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Thermal pollution of water by power plants

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Since the beginning of the last century, fossil fuel power plants have drastically diminished the quality of the air we breathe by venting most of the undesirable contaminants into the atmosphere. Despite regulatory and technical progress in pollution control, the degradation of air quality still continues, albeit at a reduced rate. But how many of us are aware that power plants also pollute rivers, lakes, and oceans? Unfortunately, we hardly mention this kind of water pollution when discussing the general issue of pollution.

Waste heat is an inevitable by-product of the power plants. In a fossil fuel power plant, the amount of heat energy rejected is approximately 60%. The amount rejected by a nuclear power plant is even larger — close to 70%. The medium that receives this no longer-needed heat is the coolant from where water was drawn to keep the equipment cool. That is why power plants are almost always built near rivers, lakes, or seashores for a ready supply of cooling water. This practice of dumping the waste heat in the form of hot water into its natural source is called thermal pollution.

Besides power plants, thermal pollution is also caused by deforestation and soil erosion. This exposes water bodies to more sunlight, thereby raising the temperature. Whatever may be the cause, thermal pollution degrades water quality of the source by a process that changes its ambient temperature.

Adding hot water to the environment is not the simple act of dilution it might appear to be. To put this subtle disturbance into perspective, we must view an aquatic organism together with its environment as an integrated ecosystem. Thus heated liquid waste discharged into a river not only affects organisms directly, but also the entire ecosystem of the aquatic environment.

One of the vital requirements for the survival of an aquatic life form is its ambient temperature. Because water can absorb thermal energy while experiencing only small changes in temperature, most aquatic organisms have developed enzyme systems that operate in a narrow temperature range.

If the temperature change is gradual or a small amount of heat is added, acclimatisation is possible and the effect on the aquatic ecosystem will be minimal. On the other hand, if the change in temperature is sudden or a large quantity of heat is added, conditions can shift beyond the tolerance limits of the aquatic organisms' metabolic systems. In most cases, the consequences are lethal. This change can devastate even heat-tolerant species that are inured to warmer waters.

The presence of dissolved oxygen is probably the single most important factor in the biology of aquatic systems, and a great variety of physical and biological interactions stem from it. But as the temperature of water increases, its dissolved oxygen content decreases. Since metabolism requires oxygen, some species may be eliminated entirely if the water temperature rises by 10 degrees Celsius. Additionally, dissolved oxygen is the key to assimilation of organic wastes by microorganisms. Heating a water body will impair this assimilation.

Thermal pollution not only kills heat intolerant fish, but also plants, thereby disrupting the web of life dependent on the aquatic food chain. Also, the elimination of heat-intolerant species may allow less desirable heat-tolerant species to take over.

The life cycles of many aquatic organisms are closely and delicately geared to water temperature. Fish are often disturbed, migrate, and spawn in response to temperature cues. When water temperature is artificially changed, the disruption of aquatic organisms' normal activities and patterns can be catastrophic. There may be large-scale migration to an environment more favourable to their survival. The addition of new species of fish will change the eco-balance of the migrated area.

Water temperature also influences the early development of aquatic organisms. Furthermore, it affects the larvae and eggs of fish in rivers. For instance, trout eggs may not hatch if the water is too warm. Even if they hatch, they won't survive for long because aquatic juveniles are the least tolerant to abrupt temperature changes. Thermal pollution can also increase the susceptibility of aquatic organisms to parasites, toxins and pathogens, making them vulnerable to various diseases.

If thermal pollution continues for a long time, it can cause huge bacteria and plant growth leading to algae bloom that will subsequently result in even less oxygen in the water. Algae have unfavourable effects on aquatic life.

We have to realise that human behaviour has led to the pollution of the planet on which we live. As renowned explorer and environmentalist Jacques Cousteau said: "Water and air, the two essential fluids on which all life depends, have become global garbage cans." If we want a healthier planet with breathable air and unpolluted water, we have to use less energy, cleaner energy, or use energy in ways that will minimize adverse environmental impacts. To that end, we have to shift from fossil fuels and nuclear power to energy sources that won't change the chemical make-up of our land, air, and water. Otherwise, we have to learn to arrest emissions from power plants and other industries and sequester them away from our environment.

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