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A REVIEW PAPER ON THERMAL POLLUTION CONTROL

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ABSTRACT
Thermal pollution is additional heat to water and atmosphere by human activities like thermal power plants, the advancement of technologies and increase in population. In-next few decades, a large amount of thermal energy will be discharged into rivers, lakes, streams that will result in degrading of the aquatic environment. Most of the industries, power plant, and manufacturing require the cooling system for efficient functioning of the equipment, better services and to raise the production, however, the waste heat generated from the cooling system when discharged to waster body leads to an increase in the water temperature, ultimately affecting aquatic life such as survival, reproduction, migration, and community composition. With more focus giving to common pollution like water, air, soil pollution, etc. people are least concerned about the thermal pollution and its mitigation measures, which is a persistent problem in our modern society. In fact, there must be adequate plans and mitigation measures for the major thermal polluting sources to minimize the risk of polluting aquatic ecosystems and other water bodies. Besides proper use of waste heat as if heating of buildings during cold seasons, the other ways to control the thermal pollution is applying bio-retention, adding grabbles, used coolant water in agriculture to some extent and a microbial ecological approach.
KEYWORDS: Ecology, migration, mitigation, industries, aquatic and building.

INTRODUCTION
The thermal pollution is defined as a sudden increase or decrease in temperature of a natural body of water including ocean, lake, river or pond by human activities. The increase in water temperature will degrade the water quality as modified and abnormal for consumption. A rise in optimum water temperature from steel factories, powerhouses, and energy plants, etc., might even be stated as "Thermal Pollution". In most of the industries, available water used for cooling the generator is discharged into a system from where it completely was drawn, inflicting a warming trend of surface water. The effects of thermal pollution include a decrease in the amount of dissolved oxygen in the water, aquatic life requires, damage to larvae and eggs of fish, killing off some species and macro invertebrates that have limited tolerance for temperature change, and migration of living entities. The waste products are often the culprits of a massive exodus of thermal pollution. In order to control thermal pollution, individuals, society and governments have been taking many steps to manage it effectively. Furthermore, the paper is arranged as, section II containing a literature review, followed by a section III conclusion, section IV review analysis and finally reference in section IV.

LITERATURE REVIEW
According to **S. Lawrence Dingman and Andrew Assur (1969)**[1],'THE EFFECTS OF THERMAL POLLUTION ON RIVER ICE CONDITIONS' it examines the effects of thermal pollution based on the report by, **Dingman et al. (1967)** developed a method for calculating the temperature profile of a cooling river below a source of thermal pollution and the length of ice-free reach. The computer programs were used to calculate the heat-loss rates based on mean daily values of meteorological parameters and numerically integrate a complicated heat-loss expression. The similar, approach also done in the heat loss using a linear function in water temperature and air temperature so that the integration can be performed analytically. A simplified but the general procedure for calculating water-air heat-loss rates based on air temperature, wind speed, solar radiation, and general atmospheric conditions.

According to **Frank L. Parker (1979)**[2]**,** 'Thermal Pollution Consequences of the Implementation of the President's Energy Message on Increased Coal Utilization', it discusses heat release in the atmosphere from thermal and nuclear power generation plant. The nuclear power plants discharge 50% more waste heat to the atmosphere through cooling towers. Its effects on the property of water, ultimately biological may amplify and veridical activity of chlorine compounds result protein denaturation takes place rapidly above 30°C. In the process, all organisms experience elevated metabolic rates at higher temperatures, which may affect total energy needs, foraging ability, reproduction, migration, and susceptibility disease. Mechanical damage in the cooling system in small organisms is generally low, but fish, larvae and eggs may be seriously damaged. The off-stream cooling systems may increase cloudiness, ground fog, precipitation, temperature, and local winds, but these effects generally extend no further than 1000m even in winter. There is considerable potential use of condenser-cooling water for agricultural purposes such as irrigation, frost protection, under soil heating, greenhouse heating, and climate control.

According to **Dong H. Choi1 et.al (2002)**[3]**,**'Effects of thermal effluents from a power station on bacteria and heterotrophic Nano flagellates in coastal waters'. In the year 1998 to 1999, the authors studied the effects of thermal effluents from a coastal power station to bacteria and heterotrophic Nano flagellates (HNF) in adjacent coastal waters. In this the surface distributions of bacteria and HNF and interrelations between microbial and environmental variables near Hadong Power Station, Korea. It takes seawater for the experiments with treatments of high temperature in the cooling system. It has found hypochlorite had much more deleterious effects on bacteria at high temperature. In the analyses of horizontal distributions of microbial variables, manipulation and dilution experiments gave consistently similar results of inhibitory effects of thermal effluents on bacteria and HNF. Hence, it suggests that a microbial ecological approach is useful for estimating the influences of thermal pollution in the aquatic environment.

According to **K.Mihaylo (2009**)[4], 'The effects of thermal pollution on marine life' it mainly on the survival of marine life or organisms as power plants and factories discharge hot and cold water into nearby rivers, lakes, and stream lead to temperature changes. This change of temperature harm to the aquatic life having specific temperature needs causing reproduction difficulties, lowering of disease resistance and sudden dead. "To prevent the release of heated water should be taken in the less vulnerable region".

According to **Daniel Lewis Long (2011**)[5],'Thermal Pollution Mitigation in Cold Water Stream Watersheds Using Bio-retention'. It has focused on strategies to reduce the thermal impact associated with urban water runoff in developing cold-water stream watersheds using bio-retention. The necessary required data were collected during ten controlled trials at a bio-retention facility located in Blacksburg, Virginia. It was significantly observed of reduction an average and peak temperature by bio-retention in thermally charged storm water runoff, received from an asphalt surface. Unfortunately, this facility was unable to consistently reduce the temperature below the threshold for trout health. Finally, it was concluded that bio-retention appears to have the capability to reduce the thermal impact of urban storm water runoff on cold-water stream ecosystems.

According to **Lewis Thomas (2011)**[6] 'thermal pollution in rivers: will adding gravel help to cool them down?' it discusses the thermal pollution in rivers from dams, logging, municipal wastewater treatment, and human activities. It observed that an increase in water temperatures lead to stress in ecosystems, kill fish, and promote disease and parasites, but the author focused on timber companies and municipalities for thermal loading during operations. A similar project, like Portland general electric (PGE), was applied for relicensing of its extensive hydroelectric project in Clackamas River at Oregon. In continuation, questions were raised to company's existing plans to improve fish habitat on the lower river by adding gravel in the channel to replace of lost sediment of high water temperatures within regulatory limits. A study co-led by Pacific Northwest research station scientists provided critical information to PGE and 33 interested parties had

signed off on in relicensing agreement on how overall temperatures affected as water flows through naturally occurring gravel bars. It observed water emerging from gravel bars tends to be cooler than the main channel; gravel augmentation is unlikely to cool the whole river. Further, it could still provide positive benefits, by increasing the number of cool spots for fish to hide during the hottest part of the day.

According to **W. K. POKALE (2012)**[7]**,** 'EFFECTS OF THERMAL POWER PLANT ON ENVIRONMENT' the author observed the thermal power plant effects on environment segments of surrounding regions are severely deteriorated and it is attributed to the emission of large amounts like SOX, NOX & SPM & RSPM. It has the power to discrete over 25 km radius and will affect human health and animal kingdom like respiratory. Moreover, it also affects the photosynthesis process, the balance of minerals & nutrients in the plants, soil strata, structures & buildings get affected due to corrosive reactions.

According to **Sameer Kumar et.al. (2013)**[8]**,** 'Environment Impact Assessment of Thermal Power Plant for Sustainable Development', it concludes that the thermal power plants are the major source of generation of electricity in most of the developing countries. Besides, it has a serious impact on land, soil, air and will emit a large amount of mercury and generate a large quantity of fly ash, which destroys the surrounding environment. The power plant required a large amount of water to serve and cooling the system. As an issue arises, it suggested followingthe proper environmental impact assessment before the commencement of the project in various mitigation to control the pollution instigated.

According to the **ManeeshPunetha(2018)**[9]**,** 'Thermal Pollution: Mathematical Modeling and Analysis' they use water as cooling due to availability and high specific heat capacity, moreover every power plants and heavy industries wish a cheap source for cooling its necessary components. This waste heat is always a major concern when it again discharged in the same water body, which disturbs the aquatic life and affects the balance of an ecosystem. It used an analytical solution to determine the thermal pollution using two-dimensional thermal dispersion considering over a surface with a velocity in only one direction of the wind. The other method was parabolic partial differential equation to solve an analytical to predict temperature contours over a surface. To prediction of near-field temperatures, the same parabolic equation or full three-dimensional energy and momentum equations were used to solve numerically. At the end it found that a numerical problem formulation methodology is discussed the accurate prediction of thermal pollution and scaling analysis is shown to develop an experimental model for proper validation of the numerical code and laboratory-scale experimental study only.

According to **S. ANWAR (2018)**[10]**,'**Thermal pollution: source, its harmful effects, and preventive measures' it studies on increasing of toxicity, the concentrate pollutant causes an increase in toxicity with a decrease of water quality which releases a toxin into the water. On the other hand, heated industrial effluent may contain toxins with elements such as radioactive and chemical materials leading to severe consequences on the aquatic ecosystems. "The toxins produced from industrial waste must be treated before discharging directly to the water bodies".

According to **K.BHATRAJU (2018)** [11]'CAUSES AND EFFECTS OF THERMAL POLLUTION' it talks about the ecological impacts of thermal pollution, especially when the heated waters dumped into the bay or river a local aquatic ecosystem can be damaged. In generally thermal pollution effects diverse such as decreased dissolved oxygen, migration, increased toxins, and loss of biodiversity, ecological impact, and reproductive effects. Among which ecological impact causes the thermal shock it kills off an insect, fish, and amphibians. The inter dependents of food sources are no longer, endangering species are wiped out and migration of species will be trendy.

REVIEW ANALYSIS

This review analysis is a collective solution from authors for the enhancement of thermal pollution. It focused on technique to preserve our aquatic life through the implementation of the following suggestion.

- The potential use of condenser-cooling water for irrigation, frost protection, under soil heating, greenhouse heating, and climate control.
- To prevent the release of heated water should be taken in the less vulnerable region".
- Applying bio-retention to reduce the thermal impact of urban storm water runoff on cold-water stream ecosystems.
- By emerging the gravel bars to the main channel so that it increases the number of cool spots for fish to hide during the hottest part of the day.
- Implementation of proper environmental impact assessment before the commencement of the project in various mitigation to control the pollution instigated.
- The toxicity produced from industrial waste must be treated before discharging to the water bodies.

CONCLUSION

In conclusion, thermal pollution is a result of increasing in power plants and industries, where uses water as cooling agents to improves the performance and extend the life of the machine. It is clear that, if the number of power plants on lakes and rivers is allowed to increase without control, these subtle effects can multiply and increase in magnitude, producing irreversible effects on our aquatic environment. One of the key factors to control thermal pollution is the selection of a suitable site for a power plant. The engineer will have to work hand in hand with the biologist on both site selection and operation of the plant. If everyone follows the system appropriately there will be a minimal impact on aquatic ecosystems such as decreasing of oxygen content in water, affecting ecosystem composition, changing of the reproductive system of aquatic living, increasing the toxicity, mass migration, and loss in biodiversity. This is the harmful effects of thermal pollution being recognized in a reduction of aquatic species from different authors.

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