Thermal and Radioactive Pollution

Thermal Pollution

- Thermal pollution is defined as sudden increase or decrease in temperature of a natural body of water which may be ocean, lake, river or pond by human influence.

- Thermal pollution is also called "thermal enrichment.

- It is the degradation of water quality by any process that changes ambient water temperature.

- Thermal pollution is when an industry or other human-made organization takes in water from a natural source and either cools it down or heats it up.

- They then eject that water back into the natural resource, which changes the oxygen levels and can have disastrous effects on local ecosystems and communities.

What is ambient water Temperature?

Ambient water temperature means the spatial (longitudinal, lateral and vertical) and temporal water temperature measured in the receiving body of water prior to a specific waste heat discharge, and is outside the influence of any thermal mixing zone.

Sources of thermal pollution

1. Industrial wastewater

(Water as Cooling Agent in Power, Manufacturing and Industrial plants)

- This normally occurs when a plant takes in water from a natural resource and puts it back with an altered temperature. Usually, these facilities use it as a cooling method for their machinery or to help better produce their products.

- This process depletes the oxygen level in the receiving body (river, lake, ocean).

- It can also wipe away streamside vegetation, which constantly depends on constant levels of oxygen and temperature.

- Ex. Nuclear Power Plant, petroleum refineries, pulp and paper mills, chemical plants, steel mills, Coal-fired power Plant, Hydro-electric power, Thermal Power Plant

2. Urban runoff (Runoff from Paved Surfaces)

- Urban runoff discharged to surface waters from paved surfaces like roads and parking lots can make water warmer.

- During summer seasons, the pavement gets quite hot, which creates warm runoff that gets into the sewer systems and water bodies.

3. Natural sources

- Natural sources like volcanoes and geothermal activity under the oceans and seas can trigger warm lava to raise the temperature of water bodies.

- Lightening can also introduce massive amount of heat into the oceans. This means that the overall temperature of the water source will rise, having significant impacts on the environment.

Effects of Thermal Pollution

1. Decrease in DO (Dissolved Oxygen) Levels:

- The warm temperature reduces the levels of DO (Dissolved Oxygen) in water. The decrease in DO can create suffocation for plants and animals such as fish, amphibians and copepods, which may give rise to anaerobic conditions.
- Warmer water allows algae to flourish on surface of water and over the long term growing algae can decrease oxygen levels in the water.

2. Increase in Toxins:

- With the constant flow of high temperature discharge from industries, there is a huge increase in toxins in the natural body of water.
- These toxins may contain chemicals or radiation that may have harsh impact on the local ecology and make them susceptible to various diseases.

3. Loss of Biodiversity:

- Changes in the environment may cause certain species of organisms to shift their base to some other place while their could be significant number of species that may shift in because of warmer waters.

- Organisms that can adapt easily may have an advantage over organisms that are not used to the warmer temperatures.

4. Ecological Impact:

- A sudden thermal shock can result in mass killings of fish, insects, plants or amphibians. Hotter water may prove favorable for some species while it could be lethal for other species.

- Small water temperature increases the level of activity while higher temperature decreases the level of activity.

- Many aquatic species are sensitive to small temperature changes such as one degree Celsius that can cause significant changes in organism metabolism and other adverse cellular biology effects.

5. Affects Reproductive Systems:

- A significant halt in the reproduction of marine wildlife can happen due to increasing temperatures as reproduction can happen with in certain range of temperature.

- Excessive temperature can cause the release of immature eggs or can prevent normal development of certain eggs.

6. Increases Metabolic Rate:

- Thermal pollution increases the metabolic rate of organisms as increasing enzyme activity occurs that causes organisms to consume more food than what is normally required, if their environment were not changed.
- It disrupts the stability of food chain and alter the balance of species composition.

7. Migration:

- The warm water can also cause particular species of organisms to migrate to suitable environment that would cater to its requirements for survival.

- This can result in loss for those species that depend on them for their daily food as their food chain is interrupted.

Control strategies

Heated water from industrial sources may be controlled with:

- cooling ponds: man-made bodies of water designed for cooling by evaporation, convection, and radiation

- cooling tower: It transfers waste heat to the atmosphere through evaporation and/or heat transfer

- Cogeneration: a process where waste heat is recycled for domestic and/or industrial heating purposes.

- Some industries use once-through cooling (OTC) systems which do not reduce temperature as effectively as the above systems. For example, the Potrero Generating Station in San Francisco (closed in 2011), used OTC and discharged water to San Francisco Bay approximately 10 °C (20 °F) above the ambient bay temperature.

Heated water from urban runoff may be controlled with

- bioretention systems and infiltration basins: Storm water management facilities that absorb runoff or direct it into groundwater. These related systems for managing runoff are components of an expanding urban design approach commonly called green infrastructure.

- Retention basins (stormwater ponds): It tends to be less effective at reducing runoff temperature, as the water may be heated by the sun before being discharged to a receiving stream.

Radioactive Pollution

The radioactive pollution is defined as the physical pollution of living organisms and their environment as a result of release of radioactive substances into the environment during nuclear explosions and testing of nuclear weapons, nuclear weapon production and decommissioning, mining of radioactive ores, handling and disposal of radioactive waste, and accidents at nuclear power plants.

- Nuclear tests are carried out to determine the effectiveness, yield, and explosive capability of nuclear weapons.

- The proportion of radioactive pollution is 15% of the total energy of the explosion.

- Radioactive pollution of water, water sources, and air space is the result of radioactive fallout from the cloud of a nuclear explosion.

- Radionuclides are the main sources of pollution; they emit beta particles and gamma rays, radioactive substances.

The sources of radioactive pollution

- Radioactive contamination can be due to a variety of causes. It may occur due to release of radioactive gases, liquids or particles. For example, if a radionuclide used in nuclear medicine is spilled (accidentally or, through ignorance), the material could be spread by people as they walk around.

- Radioactive contamination may also be an inevitable result of certain processes, such as the release of radioactive xenon in nuclear fuel reprocessing. In cases that radioactive material cannot be contained, it may be diluted to safe concentrations.
- Nuclear fallout is the distribution of radioactive contamination by the 520 atmospheric nuclear explosions that took place from the 1950s to the 1980s.

- In nuclear accidents, a measure of the type and amount of radioactivity released, such as from a reactor containment failure, is known as the source term. The United States Nuclear Regulatory Commission defines this as "Types and amounts of radioactive or hazardous material released to the environment following an accident.“

- Contamination does not include residual radioactive material remaining at a site after the completion of decommissioning. Therefore, radioactive material in sealed and designated containers is not properly referred to as contamination, although the units of measurement might be the same.

Naturally occurring radioactivity

- A variety of radionuclides occur naturally in the environment.
- Ex. uranium and thorium, and their decay products, are present in rock and soil. Potassium-40, a primordial nuclide, makes up a small percentage of all potassium and is present in the human body, carbon-14, which is present in all living organisms, are continuously created by cosmic rays.
- Naturally occurring radioactive materials (NORM) can be brought to the surface or concentrated by human activities like mining, oil and gas extraction and coal consumption.

Effects of radioactive pollution

- Depending on the amount of radiation to which we are exposed and the sensitivity of each exposed person, the effects of radioactive pollution can vary significantly between individuals.

- The exposure to high amounts of radiation generates almost immediately chronic diseases, cancer or even sudden death in rare cases of extreme pollution.

- Small amounts of radiation can cause diseases that are not so serious and develop over the course of time. The risk of developing cancer increases with the dose of radiation, but lower doses of radiation can also cause cancer after years of exposure.

- Exposure to radon is the second leading cause of lung cancer in the U.S.

Prevention of radioactive pollution

- It can be controlled and prevented at various levels, including the handling and treatment of radiation waste, the control and mitigation of nuclear accidents, as well as the control and minimization of personal exposure to radiation at an individual level.

- The treatment of radiation waste cannot be done through degradation by chemical or biological processes.

- Many radioactive materials have very long half-times (time necessary for half of the material to degrade or transform into non-radioactive materials) and thus radiation waste may pose a risk for many years after it was produced. Basically, there are only a few options for radiation waste treatment involving:

1. Containment of the waste in radiation-shielded containers usually buried underground
2. Isolation of radiation waste in remote locations such as remote caves or abandoned mines - which may also involve the use of some kind of barriers (shields)
3. When the first two alternatives are not possible, the waste may be diluted until background values are achieved.

Thank you!