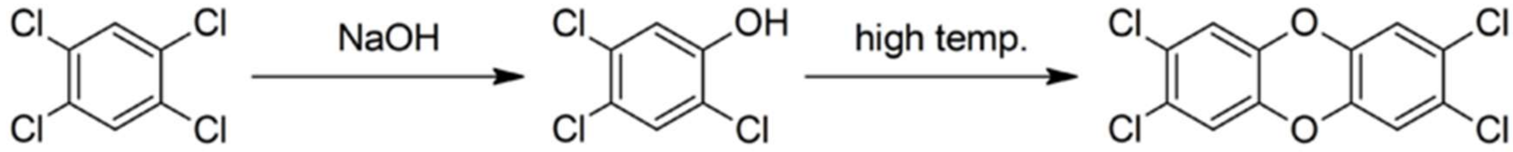
Radiation released by the was carried directly over what is now called the Red Forest. Radioactive particles settled on trees, killing approximately 400 hectares of pine forest. The Red Forest is now one of the most contaminated terrestrial habitats on earth.



Few wild animals lived in the region in 1986 because their habitats had been destroyed for Soviet dairy farms and pine plantations. But, surprisingly, large mammals started appearing almost immediately after the evacuations, and animal populations soon saw a rise (Mycio; 2013)

SEVESO DISASTER

- 10 July 1976
- Seveso, Lombardy, Italy
- ICMESA (Industrie Chimiche Meda Società Azionaria)
- Run-away reaction
- Desired product :2,4,5 trichlorophenol sodium salt (TCP)
- side product :2,3,7,8 tetrachloro dibenzo dioxin (TCDD)
  - TCP a toxic substance used in herbicides and for the preparation of cosmetics .



1,2,4,5-tetrachlorobenzene

2,4,5-trichlorophenol

TCDD-DIOXINE HIGHLY TOXIC SIDE PRODUCT

The chemical-release accident occurred when a batch process was interrupted prior to the completion of the final step – removal of ethylene glycol from the reaction mixture by distillation

Cause of the Incident:

- Stopping of the uncompleted process
- Addition of water was not carried out hence temp remained 158 ^0C
- Steam present in the jacket continued to heat the reactor
- Stopping of agitation process and cooling process .
- Operator left the site

Immediate Effects

- Within days a total of 3,300 animals, mostly poultry and rabbits, were found dead. Emergency slaughtering commenced to prevent TCDD from entering the food chain, and by 1978 over 80,000 animals had been slaughtered. 15 children were quickly hospitalised with skin inflammation
- By the end of August, Zone A had been completely evacuated and fenced, 1,600 people of all ages had been examined and 447 were found to suffer from skin lesions or chloracne and blurred vision .
- Italian government allotted 40 billion lire (US $47.8 million) for quarantining and decontaminating the area. This amount would be tripled two years later.

Minamata disaster

Minamata disease was first discovered in Minamata City in Kumamoto prefecture, Japan in 1956. It was caused by the release of methylmercury in the industrial wastewater (point source pollution) from the Chisso Corporation's chemical factory, which continued from 1932 to 1968. This highly toxic chemical bioaccumulated in shellfish and fish in Minamata Bay and the Shiranui Sea, which when eaten by the local populace resulted in mercury poisoning. While cat, dog, pig and human deaths continued over more than 30 years, the government and company did little to prevent the pollution.

Minemata disease: It is a neurological syndrome caused by severe mercury poisoning. Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision and damage to hearing and speech. In extreme cases, insanity, paralysis, coma and death follow within weeks of the onset of symptoms. A congenital f

- The chemical reaction used to produce the acetaldehyde used mercury sulfate as a catalyst
- A side reaction of the catalytic cycle led to production of methylmercury
- Methylmercury is an organic mercury compound
- Methylmercury is a highly toxic compound
- Wastewater from the Chisso factory were released into Minamata Bay

- Minamata is a small factory town dominated by the Chisso Corporation.
- The town faces the Shiranui Sea, and Minamata Bay is part of this sea.
- In Japanese, "Chisso" means nitrogen.
- The Chisso Corporation was once a fertilizer and carbicle company, and gradually advanced to a petrochemical and plastic-maker company.

- From 1932 to 1968, Chisso Corporation, a company located in Kumamoto Japan, dumped an estimated 27 tons of mercury compounds into Minamata Bay.
- When Chisso Corporation dumped this massive amount of mercury into the bay, thousands of people whose normal diet included fish from the bay, unexpectedly developed symptoms of methyl mercury poisoning.
- The illness became known as the "Minamata Disease".

$$H_3C{-}Hg^{+}\ X^{-}$$

Methylmercury, an organic mercury compound released in factory wastewater and the cause of Minamata disease.

In February 1959, the mercury distribution in Minamata Bay was investigated. The results shocked the researchers involved. Large quantities of mercury were detected in fish, shellfish, and sludge from the bay.

Minamata disease is a disease of the central nervous system, a poisoning caused by long-term consumption, in large amounts, of fish and shellfish from Minamata Bay. The causative agent is methylmercury. Methylmercury produced in the acetaldehyde acetic acid facility of Shin Nihon Chisso's Minamata factory was discharged in factory wastewater... Minamata disease patients last appeared in 1960, and the outbreak has ended. This is presumed to be because consumption of fish and shellfish from Minamata Bay was banned in the fall of 1957, and the fact that the factory had waste-treatment facilities in place from January 1960.

INDUSTRIAL POLLUTION

Cement Industry

Cement manufacturing involves mining; crushing, and grinding of raw materials; calcination in a rotary/vertical kiln; cooling of the clinker; mixing with gypsum; and milling, storing, and bagging the finished cement.

The process is very energy-intensive.

Gases from kiln and clinker cooler are used to preheat combustion air and also to generate power.

Solid waste products from other industries, such as fly ash , slag, roasted pyrite residues, and foundry sand, are used as additives in cement production.

Pollution Prevention and Control

Cement industry's focus is on reducing ambient particulate emission by reducing the mass load emitted from the stacks, and other sources up to less than 0.2 kilograms of dust per metric ton (kg/t) of clinker using dust recovery systems.

NOx emissions are controlled using proper kiln design, low-NOx burners, and an optimum level of excess air. NOx emissions are typically 1.5 kg/t of clinker. The nitrogen oxide emissions can be reduced further, to 0.5 kg/t of clinker, by after- burning in a reducing atmosphere, and the energy of the gases can be recovered in a preheater/ precalciner.

SOx emissions are best controlled by using low- sulfur fuels and raw materials. SO2 emissions is not a serius issue as the "S" compounds in flue gases react with Lime in cement and get a trapped in cement. The lime content of raw materials can be used to control sulfur oxides.

Alkaline dust removed from the kiln gases is normally disposed of as solid waste. When solid wastes such as pulverized fly ash are used with feedstock, appropriate steps are taken to avoid environmental problems from contaminants or trace elements.

Prevention and Control of Pollution

1 Choose the cleanest fuel economically available (natural gas is preferable to oil, which is preferable to coal).

Give preference to high-heat-content, low-ash, low-sulfur coal (or high-heat-content, high- sulfur coal, in that order) and consider beneficiation for high-ash, high-sulfur coal.

Select the best power generation technology for the fuel chosen to balance the environmental and economic benefits. The choice of technology and pollution control systems will be based on the site-specific environmental assessment.

2 Keep in mind, particulates smaller than 10 microns in size are most important from a health perspective. Acceptable levels of particulate matter removal are achievable at relatively low cost. Consider cost-effective technologies such as pre-ESP sorbent injection, along with coal washing, before in-stack removal of sulfur di-oxide. Use low-NOx burners and other combustion modifications to reduce emissions of nitrogen oxides.

Before adopting expensive control technologies, consider using offsetting reductions in emissions of critical pollutants at other sources within the air shed to achieve acceptable ambient levels.

3 Use SOx removal systems that generate less wastewater, if feasible; however, the environ-mental and cost characteristics of both inputs and wastes should be assessed case by case.

Manage ash disposal and reclamation so as to minimize environmental impacts—especially the migration of toxic metals, if present, to nearby surface and groundwater bodies, in addition to the transport of suspended solids in surface runoff. Consider reusing ash for building materials.

SUGAR INDUSTRY-MANUFACTURING PROCESS

No	Process	Waste produce
1	Cut the Can from the fields	
2	Washed in water	
3	cut into small pieces	
4	crushed : to extract the raw juice .	solid waste in the form of bagasse
5	Heated to 102^{0}C with lime	
6	Settled in multitray clarifiers to remove suspended solids and unreacted lime from the juice.	Sludge called 'lime mud'.
7	Dewatered on vacuum filters and the filtrate is recycled	The dewatered lime mud is disposed of
8	The clarified juice is treated with sulphur dioxide to remove its pale yellow colour , Double carbonation may also be done.	
9	The juice is then heated further to remove moisture from it	
10	Passed through vacuum pans and crystallizers for further removal of moisture and to encourage crystallization.	
11	Centrifugation of the juice separates the crystals from the remaining moisture. 'molasses'	molasses
12	The sugar crystals sticking to the wall of the centrifuge are scraped off	
13	Sieved	
14	Graded and Packed in bags.	

Effects of Effluents The immediate oxygen demand of sugar factory effluents causes rapid depletion of the dissolved oxygen of receiving streams resulting in anaerobic conditions. This results in the release of foul odours and in the production of hydrogen sulfide which precipitates iron as black sulfide leading to unsightly appearance. All these effects make the water totally unfit for fish and other aquatic life. Also, the dissolved and suspended solids deteriorate slowly resulting in bastions ordours.

Sugarcane, an agricultural waste consists of tops, leaves (STL) and fresh. STL are made up of top immature portion and the green leaves of the sugarcane plant. During the growth of the cane plant, as new leaves emerge, the older ones die and dry off. These are referred to as dry ash.

Environemntal Effects of sugar industry pollution

Being the most polluting industry, effluents discharged by sugar factories, if not treated, would inflict a serious damage to the environment. Even though, sugar industrial pollution is not toxic and detrimental to environment as such effluents from tanneries, paper mill and refineries, but large quantities of wastewater discharged have high pollutional effects on the surrounding. The high concentration of suspended solids in the raw effluents cause blockage in drains and ditches and also delayed pollutional effects due to slow decomposition of the selected matter. Effluents containing high salt concentration and toxic due to acidic and alkaline damage aquatic life. In case, if the effluents are directly discharged into a stream or river, the loss of aquatic life will be high. The other worst effect is the development of obnoxious odour in the contaminated stream. The bad odour, if inhaled by humans and animals, is inflicting to serious health effect. The septic condition of contaminated water, seen in black colour due to precipitation of iron by hydrogen sulphide, produces hydrogen sulphide gas which is bad for the surroundings.

Methods of Treatment

The effluent coming out of the sugar mill is screened on a filter (or) DSM screen to separate out the factories particles. The oil and grease are separated in an oil separator. Lime is added continuously to make up the pH of two effluents to neutralization.

Culture Preparation: Before treating the effluent water, we should first prepare culture should be prepared first for treating the effluent. Culture should be prepared and kept ready before 15 days of the commencement of the season. The effluent water mixed with cowdung culture is then subjected to anaerobic digestion. The bacterial reaction of methane is visible to age. After anaerobic digestion the effluent is subjected to aerators digestion. In the aerobic digestion we have too Hg aerators of 10Hp each which aerotes the effluents water from the aerators. The treated effluent is pumped to clarified with stires where mud settles at the bottom and the clear water overflows. The clear water is used for irrigation.

Chemical Reaction in the Effluent Treatment Plant (ETP)

Biomethanation is a microbiological process associated in the break down of complete organic matters to methane gas, carbon dioxide and water in the absence of oxygen. The formation of methane gas has a key role in mehanogensis because it is related directly to Cod reduction of the waste water. Theoretically 350 ml of methane gas is generated for every gram of COD removed. The biological process of methanogenesis is a three stage degradation of complex organic materials. The organic compound present is the sugar mill waste first hydrolysed to their monomer glucose and fructose be extra cellulasenzymes produced by fermentative bacteria (culture from cowding mixture) which further converts the organic matter into volatile acid and methanogenic bacteria are

Drug pollution or pharmaceutical pollution is pollution of the environment with pharmaceutical drugs and their metabolites, which reach the marine environment (groundwater, rivers, lakes, and oceans) through wastewater. Drug pollution is therefore mainly a form of water pollution.

Prescription drug pollution may harm humans, aquatic life because of millions of doses of prescription drugs that been swallow annually to combat cancer, pain, depression and other ailments do not disappear harmlessly into their digestive systems.

Types:

"Pharmaceuticals", or prescription and over-the-counter medications made for human use .

"Personal care products" may include cosmetics, fragrances, menstrual care products, lotions, shampoos, soaps, toothpastes, and sunscreen.

Traces of illicit drugs can be found in waterways and may even be carried by many.

Effects on Human :

- No studies have shown a direct impact on human health. However, the absence of empirical data cannot rule out the possibility of adverse outcomes due to interactions or long-term exposures to these substances.

Effect on environment :

- While the full effects on the environment are not understood, there is concern about the potential they have for harm because they may act unpredictably when mixed with other chemicals from the environment or concentrate in the food chain.

There are four ways to reduce pharmacological pollution:

1. Limit drug purchase in bulk quantities
2. Use drug take back programs
3. Do not flush unused medicines and pour them down.
4. Be careful about how you throw medicines in the trash

SAFE DISPOSAL

Depending on the source and ingredients:

- **pharmaceutical products,** the most environmentally safe disposal method is to take advantage of a community drug take-back programs that collect drugs at a central location for proper disposal .
- **Personal Care Products:** participants may bring in vitamins and homeopathic remedies and other personal care products.
- **Another method used is biodegradation,** and through this method microorganisms, such as bacteria, feed or break down these pollutants thus eliminating them from the contaminated media.

In conclusion , drug pollution or pharmaceutical pollution is harmful type of pollution happens when humans from drug industries are irresponsible for their actions and contaminate the water with their unwanted drugs and pharmaceutical products.

it is not affecting the environment only , but also organisms living in water and becomes another dangerous reasons of humans behavior . therefore , to prevent issue like such , we human should tack our actions into consideration and do things that prevent drug pollution as well as raise awareness to educate those who do not know the consequences of this issue.

PAPER AND PULP INDUSTRY POLLUTION

INTRODUCTION

- The pulp and paper industry converts wood or recycled fibre into pulp and primary forms of paper.
- First mechanical and then chemical methods have been developed to produce pulp from wood.
- Pulp mills separate the fibres of wood or from other materials, such as rags, wastepaper or straw in order to create pulp.
- Paper mills primarily are engaged in manufacturing paper from wood pulp and other fibre pulp, and may also manufacture converted paper products.

ENVIRONEMENTAL PROBLEMS

Air emissions - Nitrogen dioxide and sulfur dioxide are major contributors of acid rain.

Deforestation

Water pollution - **solid waste** such as sludge derived from their pulping and bleaching operations.

Solid wastes - Dirty wood chips or fibers as well as bark

Energy use

The pulp and paper industry uses 84% of the **fuel energy** consumed by the forest products industry as a whole.

It is one of the largest producers of greenhouse gas (GHG) emissions.

Over the past few years, the pulp and paper industry has considerably reduced its GHG emissions by introducing energy conservation projects and by increasing its use of biomass as an energy source.

Pollutants in effluents

- The most common organic pollutants are suspended solids (SS):
  - lost cellulose fibre,
  - dissolved organic compounds such as dissolved lignin compounds, carbohydrates, starch and hemi-cellulose
- Acidic compounds are predominantly natural resin acids.
- Chlorinated organics are found if elemental chlorine is used in the process.

POLLUTION CONTROL MEASURES

1. Recycling: An average of 56% can be recyled
The recycling process includes sorting, dissolving
Mixing and paper making etc.
2. By the use of genetically modified trees. For
Eg. Lignin is the main wood component in pulp
And that must be removed.

Thermal Power Plant:

"A thermal power plant is a power plant in which the prime mover is stream. Water is heated, turns into steam and spins a turbine which drives an electrical generator. After it passes through the turbine, the steam is condensed in a condenser and recycled to where it was heated, this is known as a Rankine cycle.

TYPES OF POLLUTION CONTROL METHODS ADOPTED IN THERMAL POWER PLANTS

AIR POLLUTION CONTROL

Electrostatic precipitators
Low NOX burners
Flue gas stack
Dry ash extraction

WATER POLLUTION CONTROL

Coal/oil setting pits
Ash dykes & disposal systems
Ash water recycling system
Effluent treatment plant

THERMAL POLLUTION CONTROL

NOISE POLLUTION CONTROL

Pollution control devices

ELECTROSTATIC PRECIPITATORS

The ash left behind after combustion of coal is arrested in high efficiency Electrostatic precipitators (ESP) and particulate emission is controlled well within the stipulated norms.

The ash collected in the ESP is disposed to ash ponds in slurry form.

Emission standard (world bank) Particulate matter (max)-50 microgram per cubic meter.

DRY ASH EXTRACTION SYSTEM

- Dry ash much higher utilization potential in ash based products e g

2. Land reclamation.
3. Structural land filling.
4. Road making.
5. Cement manufacturing.
6. Bricks manufacturing.

COAL & OIL SETTLING PITS

In these pits , coal dust and oil are removed from the effluents from coal handling plant ,coal yard and fuel oil handling areas before discharge into Effluent Treatment Plant (ETP).

ASH DYKES & ASH DISPOSAL SYSTEM

Ash ponds are provided for ash disposal.

Ash ponds are divided into lagoons and provided with garlanding arrangements for change over of the ash slurry feed points for even filling of the pond and for effective of ash particles.

Ash in slurry form is discharge into the lagoons where ash particle settled from the slurry and clear effluent water is discharge from ash ponds.

ASH WATER RECYCLING SYSTEM

The effluent water from ash pond is circulated back to the power plant for further slucing to the ash pond.

This helps in savings of fresh water requirement for transportation of ash from the plant.

NEUTRALIZATION PITS

Neutralization pits are provided in water treatment plant (WTP) for Ph correction of effluents before discharge into effluent treatment plant (ETP) for further treatment and use.

EFFLUENT TREATMENT PLANTS(ETP)

The objective of industrial liquid effluent treatment plant (ETP) is discharge clean effluent from the power plants to meet environmental standards and to reduce intake water requirement.

The scheme involves collection of various effluents and their appropriate treatment centrally and recirculation of the treated effluent for various plant uses.

NUCLEAR POWER PLANT

Nuclear energy originates from the splitting of uranium atoms – a process called fission. This generates heat to produce steam, which is used by a turbine generator to generate electricity. Because nuclear power plants do not burn fuel, they do not produce greenhouse gas emissions

CAUSES OF NUCLEAR POLLUTION

- Uranium mining
- Production of nuclear fuel
- Nuclear power reactors
- Transportation of Nuclear Matters
- Nuclear Accidents
- Nuclear tests carried out by the Defense Personnel; and
- Disposal of nuclear waste.

EFFECTS OF NUCLEAR POLLUTION

- Weakens the immune system of the body.
- When the radioactive material is shipped via water then it can also cause toxicity in water and we use the same water for various purposes.
- Nuclear pollution is another major cause of earth warming.
- Skin Diseases.
- Damages the reproductive organs.
- Destroys the Retina of Eyes.
- Shortening of life span.

CONTROL OF NULEAR POLLUTION

- Proper maintenance of nuclear plants.
- The disposal of radioactive material must be safe and secure.
- Ban usage of Nuclear weapons.
- Safe transportation.
- Proper storage.
- Preventive nuclear experiments.
- Fission reactions need to be minimized.
- Minimize use of nuclear elements.

Nuclear Waste and radionuclide analysis

- Nuclear wastes are wastes that contain radioactive material. Nuclear wastes are usually by-products of nuclear power generation and other applications of nuclear fission or nuclear technology.

Nuclear Waste Classification:

1. Solid waste 2. liquid wastes and 3. Gaseous waste

Classification on the basis of radio-activity

1. High level wastes, 2. Medium level wastes and 3. low level wastes

Ways for Disposal of Wastes

Liquid Waste - The disposal of liquid wastes is done in two ways:

1. ***Dilution*** - The liquid wastes are diluted with large quantities of water and then released into the ground. This method suffers from the drawback that there is a chance of contamination of underground water if the **dilution factor** is not adequate.

2. **Concentration to small volumes and storage** - When the dilution of radioactive liquid wastes is not desirable due to amount or nature of isotopes, the liquid wastes are concentrated to small volumes and stored in underground tanks. The tanks should be of assured long term strength and leakage of liquid from the tanks should not take place otherwise leakage of contents, from the tanks may lead to significant underground water contamination.

Gaseous Waste - Gaseous wastes can most easily results in atmospheric pollution. Gaseous wastes are generally diluted with air, passed through filters and then released to atmosphere through large chimneys.

Solid Wastes - Solid wastes consists of scrape material or discarded objects contaminated with radioactive matter. These wastes if combustible are burnt and the radioactive matter is mixed with concrete, drummed and shipped for burial. Non-combustible solid wastes, are always buried deep in the ground.

Disposal of low level wastes

- Low level radioactive waste consists of:
  - Contaminated solids
  - liquids
  - animal carcasses
  - small sealed sources
- Radioactive animal carcasses are either incinerated or buried onsite.
- The nuclear wastes is cast in cement in steel drum and are buried either or kept at the bed of oceans.
- 90% of wastes are of low level quality.

Disposal of medium level wastes

- Medium level waste requires shielding when being handled.
- 7% volume of wastes.
- Dependent on the amount of activity it can be buried in shallow repositories.
- These wastes are mainly contaminated with neutron activation product isotopes.

Disposal of high level wastes

- High level waste has a large amount of radioactive activity and is thermally hot.
- 3% volume of waste
- 95% of radioactivity
- Current levels of HLW are increasing about 12,000 metric tons per year.
- Most HLW consists of Pu-238, 239, 240, 241, 242, Np-237, U-236

Objective of Radioactive Waste Management

To protect radiation workers, general public and their environment from potential hazards arising from waste

Rad.Waste from Nuclear Fuel Cycle

- Mining and Milling,
- Fuel Fabrication,
- Nuclear Power Generation
- Reprocessing & Waste Management
  - Fission products: Cs^{137}, I^{131}, Sr^{90}
  - Activation products: Ar^{41}, Co^{60}, H^{3}
  - Solid and Liquid Waste from decontamination of equipment, spaces and materials, contaminated equipment etc.

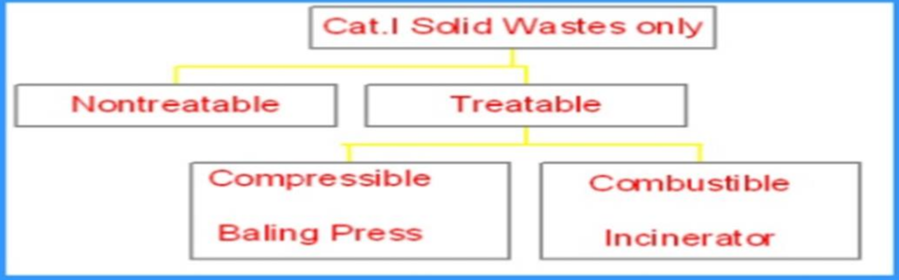
Basic Philosophies of Waste Management

- **➢Delay and decay**
- **➢Dilute and disperse**
- **➢Concentrate & contain**

CLASSIFICATION OF SOLID WASTE

CATEGORY	SURFACE DOSE [D] (mR/h)	REMARKS
I	D < 200	No shielding required
II	200 < D < 2000	Some shielding
III	D > 2000	Shielding required
IV	Alpha Contaminated (Bq/m^3)	Specially treated

TREATMENT OF SOLID WASTES



MANAGEMENT OF GASEOUS WASTES

- Particulate Removal
  - High Efficiency Filter
- Gaseous Waste Removal
  - Charcoal Filter & Molecular Sieve

- Gaseous Wastes from Nuclear Power Plants
  - Particulate Filter System (such as HEPA)
  - Iodine Adsorption System
  - Noble Gas Delay System
- Gaseous Wastes from Fuel Reprocessing Plants
  - ^{85}Kr by cryogenic distillation and adsorption
  - ^{129}I by caustic scrubbing

Some commonly used radionuclides:

Naturally-occurring radioisotopes:

Carbon-14: Used to measure the age of water (up to 50,000 years).

Chlorine-36: Used to measure sources of chloride and the age of water (up to 2 million years).

Lead-210: Used to date layers of sand and soil up to 80 years.

Tritium (H-3): Used to measure 'young' groundwater (up to 30 years).

Artificially-produced radioisotopes:

Americium-241:Used in backscatter gauges, smoke detectors, fill height detectors and in measuring ash content of coal.

Caesium-137:Used for radiotracer technique for identification of sources of soil erosion and deposition, in density and fill height level switches. Also for low-intensity gamma sterilisation.

Chromium-51 and Gold-198:Used to label sand to study coastal erosion, also a tracer in study of blood.

Cobalt-60, Lanthanum-140, Scandium-46, Silver-110m, Gold-198:Used together in blast furnaces to determine resident times and to quantify yields to measure the furnace performance.

Cobalt-60:Widely used for gamma sterilisation, industrial radiography, density and fill height switches.

Gold-198 & Technetium-99m:Used to study sewage and liquid waste movements, as well as tracing factory waste causing ocean pollution, and to trace sand movement in river beds and ocean floors.

Hydrogen-3 (Tritiated Water): Used as a tracer to study sewage and liquid wastes.

Iridium-192 Selenium-75, Ytterbium-169 :Used in gamma radiography and non-destructive testing

Krypton-85 , Strontium-90, Thallium-204: Used for industrial gauging.

Manganese-54 and Zinc-65:Used to predict the behaviour of heavy metal components in effluents from mining waste water.

Nickel-63:Used in light sensors in cameras and plasma display, also electronic discharge prevention and in electron capture detectors for thickness gauges.

Adverse effects of radioactive waste

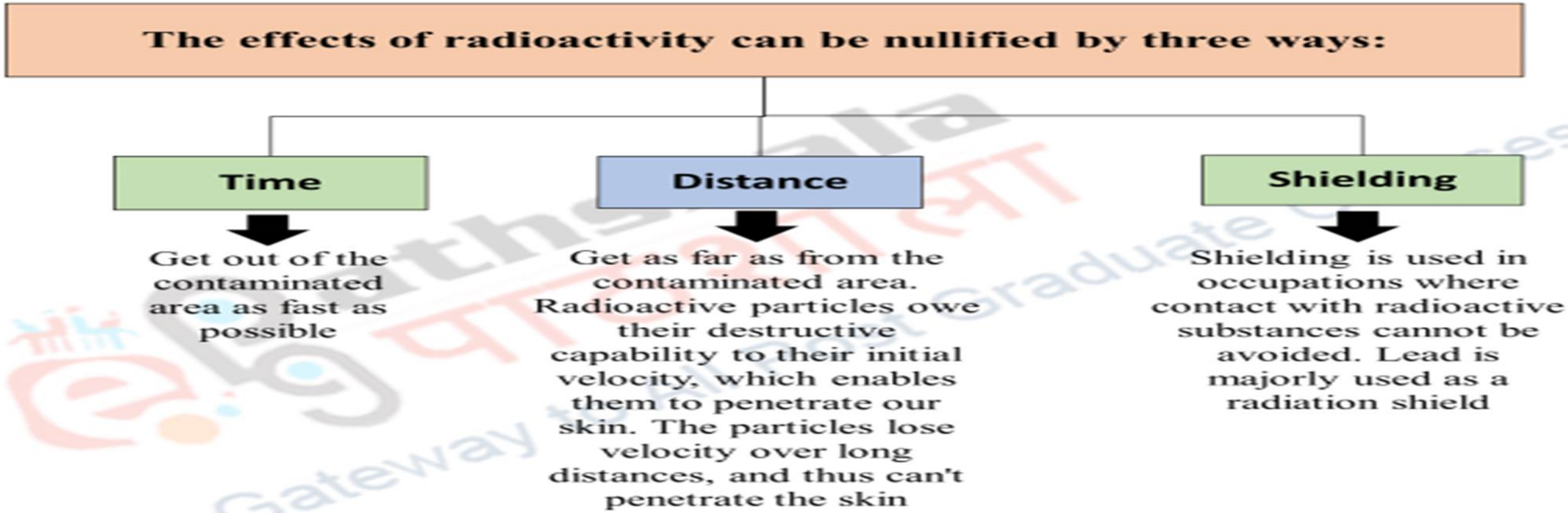
On the environment

- Radioactive substances contaminate soil by transferring harmful substances into the growing plants resulting genetic mutation and affects the plant's normal functioning. Some plants may die after such exposure, while others may develop weak seeds. Eating any part of the contaminated plant, primarily fruits, poses serious health risks. Since plants are the base of all food chains, their contamination can lead to radioactive deposition all along the food web. Similarly, when radioactive waste is washed up in a water source, it can affect the entire aquatic food web.
- Both terrestrial and aquatic radioactive contamination can culminate in human consumption. Since humans are apex predators, the accumulation of radioactive materials on the last rung of the food chain would be maximum. Both ^{106}Ru and ^{137}Cs have been found to accumulate in fish muscle (plaice) and in crab *Cancer pagurus* hepatopancreas and muscle tissue. Crabs were found to accumulate ^{144}Ce and $^{95}Zr/^{95}Nb$ in addition to ^{106}Ru and ^{137}Cs. The most significant uptake route for these species is believed to be via the diet.

On human beings

- Human beings are affected by radioactive pollution in variable magnitude depending upon the level and duration of exposure to radioactivity. Low level exposure may have a mild skin irritation. On the other hand long-term exposure or exposure to high amounts of radiation can have far more serious health effects. This can result in irreparable DNA damaging leading to a life-threatening condition. Continuous exposure to radioactive substance lead to ionization of large number of molecules inside the body into free radicals. These free radicals then increase the rate of multiplicity of cancerous cells, i.e. tumors, in the body. People with heavy radiation exposure are at a very high risk for cancers.

- The cells undergoing rapid cell division are more sensitive to radioactive pollution such as skin, bone marrow, intestines, and gonads. On the other hand, cells that do not undergo rapid cell division, such as bone cells and nervous cells, aren't damaged so easily. Skin cancer, lung cancer and thyroid cancer are some of the common types of cancers caused by radiation.



TREATMENT

The radioactive pollution can be minimized by storing radioactive substances for an appropriate time before dumping. Generally, after a period of 7 to 10 half-lives the radioactivity could decay appropriately so as to allow the contents to be disposed into the municipal dump as normal waste. The radioactive waste can be treated depending upon the state of wastes under the three heads, solid, liquid and gaseous.

Solid: Solid wastes are generally treated as first for volume reduction by compaction or by incineration. Further treatment of wastes so reduced in volume depends on their level of activity. If such wastes carry low and short lived activity, they are put directly in shallow earth trenches. If they contain higher radioactivity with longer half – life they are put in RCC trenches either directly or after fixing it with concrete in drums. If solid wastes are highly radioactive with long lived nuclides they are first immobilised in concrete/bitumen and further covered by adequate thickness of concrete. Containment of such deep trenches is further improved by steel lining if necessary. The location of storage/ disposal sites is selected after thorough site investigation in terms of geohydrology, geochemistry and other soil and sub-soil characteristics.

Liquid: Liquid wastes by their very mobile nature need to be stored carefully and managed efficiently. Their treatment depends on their category

LLW: These treatment are specific with respect to sites and the operations and consist mainly of chemical precipitation and ion exchange treatment. The treated effluent is then discharged into a waterbody after ensuring adequate dilution. The sludge (Solid) or the resin containing radioactivity is fixed in cement matrix and disposed off as solid waste.
ILW: The ILW, mostly from fuel reprocessing plant, are chemically treated in a way similar to LLW. The sludge/ion exchange resin are conditioned in Bitumen matrix and then stored. More recently polymer matrices have been used for immobilization of spent ion – exchange resins and higher active waste concentrates.
HLW: It arises from the processing of spent fuel for the recovery of Plutonium. Practically all the radioactivity (99% or more) is first concentrated and then stored in liquid form in Stainless Steel Tanks surrounded by concrete shield and cooled with water if required.

Gases: These wastes are mainly in the form of ventilation air and in a few cases consist of volatile products generated during certain chemical reactions. Its management is an integral part of the general plant ventilation system and takes place at or near the plant sites. The degree of decontamination /filtration required for the exhaust air, coming either from the vessel/a cell or general ventilation, is worked out in advance and scrubbers/charcoal filters/absolute filters/HEPA filters are installed accordingly. It further involves the combination of principles that is collections and concentration of air through a well-designed stack. The height of stack and efflux velocity through it are so chosen that the ground level concentrations, after atmospheric dispersion, at the site boundary are within the allowable levels.