Thermal effects on water Quality

Introduction

The term "thermal pollution" is used to describe water quality deterioration caused by inputs of heated water, mostly from industrial cooling processes . As the natural temperature regime of a water system changes because of thermal pollution , environmental systems became stressed.

⇒ Although some members of aquatic systems can adapt to the heated water , many are incapable of doing so and either die or are forced to relocate. However, the temperature range which can be tolerated by aquatic organisms is narrow. Therefore , when large volumes of heated effluent introduced to a water system , at least some degree stress quickly develops.

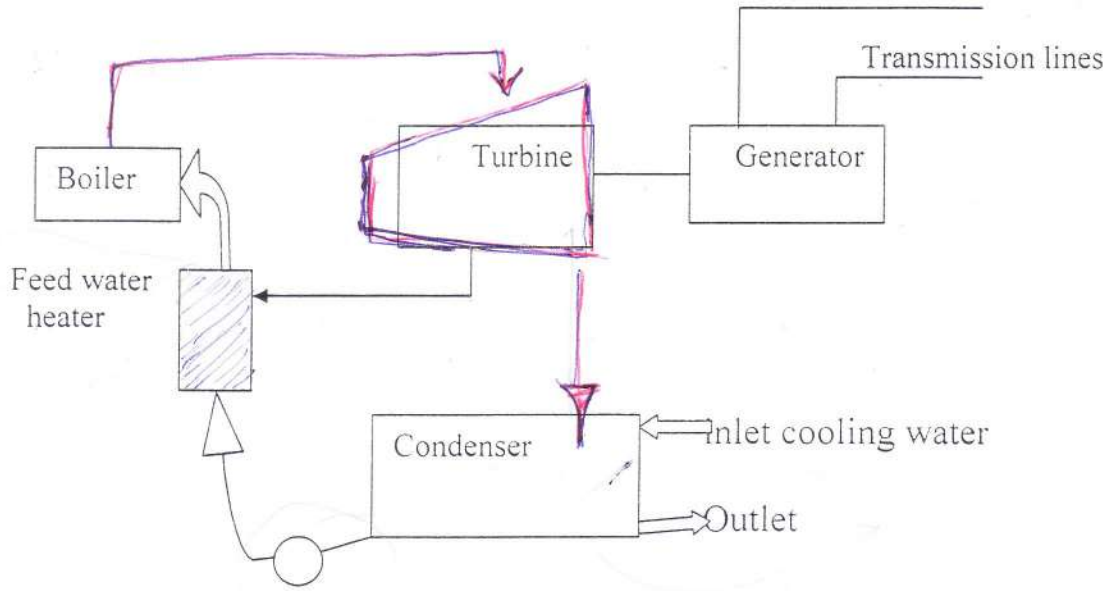
Many industries use water as a coolant. the iniupel user is the thermoelectric power industry, which consumes approximately 70% of all the water use for industrial cooling.

Nuclear power plants are even more wasteful (less efficient) because of the lower steam temperature in the throttle. Some nuclear facilities waste 40% more heat then fossil fuel plants. However, the trend toward large power facility results in the generation of more concentrated loads of waste heat that must be handled by the environment.

Sources of heated effluents

Because the electric power industry is mainly responsible for the discharge of heated effluents. Abrief review of the thermoelectric generation process is required. Most large thermoelectric power.

Plants use Ranking steam-electric power conversion cycles in which high- pressure steam is produced in boilers and then expanded through turbines to convert the thermal energy to mechanical energy.



The figure above shows a schematic diagram of a typical power plant using a Rankine energy conversion cycle.

If the diagram in the fig. were a fossil fuel plant , the following steps would take place in the generation of electric power .

1- Water from the condenser is pressurized by pumping and heated in feedwater heaters .
2- The pressurized water is heated in the boiler and converted to saturated steam .
3- The superheated steam is expanded through the turbine , creating mechanical energy that drives the turbine and subsequently the generator .
4- The resulting expanded, low pressure steam is condensed in the condenser , the heat from The low pressure steam must then be carried away from the power plant by the cooling water that circulates through the condenser subsequently discharging high temperature water.

* There is a slight differences between the power conversion cycles associated with nuclear and fossil fuel power plants.

The maximum operating. Temperature of a nuclear reaction is limited , as are the maximum pressures in nuclear pressure vessels , therefore, nuclear steam boilers are generally not designed to produce superheated steam.

There are several ways of estimating the thermal discharge from a given power plant. All of the estimation methods take into account plant efficiency , cycle efficiency , boiler efficiency etc, and all assume that the amount of thermal energy discharged is equal to the total energy input minus

the thermal energy discharged is equal to the total energy input minus the thermal energy loss minus the electrical energy produced .

The total energy input to the utility is equal to the heat value of the fuel at the time the quantity of the fuel , which is usually expressed as kilocalories or Btu's per kilowatt hour. For modern steam power plants ,these values range from 11,000 Btu.KW._h _. These same calculations can be made for nuclear plants , except that nuclear plants do not have thermal losses through then stacks, which would normally be included in the last energy term .

All electric power generators use condensers cool low – pressure steam that has entered the condenser from the turbine.

The steam entering the condenser then expends so that its concentration is below, saturation, with approximately 1000 Btu lb steam required for condensation. the quantity of water required for this condensation is inversely proportion to the temperature rise allowed in the condenser . for example , the quantity of cooling water required for an 800 MW fossil fuel plant operating at normal efficiency (35%) with an allowed temp rise of 10f is approximately 800,000 gal min _1 . This tremendous volumes of water is required for only an 800 MW plant .

Current practice is to build much larger facilities . this , the potential for discharging large volume of heated effluent can be seen.

Nowadays, power plants become larger and more numerous and producing increased volumes of heated effluents , thus controls on the temp . of water discharges may have to be implemented .

In principle , by limiting the temperature rise in the condenser , the discharge temperature of the rejected coding stream can be controlled , thereby minimizing its environmental impact . Increasing the temp. in the condenser to minimize cooling water requirements is generally unacceptable, however, because it increasy the temp. of the discharge water. This is contrasted with the low temp. rise in the condenser that results when using a large flow of cooling water , which is also unacceptable because a large amount of biological material builds up in the cooling system .

☒ Temperature Effects on Biological systems .

Most plants and animals associated with water systems are incapable of regulating their internal body temp.

Therefore , the temp. of such organisms fluctuates in accordance with ambient temp. of the environment. This means that little buffering capability is available in aquatic ecosystems for withstanding large fluctuations in water temp. If ambient water temp. change owing to additions of thermal effluents , for instance

, a shift in species diversity usually results and organisms incapable of functioning optimally at the new temp. eventually disappear .

☒ Natural communities :

The natural temp. regime of water systems is a function of latitude , altitude , and regional climatic patterns

There are certain organisms, that occupy regimes of extolment temp. some microorganisms are known to be metabolically a active in temp. approaching freeing , whereas at the other extreme , for example , hot springs , bacteria have been isolated from 88℃ water and algae from 73℃ water . Although it is apparent that some forms of life can exist in there extreme conditions , one should consider these as unusual groups of organisms . this is verified by the fact that only a few spines are found in extreme temperate environments.

The effect of temp. fluctuations are different for different organisms . death can occur when temp. fluctuations become severe and in the case of warm water enzymes begin to be deactivated at temps. Above 35℃ . for higher life forms, the effects of temp. fluctuations can be more subtle. Slight changes in respiratory activity occur stamp.

⇒ Increases In these cases change in the structure of the biological community is slow and can be observed only with careful study.

One of the more common physiological responses to temp. change is the alteration of osmotic regulation . freshwater organisms must maintain ions inside their bodies at higher concentrations than in the surrounding water . this is done by concentrating salt within body membranes . As the temp. of the ambient water increases , this process is altered , affecting the ionic balance of the organisms.

When the temperature shifts in natural systems are slow and relatively small in magnitude , most of the biological community can adapt . the degree of adaptability to temp. changes , however is different for different organisms and generally depends on their natural optimum temp.

This temp. tolerance for organisms has been designated as cold stenothermal , eurythermal , and warm stenothermal the largest tolerance range is associated with those organisms classified as eurythermal.

Organisms normally classified on either the warm or cold side of eurythermal have small thermal tolerence ranges , and therefore warm water discharges to cold environments, for example would tend to be more harmful to there groups then to the eurythermal group .

As we know, there is a different and often more complex response to temp. changes for higher order aquatic organisms. But we shall focus on the lower life

forms , for example .bacteria protozoa ,fungi and algae rather than more complex organisms such as fish .

As organisms be come mare complex , with mare complex life cycles , different phases of their existence require different temp. regimes . data on the lethal temp. for a full grown fish , for example, does not imply that the juvenile or larval stage of the animal will survive that temp. range . this means that a wide range of temps. Can be tolerated by complex organisms depending on the stage of the life cycle .

Also , higher organisms that are mobile (i.e\ fish) are able to move to temp. that are more suitable for their life processes . Evaluating of water temp. is therefore difficult . As an example of the complexity of temp. requirements for fish , we provide the optimum temp. ranges for two common freshwater fish in our inland water I .e carp and Gambusia affinis