MODULE – IV

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ENVIRONMENTAL IMPACT OF POWER PLANT

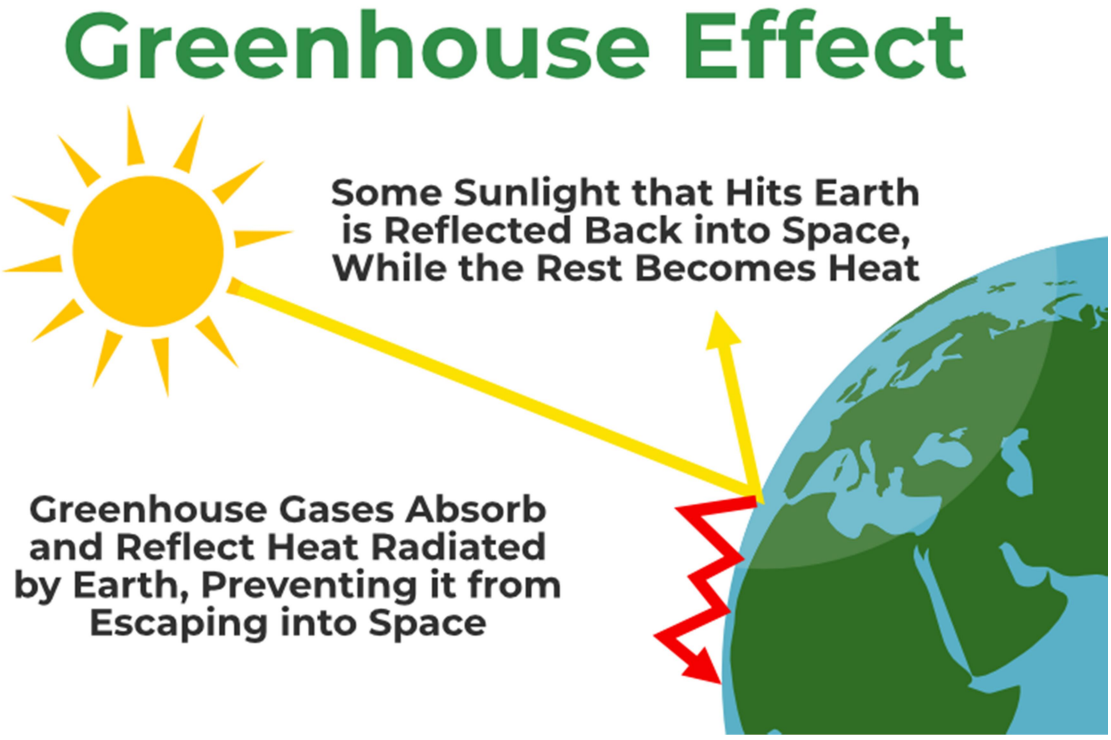
4.1.GREENHOUSE EFFECT

Greenhouse Effect is a natural process that occurs in Earth's atmosphere, where certain Greenhouse gases trap heat from the sun and keep the planet's temperature within a range that is suitable for life. The greenhouse effect is important for maintaining the balance of the Earth's climate, but human activities such as burning fossil fuels have caused an increase in the concentration of greenhouse gases, leading to an enhanced greenhouse effect and global warming.

A greenhouse is a glass structure used to grow plants. The sun's beams warm the plants and the air in the greenhouse. The trapped heat cannot leave, therefore warming the greenhouse, which is required for plant growth. The same may be said for the atmosphere. The sun heats the earth's atmosphere during the day. Heat is reflected into the atmosphere as the ground cools at night. Heat is absorbed by greenhouse gases in the earth's atmosphere during this process. This is what keeps the surface of the world warm and allows life to exist.

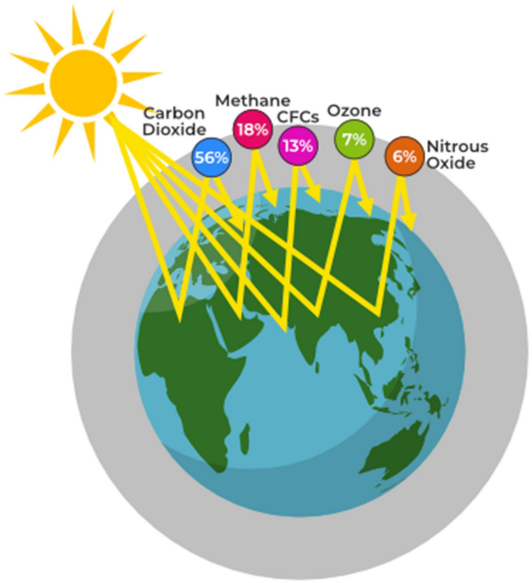
Through the glass, solar energy enters a greenhouse, warming the soil and atmosphere and stimulating plant development. The earth and plants emit infrared radiation, which the glass absorbs and reflects in various ways. This traps the sun's energy in the greenhouse. Carbon dioxide absorbs heat and strongly contributes to global warming.

In addition to carbon dioxide, greenhouse gases such as methane, ozone, CFCs, and nitrous oxide have a significant role. These compounds are either naturally occurring or created by humans. These compounds should be used less frequently; else, the average temperature of the planet would rise. As a result, the polar ice caps will melt, flooding coastal areas. As the world temperature rises, diseases such as dengue fever, malaria, and yellow fever become more common.



4.1.1. Greenhouse Gases

Gases those absorb the infraraid tradition from the surface of earth and cause the greenhouse effect is known as **Greenhouse Gases**.



The atmosphere contains several chemical substances that serve as greenhouse gases. These gases allow sunlight to readily flow through the Earth's atmosphere and heat the land and oceans. This heat is released by the warmed Earth in the form of infrared light, which is invisible to the human eyes. Some infrared light emitted by the Earth returns to space via the atmosphere. Green house gases major producer are factories, deforestation automobiles pollution, etc. Greenhouse gases, on the other hand, will prevent all infrared light from passing through the atmosphere. They absorb some of it and return it to the Earth. The greenhouse effect is a naturally occurring phenomenon that keeps the Earth's surface warm. It is critical to our survival on our planet. The Earth's average surface temperature would be around 60 degrees Fahrenheit (15.56 °C) colder without the greenhouse effect, making our existing way of life unthinkable.

Greenhouses gases can further be divided into 2 types:

1. Direct Greenhouse Gases: Gases that directly absorb the rays are known as direct greenhouse gases. Examples: Ozone, Carbon dioxide.
2. Indirect Greenhouse Gases: They are not capable to absorb rays on their own, but they form those gases that absorb the rays, such gases known as indirect greenhouse gases. Example: Methane, Carbon monoxide.

4.1.2. Causes of Greenhouse Effect

Due to some process that directly accelerates the greenhouse effect. Those causes are:

1. Burning of Fossil Fuels

Transportation and power generation both rely on fossil fuels. When fossil fuels are burned, carbon dioxide is released. As the world's population has expanded, so has the use of fossil fuels. As a result, the atmospheric concentration of greenhouse gases has risen.

2. Deforestation

Plants take carbon dioxide and release it as oxygen. Cutting down trees causes a huge increase in greenhouse gases, which causes global warming.

3. **Farming**

   Fertilizers include nitrous oxide, which adds to the greenhouse effect on the environment.

4. **Industrial Waste and Landfills**

   Industries and industries emit hazardous gases into the atmosphere. Landfills also emit CO_2 and methane, both of which contribute to global warming.

4.1.3. Effects of Greenhouse Effect

Increase in temperature, which causes the greenhouse effect. Some are the effect causes due to the greenhouse effect:

1. **Global Warming**

   It is the progressive rise in the average temperature of the Earth's atmosphere. The fundamental source of this environmental issue is the growing amount of greenhouse gases such as carbon dioxide and methane emitted by the combustion of fossil fuels, as well as emissions from vehicles, factories, and other human activities.

2. **Depletion of the Ozone Layer**

   The ozone layer shields the Earth from the sun's damaging UV rays. It can be found at higher heights of the stratosphere. The depletion of the ozone layer allows harmful UV radiation to reach the earth's surface, potentially causing skin cancer and catastrophic climate change. The fundamental cause of this phenomenon is the accumulation of natural greenhouse gases such as chlorofluorocarbons, carbon dioxide, and methane, among others.

3. **Smog and Air Pollution**

   Smoke and fog mix to create smog. It could be caused by both natural and man-made factors. Smog is caused by the accumulation of additional greenhouse gases such as nitrogen and sulfur oxides. Smog is caused by automobile and industrial emissions, agricultural fires, natural forest fires, and chemical reactions between these compounds.

4. Acidification of Water Bodies

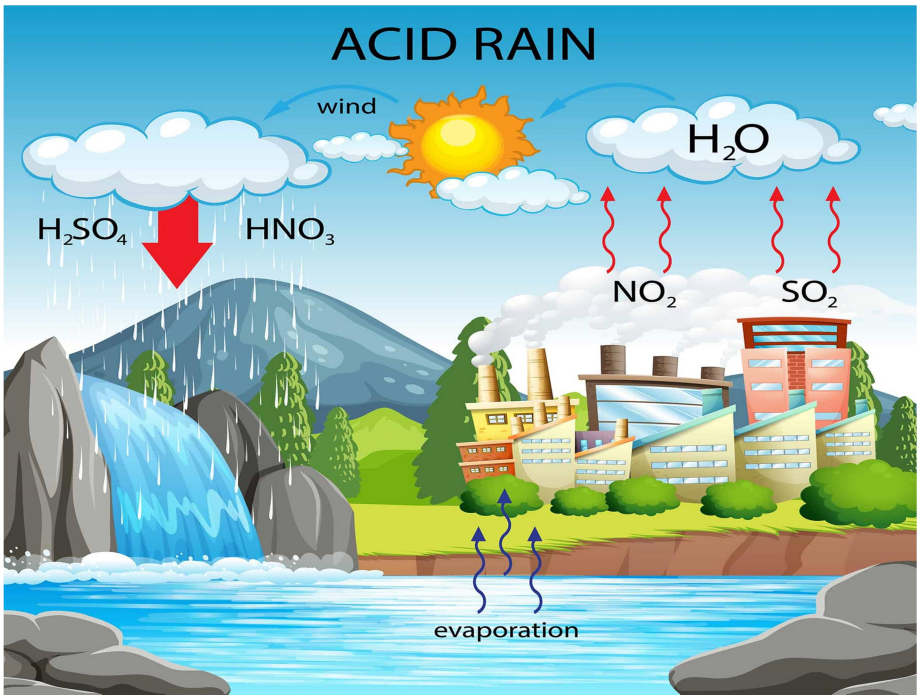
Most of the world's water bodies have become acidic as the total amount of greenhouse gases in the atmosphere has grown. When greenhouse gases and precipitation combine, acid rain is created. Water bodies become corrosive as a result. Precipitation also transports toxins to rivers, streams, and lakes, resulting in acidification.

4.1.4. Prevention Greenhouse effect

1. **Reduce Carbon Emissions:** The most effective way to prevent the greenhouse effect is to reduce carbon emissions. This can be achieved by using renewable energy sources, such as wind, solar, and hydro power, reducing dependence on fossil fuels, promoting energy efficiency, and adopting sustainable practices.
2. **Promote Afforestation:** Trees absorb carbon dioxide from the atmosphere and release oxygen, making afforestation a crucial measure for reducing greenhouse gas concentrations. Promoting afforestation, especially in urban areas, can also help to reduce air pollution and enhance the quality of life.
3. **Reduce Waste:** Landfills are a major source of greenhouse gas emissions. Reducing waste can help to reduce the amount of methane produced in landfills. This can be achieved by reducing, reusing, and recycling waste materials.
4. **Adopt Sustainable Agricultural Practices:** Agriculture is another major source of greenhouse gas emissions. Adopting sustainable agricultural practices, such as reducing fertilizer use, promoting organic farming, and adopting water conservation techniques, can help to reduce greenhouse gas emissions from agriculture.
5. **Promote Sustainable Transportation**: Transportation is a major source of greenhouse gas emissions. Promoting sustainable transportation, such as public transportation, carpooling, cycling, and walking, can help to reduce greenhouse gas emissions and improve air quality.

4.2.ACID RAIN

Acid rain, also called acid precipitation or acid deposition, precipitation possessing a ph of about 5.2 or below primarily produced from the emission of sulfur dioxide (SO2) and nitrogen oxides (no_x; the combination of NO and NO_2) from human activities, mostly the combustion of fossil fuels. In acid-sensitive landscapes, acid deposition can reduce the ph of surface waters and lower biodiversity. It weakens trees and increases their susceptibility to damage from other stressors, such as drought, extreme cold, and pests. In acid-sensitive areas, acid rain also depletes soil of important plant nutrients and buffers, such as calcium and magnesium, and can release aluminum, bound to soil particles and rock, in its toxic dissolved form. Acid rain contributes to the corrosion of surfaces exposed to air pollution and is responsible for the deterioration of limestone and marble buildings and monuments.



Acid rain is a popular expression for the more scientific term acid deposition, which refers to the many ways in which acidity can move from the atmosphere to Earth's surface. Acid deposition includes acidic rain as well as other forms of acidic wet deposition such as snow, sleet, hail, and fog (or cloud water). Acid deposition also includes the dry deposition of acidic

particles and gases, which can affect landscapes during dry periods. Thus, acid deposition is capable of affecting landscapes and the living things that reside within them even when precipitation is not occurring.

Normal rainwater is weakly acidic because of the absorption of carbon dioxide (CO_2) from the atmosphere—a process that produces carbonic acid—and from organic acids generated from biological activity. In addition, volcanic activity can produce sulfuric acid (H_2SO_4), nitric acid (HNO_3), and hydrochloric acid (HCl) depending on the emissions associated with specific volcanoes. Other natural sources of acidification include the production of nitrogen oxides from the conversion of atmospheric molecular nitrogen (N_2) by lightning and the conversion of organic nitrogen by wildfires. However, the geographic extent of any given natural source of acidification is small, and in most cases it lowers the pH of precipitation to no more than about 5.2.

Anthropogenic activities, particularly the burning of fossil fuels (coal, oil, natural gas) and the smelting of metal ores, are the major causes of acid deposition. In the United States, electric utilities produce nearly 70 percent of SO_2 and about 20 percent of NO_x emissions. Fossil fuels burned by vehicles account for nearly 60 percent of NO_x emissions in the United States. In the atmosphere, sulfuric and nitric acids are generated when SO_2 and NO_x, respectively, react with water. The simplest reactions are:

$$SO_2 + H_2O \rightarrow H_2SO_4 \longleftrightarrow H^+ + HSO_4 \longleftrightarrow 2H^+ + SO_4^{2-}$$

$$NO_2 + H_2O \rightarrow HNO_3 \longleftrightarrow H^+ + NO_3$$

These reactions in the aqueous phase (for example, in cloud water) create wet deposition products. In the gaseous phase they can produce acidic dry deposition. Acid formation can also occur on particles in the atmosphere.

Where fossil fuel consumption is large and emission controls are not in place to reduce SO_2 and NO_x emissions, acid deposition will occur in areas downwind of emission sources, often hundreds to thousands of kilometres away. In such areas the pH of precipitation can average 4.0 to 4.5 annually, and the pH of individual rain events can sometimes drop below 3.0. In addition, cloud water and fog in polluted areas may be many times more acidic than rain falling over the same region.

Many air pollution and atmospheric deposition problems are intertwined with one another, and these problems are often derived from the same cause, namely the burning of fossil fuels. In addition to acid deposition, NO_x emissions along with hydrocarbon emissions are key ingredients in ground-level ozone (photochemical smog) formation, which is one of the most widespread forms of air pollution. The SO_2 and NO_x emissions can generate fine particulates, which are harmful to human respiratory systems. Coal combustion is the leading source of atmospheric mercury, which also enters ecosystems by wet and dry deposition. (A number of other heavy metals, such as lead and cadmium, and various particulates are also products of unregulated fossil fuel combustion.) Acid deposition of nitrogen derived from NO_x emissions creates additional environmental problems. For example, many lake, estuarine, and coastal marine systems receive too much nitrogen from atmospheric deposition and terrestrial runoff. This eutrophication (or over-enrichment) causes the overgrowth of plants and algae. When these organisms die and decompose, they deplete the dissolved oxygen supply necessary for most aquatic life in water bodies. Eutrophication is considered to be a major environmental problem in lake, coastal marine, and estuarine ecosystems worldwide.

4.2.1. Effects of Acid Rain

1. Acid rain is very harmful to agriculture, plants, and animals. It washes away all nutrients which are required for the growth and survival of plants. Acid rain affects agriculture by the way it alters the composition of the soil
2. It causes respiratory issues in animals and humans.

3. When acid rain falls down and flows into the rivers and ponds it affects the aquatic ecosystem. It alters the chemical composition of the water, to a form which is actually harmful to the aquatic ecosystem to survive and causes water pollution.
4. Acid rain also causes the corrosion of water pipes, which further results in leaching of heavy metals such as iron, lead and copper into drinking water.
5. It damages the buildings and monuments made up of stones and metals.

4.2.3. Prevention of Acid Rain

1. The only precaution that we can take against acid rain is having a check at the emission of oxides of nitrogen and sulphur.
2. Acid rain is harmful to animals, plants and the monuments.
3. Being responsible citizens, one should be aware of the harmful effects they cause and of the industries which give out nitrogen and sulphur compound wastes unethically.

4.3. AIR POLLUTION FROM POWER PLANTS

The environmental pollution by thermal power plants using fossil fuels poses a serious health hazard to modern civilization. Air pollution by thermal plants is a contributing factor in the cause of various respiratory diseases and lung cancer and causes significant damage to the property in addition to causing annoyance to the public.

The thermal power plants burning conventional fuels (coal, oil or gas) contribute to air pollution in a large measure. The combustible elements of the fuels are converted to gaseous products, and noncombustible elements as ash. The common gaseous products of interest are sulphur dioxide, nitrogen oxide, carbon dioxide and carbon monoxide, and large quantities of particulate materials as fly ash, carbon particles, silica, alumina and iron oxide.

The energy industries are one of the largest sources of environmental pollution. A 350 mW coalfired station emits about 75 tons of SO2, 16 tons of nitrogen oxide, and 500 tons of ash per day if no safeguards is adopted. All steam-generating plants also discharge nearly 60% of heat produced back to the atmosphere irrespective of the fuel used.

Due to large emissions from the thermal power plants, air pollution has become an international problem. This problem is mainly faced by 11 countries in the world, which share 80% of the world's fossil-fired generating capacity. Emissions from their power plants have grown to point where we and all of them now must think for controlling the pollution contributing to a common atmosphere.

Many countries have unique air pollution problems. These are due to fuel characteristics, unfavorable topographical conditions, concentration of power plants in limited area and high population densities. The production capacities of 11 countries, which share 80% world-electric generation. The major pollutants given off by fossil fuel combustion are particulates, SO2 and other gases and it will be sufficient to discuss about these pollutants.

4.4. WATER POLLUTION FROM POWER PLANTS

Another serious problem is the water pollution caused by thermal power plants. The water pollution is caused by discharging hot condenser water and water discharged into the river carrying the ash of the plant. The discharge of polluted water causes hydrological and biological effects on the surrounding ecology. The biological study should determine the types of aquatic organisms in the area and their adaptability to the environmental variations.

Thermal pollution of water is very important for the fish cultivation, as their growth is very susceptible to the temperature changes. Another important constituent in the discharge of cooling water is residual chlorine as chlorine or sodium hypochlorite is used to prevent fouling of the condensers.

Another serious problem associated with the discharged water is the ash carried by the water. The ash gets spread over the large cultivated area along the path of the river and affects the agricultural growth very much. This is because; the ash has high alkaline characteristics, which are injurious for the growth of many agricultural products. The ash destroys the fertility of the land forever. Such phenomenon was badly experienced when the ash from Koradi thermal power station in Maharashtra was discharged in the river. The wastewater from water demineralization plant contains large quantities of chlorides of Ca, Mg, Na and K. This

wastewater is channeled out to some river or to an ash pond along water salty. In the ash pond, the situation is worse as there is continuous accumulation of these salts and the pond reaches a saturation level of these salts. The process of salt saturation in the pond is further accelerated by solar evaporation of the water. The wells on the area covering a few kilometers from the ponds become salty and polluted water from these wells becomes harmful for human consumption as well as for irrigation purposes. Discharging these salts with the wastewater aggravates the pollution problem but also loses them, even though; their recovery is simple and economical

The wastewater can be treated first with lime, to precipitate magnesium hydroxide and then with soda ash to get precipitated calcium carbonate and the resulting sodium chloride solution can be reused far regeneration of softeners. The above-mentioned reactions are listed below.

$$MgCl_2 + Ca(OH)_2 = Mg(OH)_2 \downarrow + CaCl_2$$

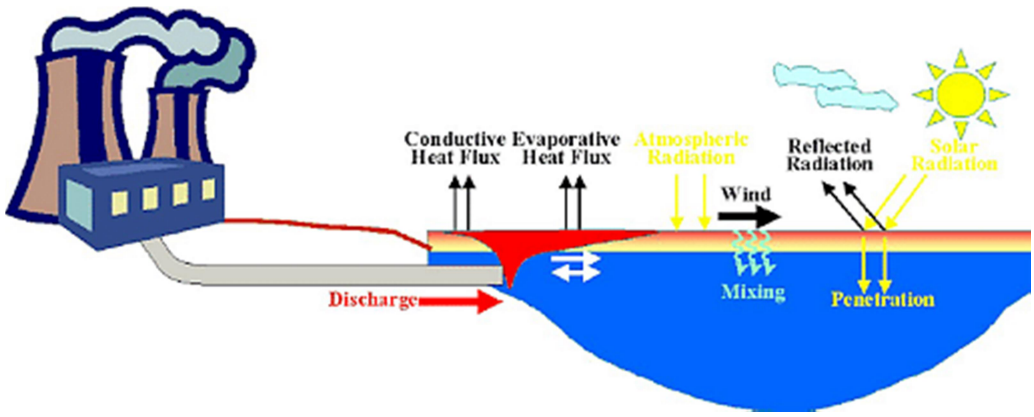
$$CaCl_2 + Na_2CO_3 = CaCO_3 \downarrow + 2\ NaCl$$

4.5. THERMAL POLLUTION FROM POWER PLANTS

The rise or fall in temperature of a natural aquatic environment induced by human intervention is known as thermal pollution. This has become increasingly common due to the expanding demand for globalization everywhere. Thermal pollution is generated by dumping hot water from factories and power plants, or by removing trees and vegetation that shade streams, allowing sunshine to raise the temperature of these waters, and then releasing cold water to cool them down. Thermal pollution, like other types of water pollution, is ubiquitous, impacting numerous lakes and a large number of streams and rivers around the world.

Thermal pollution is caused by **thermoelectric power stations** that use coal, natural gas, nuclear power, biomass, and other waste products as fuel. Typically, power plants are situated next to a river, lake, or ocean, which provides a constant supply of water. This is transformed into steam, which is used to power turbines, which generate electricity. Water is also utilized to keep machinery cool when it gets too hot. The water absorbs heat and is normally released back

to its source if it does not evaporate. This ultimately results in a rise in the temperature of water bodies and causes thermal pollution.



4.5.1. Nuclear Power Plants:

A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. When water used as a coolant is returned to the natural environment at a higher temperature, the sudden change in temperature decreases oxygen supply and affects ecosystem composition. After the water is used, it is put back into a water supply at 9-20°C warmer Emission from nuclear reactors increases the temperature of water bodies.

Nuclear power plants discharge a lot of heat along with traces of toxic radio nuclides into nearby water streams. Emissions from nuclear reactors and processing installations are also responsible for increasing the temperatures of water bodies. Heated effluents from power plants are discharged at temperature 10˚C higher than the receiving waters and affect the aquatic animals and plants. The cooling water discharge from Nuclear power plants is among the greatest local sources of thermal pollution due to the high levels of energy produced per plant. In addition, nuclear power plants require 30–100% more cooling water than other types of plant with a comparable power output. The warm water discharge from the Nuclear power plant super

imposes the regional climate warming, which provides an additional heat stress at the water surface.

4.5.2. Coal-Fired Power Plants:

Water from nearby lakes or rivers is used to cool the condenser coils in coal fired power plants. That heated water is discharged into lakes and streams thereby raising the water temperature by 15˚C. Heated effluent decreases the dissolved oxygen content of water resulting in death of aquatic organisms. The sudden fluctuations in temperature also lead to "thermal shock" that can kill aquatic life. Globally, over 46% of the thermal emissions into rivers are due to coal-fuelled power plants and almost one third due to nuclear power plants. The countries like United States, China and France are with the highest combined rates of riverine thermal emissions, occupying shares of 26%, 16%, and 12% of the global thermal emission rate, respectively.

4.5.3. Thermoelectric Power Plants:

Thermoelectric power plants are one of the main causes of thermal pollution. Such plants pump water directly from rivers, lakes or the ocean, to cool the turbine condensers. During the process, which usually involves once-through cooling, the water becomes warmer than the source water, so that the wastewater is returned to its source at temperatures significantly higher than the freshwater that originally entered the electric generation station.

4.5.4. Hydro-Electric Power Plants:

Generation of hydroelectric power sometimes leads to negative thermal loading in water systems. Dams may change a river habitat into a lake habitat by creating a reservoir (man-made lake) behind the dam. The reservoir water temperature is often colder than the original stream or river. On the contrary, downstream of dams and Hydropower Plants (HPPs) has generally warm water than upstream because of passing of water from pipelines, penstock, turbine and cooling system. Despite the change in water temperature emerging from construction and operation of Hydropower Plants not as high as that in fossil-fuel and nuclear power plants, it is too important to affect lifecycle and survival of aquatic organisms.

4.5.5. Effects of Thermal Pollution

4.5.5.1. Decrease in DO (Dissolved Oxygen) Levels

- The amount of DO (Dissolved Oxygen) in water decreases as the temperature rises.
- Warm water has a lower oxygen content than cold water.
- Reduced DO can cause suffocation in plants and animals like fish, amphibians, and copepods, resulting in anaerobic conditions.
- Animals that are unable to relocate to another place may begin to die if the oxygen level falls.
- Warm water injections into deeper bodies of water can prevent oxygen from diffusing, which is beneficial to bacteria but harmful to aquatic species.
- **Algal blooms** can result from a lack of oxygen, posing harm to aquatic plants and animals.
- The most common and well-known negative effect of thermal pollution is algal blooms.

4.5.5.2. An Increase in Toxins

- Toxins in the water are a result of dumping wastewater rather than being a direct result of thermal pollution.
- The toxins include heavy metals such as **arsenic, mercury, cadmium, chromium, lead**, and more.
- The use of water for cooling almost always results in chemical contamination.
- Solvents, fuel oil, and dissolved heavy metals end up in the lake or river where cooling water is discharged.
- Cooling water from nuclear power plants can be mildly radioactive.
- The compounds could have a **wide range of adverse consequences** on plants and animals, including death, mutations, and sterilization.

4.5.5.3. Loss of Biodiversity

- The sudden rise in temperature might kill or drive away vulnerable organisms.
- For fragile and endangered animal species, this is just one of many critical challenges.
- Organisms suffering from the hot water, being unable to reproduce as effectively as before, or simply abandoning the area can all contribute to this loss.
- Animals are frequently the victims of water pollution, but multicellular aquatic plants are also at risk when the local aquatic ecology is altered by thermal pollution.

4.5.5.4. Ecological Impact

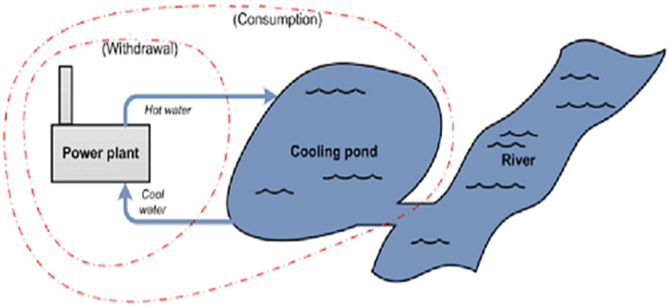
- Thermal pollution can harm the local aquatic ecosystem, especially if it is severe, such as when large amounts of warm water are poured into a frigid pond, bay, or river.
- The fast shift in water temperature, either an increase or reduction, known as **thermal shock,** can kill fish and other creatures that evolved to a specific temperature range when a power plant first opens or shuts down for repair or other reasons.
- This untimely death has exacerbated the ecosystem's problems. The availability of key food sources has dwindled.
- A local population that is threatened or endangered may be wiped out or put under even more stress.
- When waste from a power plant or business is thrown into coastal waters, coral reef bleaching can occur. When coral organisms die, coral bleaching occurs.

4.5.6. Measures to Control Thermal Pollution

4.5.6.1.Cooling Ponds

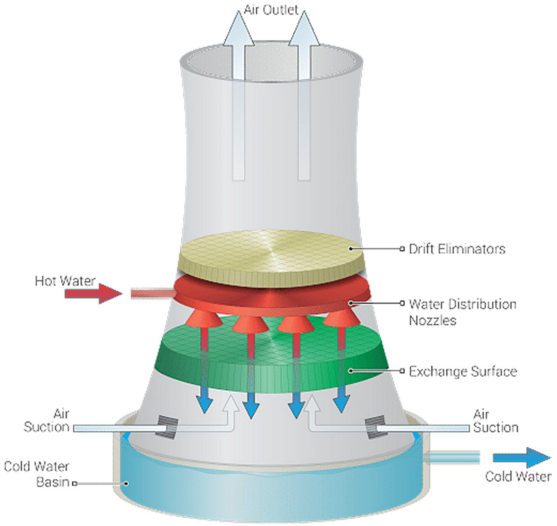
- The most basic ways of controlling thermal discharges are **cooling ponds or reservoirs.**
- Heated effluents on the surface of the water in cooling ponds maximize heat dissipation to the atmosphere while reducing the area and volume of water.

- This is the simplest and most affordable way to chill the water to a very low temperature.
- However, in terms of air-water contact, the method alone is less attractive and inefficient.



4.5.6.2. Cooling Towers

- The cooling process is defined as the process of taking water from water sources for cooling purposes and then returning it to the water body after passing through the condenser.
- As a result, cooling towers are built to regulate the temperature of water in order to improve the cooling process.
- Cooling towers are primarily used to dissipate recovered waste heat and hence alleviate thermal pollution issues.

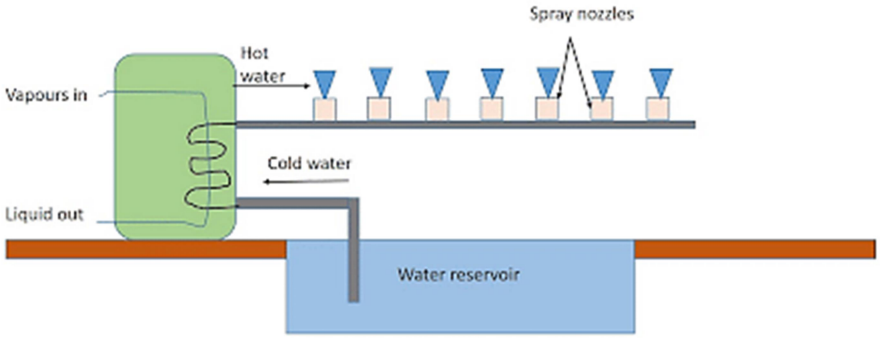


4.5.6.3. Artificial Lakes

- Artificial lakes are man-made bodies of water that can be used as an alternative.
- It can be created by damming a valley, digging the land, or enclosing an area of land with dykes and redirecting a portion of the river flow into the reservoir.
- The heated effluents could be dumped into the lake on one end, and the water could be recovered for cooling on the other.
- Through evaporation, the heat is gradually released. However, these lakes must be replenished on a regular basis.

4.5.6.4. Spray Ponds

- A spray pond is a reservoir where overheated water from a power plant is cooled before reuse by spraying it into the cooler air via nozzles.
- Cooling is accomplished through heat exchange with the surrounding air.
- This includes both conductive heat transfer between the water droplets and the surrounding air as well as evaporative cooling which provides by far the greatest portion, typically 85 to 90 percent, of the total cooling.
- This eventually aids in controlling thermal pollution.



4.6. RADIATIONS FROM NUCLEAR POWER PLANT EFFLUENTS

Radiations from nuclear-power plant effluents are low-dose-level types of radiations. The effluents are mainly gases and liquids. Mainly the effects of these radiations on the populations living near the plants prompt environmental concerns about nuclear power plants. Sources of effluents vary with the type of reactor.

In both pressurized-water reactors (PWR) and boiling-water reactors (BWR), two important

sources of effluents are

(1) The condenser steam-jet air ejectors and

(2) The turbine gland-seal system.

The ejector uses high-pressure steam in a series of nozzles to create a vacuum, higher than that in the condenser, and thus draws air and other non-condensable gases from it. The mixture of steam and gases is collected, the steam portion condenses, and the gases are vented to the atmosphere. In the gland seal, high-pressure steam is used to seal the turbine bearings by passing through a labyrinth from the outside in so that no turbine steam leaks out and, in the case of low-pressure turbines, no air leaks in. The escaping gland-seal steam is also collected and removed. In the BWR, the effluents come directly from the primary system. In the PWR, they come from the secondary system, so there is less likelihood of radio-active material being exhausted from a PWR than a BWR from these sources.

The primary-coolant radioactivity comes about mainly from fuel fission products that find their way into the coolant through the few small cracks that inevitably develop in the very thin cladding of some fuel elements. Such activity is readily detectable. However, to avoid frequent costly shutdowns and repairs, the system is designed to operate as long as the number of affected fuel elements does not exceed a tolerable limit, usually 0.25 to 1 percent of the total. Also, some particulate matter finds its way into the coolant as a result of corrosion and wear (erosion) of the materials of the primary system components. These become radioactive in the rich neutron environment of the reactor core. Corrosion occurs because the radiolytic

decomposition of the water passing through the core results in free O_2 and free H and OH radicals as well as some H_2O_2. These lower the pH of the coolant and promote corrosion. Finally, radioactivity in the primary coolant may be caused by so-called tramp uranium. This is uranium or uranium dioxide dust that clings to the outside of the fuel elements and is insufficiently cleaned off during fabrication. It will, of course, undergo fission, and its fission products readily enter the coolant. Improved processing and quality control are minimizing the problem of tramp uranium.

POWER PLANT SAFETY

4.7. SAFETY OBSERVED IN POWER PLANTS

Considering the cost and benefit of providing the safety in power plants the followingsafety policies have to be observed in power plant:

- Demonstration of organization commitments to the safety priorities.
- Defining and providing clear authority and responsibility for every organization and employees of the power plant.
- Providing assistance and budgetary support for all safety activities.
- Scheduling regular workplace inspection. These may be a visual inspection of facilities, equipment, and the tool to identify hazards, physical deterioration, anddefects.
- Work observation is developed as ways to monitor.
- Conducting courses and training on safety while they are actually working on thejob.
- Providing well qualified and trained safety staff.
- Conducting regular evaluation of employees opinion about the safety program andsafety culture.
- Implementing a safety audit for various safety regulation, standards, and codes. Developing real-time safety management information system.
- Displaying the safety posters at the dangerous places.

- Implementing the proper communication system to ensure safety at all the time.

4.8. SAFETY OBSERVED IN BOILER OPERATION

Following are the safety practices observed in boiler operation:

- Good housekeeping for safety and good plant operation. Maintaining properventilation and fresh air circulation.
- Proper clothing should be worn at all the time. Avoid loose clothing and jewelry.
- Providing the boiler operating log book.
- The boiler operator must be experienced and familiar with boiler accessoriesmounting and other safety devices.
- Investigate and identify the causes of any trip before attempting to start.
- Before starting the boiler, always purge the Furnace thoroughly and boiler roomshould be free from Dangerous explosive materials.
- Perform routine maintenance, calibration, and testing of the burner managementsystem and combustion control safety device and transmitter.
- Verify that the water treatment system is operating properly producing boiler feedwater of sufficiently high quality.
- Never allow using untreated water in a boiler.
- Blowdown all the dead legs of the low water tips, water column, etc. on a regularbasis, to prevent sludge build up.
- Verify that water leaving is free from oxygen so that it is operated at the properpressure.
- Maintain the storage tank water at saturation temperature.
- A Continuous vent from the deaerator is necessary to allow the discharge of non-condensable gases.
- Continuously monitor the quality of condensate coming from the process which enable the diversion of condensate in the event of catastrophic process equipmentfailure.

- Adjust continuous blowdown to maintain conductivity of the boiler water withinrequired operating limits.
- Never blowdown furnace wall header while the boiler is operating.
- Boiler water side should be inspected on a regular basis. If there is any sign of the scaling for the build-up of solid on the tubes, water treatment adjustment should bemade.
- The deaerator vessel and internal should be inspected on a regular basis for thesign of corrosion.
- Maintain regular preventive maintenance according to the manufacturers manual.

4.9. SAFETY OBSERVED IN OIL HANDLING SYSTEM

Following safety practices are followed in oil handling system:

- Displaying the information about oil handling hazards and way of handling andstoring.
- Storing the oil in a properly Sealed tank either in open or in the ground.
- The tanks should be surrounded by oil tight Bond walls to prevent the leakage. Development of skills to the worker for handling the oil in case of leakage.
- Implementing the TQM for the production of tanks
- Before filling the oil in a tank, proper inspection should be carried out to achieve thesame quality as per the standards.
- If there are open storage tank, then the electrical equipment within the space mustmeet the appropriate safety standards.
- The fuel storage and transfer line temperature should not exceed 50 to 55 degreeCelsius.
- Smoking and carrying matches should not be permitted around the Storage area.
- Material safety data should be maintained.
- Non-Intrinsically, battery operated items example flashlight, mobile phone, camera, pagers extra are not permitted.

- Safety helmet with dark yellow in color with a name in front of the portion should beused in premises.
- Wearing of proper cotton clothes impervious gloves and safety shoes should bestrictly maintained.
- A rated fire extinguisher should be provided around the Storage Area.Avoiding skin contact during transferring or maintenance work.
- Oil container should be labeled with all the information.
- All lifting machines, lifting tools and tackles brought inside the refinery should be checked against the quality standard required.
- Maintaining a pre-use checklist for the oil handling equipment.Immediate replacement of defective equipment.

4.10. SAFETY OBSERVED IN CHEMICAL HANDLING SYSTEM:

Great care should be taken while handling the Chemicals due to dangerous hazards associated with mistakes in handling. A Chemical safety data sheet should give information about chemical hazards and the safety measures to be taken and emergencyhandling procedure.

Following procedures need to be followed in chemical handling system:

- Keep the work area clean and uncluttered. Always use adequate safety measuresand never leave the following unattended: 1. The ongoing chemical reaction in Laboratories. 2. Exposed sharps(needles, Razer blade, extra) 3. Heating equipment.
- Name the chemical products clearly and display the company.Identification of chemical containers.
- Give complete information about the composition of the chemical and way of usingalong with safety measures to be taken on containers.
- Maintain lean, well-managed chemical inventories to avoid fire code violation.Follow Chemical storage and compatibility guidelines.

- Post warming sign if there are any dangerous equipment and reaction.
- Post a list of chemical abbreviation used on chemical containers levels near the lab entrance.
- Keep containers closed except when in use, including hazardous waste containers.Post a list of personal protective equipment required for entering the facility.
- Read the safety data sheet before beginning the work with the chemical.Follow hazards control plan for extremely hazardous material.
- Never underestimate the risk.Do not pipette by mouth
- Navel smell Chemicals to identify themBe aware of an electric hazard
- Electric panel is visible and unobstructed.
- Do not eat, drink, store food, smoke or apply cosmetics in the work area.
- First aid and self-help measure should be displayed at the clear visible places.
- Providing Fire extinguisher around the chemical handling areas. Never allowed to work alone when hazards chemical is involved.Know the location of emergency types of equipment like: Telephone ,First aid kit, Fire alarm pull, Station emergency guide and Fireextinguisher

4.11. STATUTORY PROVISION RELATED TO BOILER OPERATION.

Statutory Instructions under the Boilers Act,1923:

1. Boiler shall not be used unless it is registered and certified.(Sec.7)
2. Boiler shall not be used after expiry of Certificate/P.O. (Sec.8)
3. Boiler shall not be used unless transfer is reported to Chief Inspector of Boilers. (Sec.16)
4. Boiler shall not be used at higher pressure than the maximum pressure for which it is approved and certified . (Sec.6)
5. Boiler shall not be used unless it is in-charge of person holding the certificate of Competency/ Proficiency as required. (Sec.6)

6. Explosion of boiler/boiler component shall be reported to the Chief Inspector of Boilers within 24 hours and such report shall contain true description of nature of accident and of the damage. (Sec.18)
7. Works such as repairs, welding, tube replacement, alteration/ addition/modification etc. shall not be carried out to boiler/ boiler component without sanction/ approval of Chief Inspector of Boilers in writing.(Sec.12)
8. Registration number as marked on boiler shall not be removed/ altered/ defaced/ tempered. (Sec.25)
9. Boiler shall not be used with tempered safety valves. (Sec.24)