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The Thermal and Mechanical Effects Due to Discharges of Water from the Steam Thermal Power Plant on Small Fish and Mussels: The Case of Site of Power Generation at Cap Des Biches

[1]A. Kane, [1]I. Diagne, [2]A. Diene, [3]S. Tamba, [4]F. Niang and [1]G. Sissoko
[1]Faculty of Science and Technology, University Cheikh Anta Diop, Dakar, Senegal
[2]Mechanical Engineering Department, Ecole Polytechnique of Thies, Senegal
[3]Civil Engineering Department, Ecole Polytechnique of Thies, Senegal
[4]IUT/UT, University Thies, Thies, Senegal

Abstract: In this research study on thermal pollution, we first studied the causes of this form of pollution, then used the parameter of thermal pollution which is the temperature difference in order to evaluate it. We have highlighted the adverse effects of pollution on the thermal power plants on one hand and other hand on the surrounding environment (people and beaches). We also attempted to assess its financial impact on facilities and environment; indeed Senelec loses more than 5 377 600 dollars during seven months and causes financial losses of about 4000 dollars by killing 10 tonnes of small fish and five tonnes of mussels. We have proposed solutions after diagnosis with particular emphasis on good policy of water treatment and close monitoring to maintain the facilities and respect environmental standards set by international bodies. We finally gave recommendations that can be used both for increasing the production efficiency and for respecting the environmental standards.

Keywords: Environmental facilities, pollution, power generation, thermal power plant

INTRODUCTION

Temperature is an important parameter in the conduct and operation of a steam power plant (Kane, 1999). It operates in cooling systems, heating and control for the normal functioning of steam thermal units.

The C3 power plant of Cap des Biches rejects 22 m^3 of water per regeneration of demineralized water station (PDD) (APHA, 2012), a regeneration occurring every 20 h of walking, in addition to water discharged from the channel GTI/303, the channel 301/302 and the channel C4 . These water discharged into the sea induce thermal pollution and chemical pollution (Akhtar *et al*., 2005; Vega *et al*., 1998) caused by chemistry products (Johnson, 1998) used. Here we focus on thermal pollution.

To study the thermal pollution due to discharge these waters and their impact on the lives of living organisms particulary small fish (El Nabawi *et al*., 1987) and mussels in different channels of water, we determined for a day to three times the temperature difference of each channel, the temperatures of the water sea and of the condenser of each group.

Finally we quantified financial and energy losses due to these thermal and mechanics effects in fish and mussels and facilities.

The objective of this work is to show the impact of differences in temperature between that of the inlet channel (entry of seawater into the power plant to cool the condenser) and that of channel return (water discharge to the sea) on living organisms in particular on the small fish and the mussels. We note that the mechanical effect is resulting from the migration of organisms caused by the thermal effect to the bar screen that systematically kills these organisms.

The temperature gap:
Definition and role: The temperature gap is the difference in temperature between the feed channel and return channel. It is set at 5°C by international standards see Appendix (World Bank and World Health Organization).

The high temperature reduces the solubility of the gases in water and in particular the levels of oxygen, yet the role of oxygen are essential for living organisms and for the oxidation of waste. If the temperature is low, oxidation reactions are slowed and this affects the assimilative, however for a high temperature, oxidation reactions are accelerated but involve higher consumption of dissolved oxygen.

MATERIALS AND METHODS

Sampler to depth (capacity 1.5l, copper ballast, pyramidal):
Mercury thermometer (precision 1/10°): We used a sampler for depth sampling of the different samples on

Corresponding Author: G. Sissoko, Faculty of Science and Technology, University Cheikh Anta Diop, Dakar, Senegal

the channel GTI/303, the channel 301/302 and the channel of deionized water station, then we use a thermometer to measure the different temperatures. One rinses three times the containers and the sampler to depth; then one draws water in each channel.

One rinses the thermometer three times then one inserts it into a container for measurement.

The Te inlet temperatures and the Ts outlet temperatures of the two channels GTI/303 and 301/302 site of Cap des Biches were measured three times during each discharge over a period of 7 months (December 2004-June 2005). Each temperature value is an average of three measurements. The temperature gap Dt = Ts - Te was calculated.

Over a length of 50 m of each output channel, we conducted three separate sampling points of daily readings on three occasions.
The places chosen are:

Point A: Right off the exit channel
Point B: Twenty five meters of the outlet channel
Point C: Fifty meters of the outlet channel

This is determined by observing the behavior of small fish and mussels at these points:

- At point A, the little fish and the mussel will die suddenly
- At point B, some of these small fish and the mussels cannot survive
- At point C, the small fish and the mussels will migrate to the inlet channel

At each location, we have the temperature to about 8 h, 13 h (tip: high energy demand) and 18 h. These slices allow us to appreciate the evolution of temperature gaps.

Thermal pollution: The thermal stability prevailing at sea makes the fertilization of living organisms much more favorable in the sea than on land. Cooling waters from power plants leave a lot of calories in the sea and they induce temperature gaps that can have adverse effects on the aquatic ecosystem. Indeed, we will use the temperature gap to evaluate the thermal pollution. In our study, it means a temperature difference between inlet channel and the return channel. It is set at 5°C by international standards.

Because of the relatively high temperature differences between the inlet channel and the channel back, living organisms which are plants or animals tend to be localized at the inlet channel where the temperature is identical to that of the sea. This migration requires us to operate at half condenser for all groups of the power plant for the cleaning of condensers because they are blocked by sand or shells or small algae or for the repair of the condenser because the coils are pierced. All the consequences of this migration train a poor heat exchange. The bad heat exchange deteriorates facilities and cause considerable financial losses. These consequences may result from algal blooms slowing the debit of intake channel, from the increase of microorganisms slowing the rate of the inlet channel and clogging the condenser, from the amount of sand that clogs the condenser and from the destruction of coils or destruction of condensers themselves.

This thermal pollution inevitably leads to additional costs in maintenance of groups and auxiliaries.

Note: The study of thermal pollution at the site of Cape deer does not concern.

Diesel power plant: In fact, the return channel of this power plant does not spill on the sea; a pit was created in the open where stagnant waste. Discharges have no direct impact on the sea.

The station of deionized water commonly known PDD: Because it does not have a system of steam condensation therefore the waters discharged during regeneration don't store calories.

RESULTS AND DISCUSSION

On each table (Table 1, 2 and 3), we postponed the temperatures at different points of channels 301/302 and 303/GTI expressed in °C as well as temperatures and sea condensers.

T = Wed
T = Output condenser (outlet temperature)
Dt = The temperature difference between point C and T Wed

The temperature differences are high and the two sites do not meet environmental standards set to 5°C causing thermal pollution.

We note in Table 1 and the Table 2 that the Ts temperatures at point C of the channel 301/302 are also important with respect to the temperature of the sea.

We note in this Table 3 that the Ts output temperatures at point C of the channel GTI/303 are very high at 8 and 18 H, respectively. The high temperatures reduce oxygen levels therefore there is a low oxidation of waste; therefore biological pollution is favored and it becomes dominant in the marine environment. The channel GTI/303 gives us highest values because the calories accumulated from the GTI and the 303 slice are more important. In conclusion, the GTI/303 channel indicates a higher thermal pollution.

Table 1: Temperatures collected for group 301

Location	8 H	13 H	18 H
Point A	42°C	43°C	43°C
Point B	35°C	34 °C	39°C
Point C	28°C	30°C	29°C
T wed	20°C	25°C	24°C
T outlet condenser	28°C	29°C	29°C

Table 2: Temperatures collected for group 302

Location	8 H	13 H	18 H
Point A	42°C	43°C	43°C
Point B	35°C	34 °C	39°C
Point C	28°C	30°C	29°C
T wed	20°C	25°C	24°C
T outlet condenser	29°C	29°C	29°C

Table 3: Temperatures collected for group 303

Location	8 H	13 H	18 H
Point A	38°C	29°C	43°C
Point B	33°C	28 °C	43°C
Point C	27°C	27°C	43°C
T wed	20°C	25°C	24°C
T outlet condenser	28°C	29°C	29°C

Impact on facilities and the environment: The effects of thermal pollution have negative impacts on the production facilities of electric power of Senelec on the one hand and secondly on the environment.

We tried to study the consequences of this pollution on the facilities of power plants in terms of the energy losses by one hand and the other on the environment by the financial quantification of the death of small fish and mussels caused by SENELEC on this site.

The daily observations at time intervals showed a proliferation of microorganisms which are plants and animals in the channels (see photos) caused by a migration of these living beings due to high temperature differences exceeding the required standard, they reduce the surface of the channels which leads to poor heat transfer. This poor heat exchange obliges SENELEC to clean the condenser and the channels.

Calculation of energy losses: The poor heat exchange reduces the yield of the power plant and leads to considerable energy losses, because the micro organisms plants and animals cause poor heat transfer. The Cleaning condenser causes a loss of 10 MW in 4 h/week for each slice (source Conduct Unit CIII). This situation persists since January 2005. Nous we propose to evaluate the financial shortfall from January to July which is a period 7 months for the three groups 301, 302 and 303 of the power plant steam Cape stag. We first evaluate the monthly energy by considering only 4 weeks in the month for each group of the CIII power plant at cap des biches.

The energy is equal:

Energy = Power × number of hours in KWh

Monthly Energy/slice = 10 = 160,000 kWh ×103×4×4

Energy monthly total slices = 3×3 = 160,000 480,0000 KWh

The total energy in 7 months is:

Total energy = 480,000×7 = 3,360,000 kWh

Energy losses can be evaluated in CHF whereas the average price per KWh is 80 francs (Senegal in africa):

= Total energy loss × average price/KWh

Loss = 3,360,000×80 = 268,800,000 francs

Thus, Senelec loses an amount of 268.8 million francs because of poor heat exchange.

This non-distributed energy means load shedding which causes inconvenience to customers and a decline in economic and industrial activities.

The effects of thermal pollution are harmful to the environment and they displace many small fish and large amounts of molds. We will try to quantify these effects in cash and in kind.

Price survey of:

- Fish
  - Diola women selling bags of fish 25 to 30 kg at 2500 francs per unit. This gives an average of 100 francs/kg
  - To Niodior (Department Foundiougne, Fatick region), are sold at 100 francs/kg approximately
  - In some markets of Dakar, we sell this type of fish in pots at prices ranging between 100, 200 and 300 francs the pot according to the market, stock exchange and the quality of fish (Soumbédioune, beavers, kermel, niarry tally, market ndiagou at sicap Freedom III ...)
- Mussels
  - The Diola women who come to collect these mussels at Cape deer sell a kilogram to 300 CFA francs.
  - To Niodior (Department Foundiougne, Fatick region), they sell the double bucket to 1000 francs. After weighing with tare, double bucket is equivalent to 7,864 kg of mussels. Kilogram of mussels amounts to 130 francs.

Calculation of financial loss for fish: We deposit an average of ten tons of dead small fish on the site.

The Kilogram of fish cost an average of 100 francs by considering the values of the Cape des biches and Niodior, the shortfall is one million francs per year.

Calculation of financial loss for mussels: We deposit an average of 5 tons of mussels on the site.

The Kilogram of mussels cost on average 200 francs by considering the average values of Cape des biches and Niodior, we recorded a loss of one million francs for the Senegalese economy;

We could do the same for all other marine products that have suffered the same fate such as molluscs, toads, among others; we wanted to have an idea about the consequences of thermal pollution and chemical pollution on the immediate environment of Senelec which manifested in part by the imbalance of the mechanism of temperature control and the other by the death of these organisms and deteriorating facilities.

Method against thermal pollution: It is to reduce the temperature of water from condensation using towers where runoff waters are cooled by side fans. The water is then collected in a tank before being returned to sea.

In the case of the use of cooling towers, when the power increases, the humidity of the air coming from the towers no longer meets the standards, therefore we must use of dry cooling towers in which the air is dried before being vented to atmosphere.

You can also use a cooling tower or an air condenser:

Cooling tower: In this system invented in Hungary, the condensed water is cooled in a heat exchanger surface placed in a flow of outside air. It allows a clear separation of air and water on the one hand (problem of humidity is solved) and also the removal of water discharges into rivers or lakes (water heating problems).

Air condenser: In this system, the main condenser is placed directly into the cooling tower. The steam to be condensed flows in tubes which are in contact with the ambient air in the cooling tower. The air condenser allows a clear separation of air and water on the one hand (problem of humidity is solved) and also the removal of water discharges into rivers or lakes (problems of overheating water). The air condenser can be used for small power plants.

RECOMMENDATIONS

- Proceed to the removal of algae, fish, mussels and other regular by cleaning the feed channel with quality products.
- Daily monitoring of the inlet channel by performing analyzes and looking at what is visible to the eye.
- Establish a filtration system upstream of the circulation pumps capable of retaining all the elements.
- Implement a maintenance program and maintenance that is mixed. This means a curative and preventive program.
- Associate the chemists in the development of maintenance programs of power plants; this will prevent some errors found.
- Make a wise choice on the order of conditioning products and fuel as well as the one of oils.

CONCLUSION

- This research allowed us to highlight the consequences of thermal pollution on the immediate environment of power plants and facilities thereof.
- We were able to give an approximate idea of the shortfall for both Senelec and for the national economy.
- Medical tests on people bathing in the large plants might reveal the real dangers to the health of individuals.
- Fine analysis of living organisms with wide of power plant could help to quantify the level of pollution.
- We finally tried to provide solutions to minimize thermal pollution.

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