



Research Paper

Impact that chemical treatments on cooling systems cause to the environment

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ABSTRACT

The objective of the study is to determine the operational conditions of cooling systems. They are important in power generation, and ensure continuity if treated properly. They play an important role in water consumption and in the treatment of wastewater caused by the purges of these systems. The problems are: corrosion, fouling and microbial growth. We analyzed the method impacting the environment by a bad operation, mechanical conditions, chemical treatments and control.

Key words: Corrosion, embedding, energy, purge.

INTRODUCTION

There is shortage of water in so many parts of the world. There is a fixed amount of water on earth, according to the law of flame, which satisfies the numerous needs, part of it must be used repeatedly. The water cycle from the atmosphere to the earth and then to the ocean, to once again enter the atmosphere, is not uniform throughout the world (American Society for testing and materials, 2000).

Industrial needs would vary in a drinkable way. Chemical and metallurgical industries have 5 to 30 times more water than smaller industries. Approximately 80% of all the water used in the industry is used for cooling, the elimination of the caustic pollution is a vital problem. In recycling systems, the water is cooled by means of spray tanks, sprinklers, tanks and cooling towers, evaporation condensers and air-cooled heat exchangers (American Society for testing and materials, 2000).

Normally this fresh replacement water contains minerals, soil, bacterial waste and other impurities. Moreover, as the water circulates through the system, it accumulates with contaminants. Immediately the temperatures begin to rise, the efficiency of the cooling equipment decreases and it may even be necessary to stop the plant (Kemmer, 1989).

The cooling systems have four basic problems: corrosion, fouling, fouling and microbial contamination. Each one is related to the basic natural laws by which they are intended to be treated by natural oxidation, the minerals are to be precipitated, the solid is suspended and cemented, and the microorganisms to multiply. These problems can stop the optimal operation of a cooling water system quickly.

As regards protection methods we will focus on analyzing the impact they cause to the environment, when chemical methods are abused. The cooling tower itself is a measure of positive impact. These systems which help the water used in a company for cooling system can be refused by recirculating it for several concentration cycles, the number of cycles is determined by the quality of the water.

Closed cooling systems

In enclosed circulation systems, the heat transfer is processed from the process to the cooling water or by the middle conduction or the heat transfer equipment. These systems are not concentrated or concentrated in the water.

A system is "closed" when it is designed to fill up with water only, close and operate after long periods without adding significant amounts of replacement water. In closed cooling systems, the heat is normally dissipated by an open cooling circuit or forced reinforcement that exceeds the pipes containing water from the closed system (Kemmer, 1988).

Open cooling system

The most common cooling system used in the industry is the open recirculation system. These units are basically open to the atmosphere, to which heat is transferred during

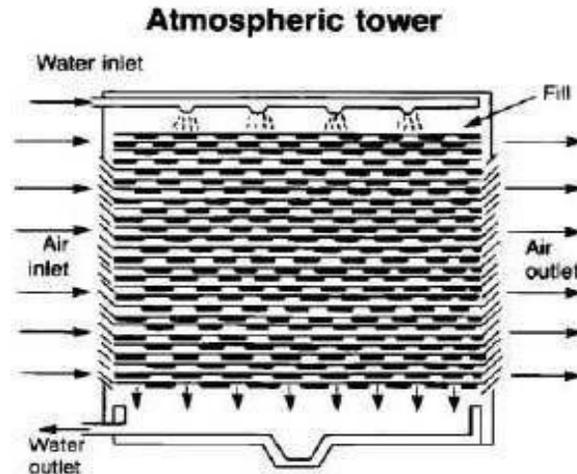


Figure 1: Cooling tower.

Table 1: Systems analyzed.

System	Type of monitoring	Date
Evaporative condenser	CF, biological	Dec 2017
Cooling tower 1	CF, biological	Jan. 2018

the evaporation process. The evaporation and cooling effect produced decreases the temperature of the water body, which circulates through a variety of heat exchange equipment, absorbs heat and returns to the open tower to repeat the cycle.

Open circulating systems can form part of other systems, such as a closed system, where heat is removed from a source that is not open to the atmosphere. The process is very simple and efficient, as long as the different equipments are maintained under the appropriate working conditions (Galveneale, 1979).

Cooling towers

When the circulating cooling water passes through the process equipment, it absorbs the process heat and transports the cooling system. When the water reaches the tower, it releases the heat to the atmosphere. Then the water returns to the process equipment and repeats the cycle (Figure 1).

METHODOLOGY

The methodology was integrated by the activities presented in:

- Analysis of system data: It involves determining the tendency of the system of incrustations, corrosion or fouling in the systems selected for the tests.

- Water sampling.

- Application program selection.

- Evaluation of polluting charges.

They are designed based on the program (Table)1

Analysis of water samples

The parameters were determined according to Mexican standards and techniques recommended in the standardized method for the analysis of wastewater and drinking water. The parameters include: pH, conductivity, total iron, total hardness, calcium hardness, magnesium hardness, alkalinity, sulfates, chlorides, turbidity, and silica.

Contaminant charge evaluation

The evaluation of the contaminant load results in limited operational aspects of design, location and programs. Water volumes and biodegradability of the chemicals used in each treatment were analyzed in each system.

RESULTS

The values of three samples performed were reported monthly for the physical and chemical analysis of the evaporative condenser (Table 2). An average of three values of the softened replacement water is presented,

Table 2: Chemical physical analysis, evaporative condenser.

S/N	pH	Cond. μ mohs	Fe ppm	Ex free ppm	PO ₄ ppm	SO ₄ ppm	Cl ⁻ ppm	SiO ₂ ppm	D _{Ca} ppm,CaCO ₃	D _T ppm,CaCO ₃	T _Z	CiclesConc.
1	8.8	4430	1.0	0.93	3.5	786	1234	252	2	12	24	6.2
2	9.4	21300	1.1	0.42	4.3	4210	6850	319	72	220	147	30
3	9.0	1970	2.0	0.93	0.5	240	648	249	2	16	16	2.7

Table 3: Softened replacement water, evaporative condenser.

pH	Cond. μ mohs	Fe ppm	Alkalinity M	Alkalinity F	PO ₄ ppm	Cl ⁻ ppm	SiO ₂ ppm	D _{Ca} ppm,CaCO ₃	D _T ppm,CaCO ₃
7.5	723	0.9	320	0	0.6	127	113	0	80

Table 4: Biological analysis, evaporative condenser.

Total count	No Esporog	B Esporog	Desulfovibrio	Clostridium	E. coli	Mushrooms	Yeasts	D _T ppm,CaCO ₃
2000000	1500	30	25	25	1	1	1	80

Table 5: Chemical physical analysis of cooling tower 1.

S/N	pH	Cond. μ mohs	Fe ppm	Ex free ppm	PO ₄ ppm	SiO ₂ ppm	D _{Ca} ppm,CaCO ₃	D _T ppm,CaCO ₃	T _Z	Cycles Conc.
1	7.8	5670	2.1	0.4	8	12	86	780	13	3.3
2	7.7	5860	2	0.36	9	10	88	690	15	3.41
3	7.6	5760	2.3	0.28	8	12	94	870	12	3.35

Table 6: Replacement water, cooling tower 1.

pH	Cond. μ mohs	Fe ppm	PO ₄ ppm	Cl ⁻ ppm	SiO ₂ ppm	D _{Ca} ppm,CaCO ₃	D _T ppm,CaCO ₃
8.9	1720	0.2	0	427	4	32	230

Table 7: Biological analyzes, cooling tower S3.

Total count	No Esporog	B Esporog	Desulfovibrio	Clostridium	E. coli	Mushrooms	Yeasts
70000	30	20	5	3	0	0	0

averaged because the values are similar to that of the condenser (Table 3). The results of the biological analysis of the evaporative condenser are shown Table 4. The values of three samples performed on this equipment are indicated with a monthly frequency for the chemical physical analysis of the cooling tower 1 (Table 5). There is an average of the three values of the water set, the average is due to those values with very similar cooling tower 1 (Table 6). The results of the biological analyzes of cooling tower are shown in Table 7.

System conditions

- Evaporative condensing system
- High efficiency packaging presents mud and yellow inlays.
- Corrosion in tube and shell heat exchangers-the flux are made of copper and the steel mirror shows galvanic corrosion.
- Presence of algae on the banks of wetlands. Sludges are found in the basin.
- Biopelicula areas are presented in the system.

- Corrosion in some areas of the deposit.
- Magnesium silicate inlays.

Cooling tower system 1: Heat exchanger, sludge is observed. Bacín presents sludge in the background.

Low flow zones for the cooling water system: Gas pollution dryers are located near the tower.

Analysis of results

Some common conditions were found that have repercussions on the continuous operation of the system. High efficiency packaging is very effective in heat transfer. The disadvantage is that if the hydraulic load is very high or is greater than the calculated one, it undergoes a deformation, close the spaces by trapping the solids that the water may contain. It is important to maintain the pH values to avoid the precipitation of some solids, which could be the beginning of a nucleation point. If mechanical conditions are maintained, a chemical problem would be avoided. Packaging can change its function to act as percolating filters that are used in biological film processes in the treatment of wastewater. If there is a good control of the system, there will be a large number of dispersants and scale inhibitors such that, if operated properly, an excellent result will be obtained.

Galvanic corrosion in heat exchangers: In some equipment where there is a combination of materials, for example in heat exchangers with copper flux, it causes almost uncontrollable galvanic corrosion. Sometimes some methods are applied to minimize the effect with sacrificial anodes. When they are different equipments, separation with inert flanges can minimize the galvanic effect. However, it is a mechanical design problem. Fixing it chemically would be very expensive.

Presence of algae in wet and wet areas: The presence of some cooling agents is inevitable. Minimum conditions are required for the formation of these organisms. There are countless biocides that, with a correct application, give a good result.

Presence of sludge in the pot: If there is dispersion and purge control, these should be minimal and can be eliminated with the collapse of the catalyst. The presence of muddy problems is a chemical consumption, they accumulate in the sludge, where anaerobic biological processes occur in which there is a development of sulfate reducing bacteria that feed on the system and can contaminate some area of low flow which will cause corrosion by generation of by-products of these anaerobic processes, for example, hydrogen sulfide, corrosion under deposit, chemical species inlay and biofilm formation.- The

formation of biofilm and encrustation as a consequence also lowers deficiency in heat exchangers.

Corrosion under deposit, areas under flow, values out of control, uncontrolled system microbiology are contributing factors to these effects. The application of Biodispersants inlay inhibitors in a good chemical program, and appropriate mechanical and operational conditions would avoid these negative conditions in the system. Some mechanical modifications in areas of low flow or stagnations with periodic purges at these points would be favorable to avoid corrosion.

Silica or carbonate inlays: The management of automated purges is a good operational control, which avoids chemical analysis of the system inlaid conditions and avoids the saturation of compounds or solids as well as water losses due to unnecessary purges.

Pollution from gas emissions or nearby chimneys: The cooling towers are air washers, beneficial to the middle of the earth, attract gas from the chimneys, increase the concentration of sulfates, and determining factor in the corrosive characteristics of water. The towers are very attractive to birds, some end up inside the tower and die of chemicals, which are a polluting source.

Impact of chemicals on discharges

The discharges of water from the purges of the cooling systems in a company have an impact according to where they are directed: to a sewage treatment plant, to the sewer system or to a body of water.

A factor considered to be the one to be established in the hot water return pipe or in the cold water return of the tower is set as maximum permissible limit of 40°C.

The purge contains chemical residues and may cause an impact on the environment. A detailed analysis of the power system is required to identify a suitable point of the purge considering the energy and environmental aspects.

Persistence and degradation: Biological Oxygen Demand (BOD): This matter is an oxidizing biocide and is not expected to persist in the environment.

Potential for mobility: It is expected that, if this material is released into the environment, it will be dispersed in the air, water and soil / sediments.

Bioaccumulative potential: It is expected that this preparation or material does not generate bioaccumulation.

Characterization of environmental and exposure hazard: According to our hazard characterization, the potential danger to the environment is moderate.

For multifunctional, oxidizing biocides, non-oxidizing biocides of high organic load and some of these toxic or of high permanence, it is important to consider minimizing the impact on the environment by minimizing the dose.

Conclusions

The personnel in charge must have knowledge of the processes of the cooling systems, critical processes, mechanical, operational and chemical conditions. According to the simulators and recirculation water analysis, good control is achieved in the pH and conductivity system.

The problems of a bad treatment or lack of treatment, corrosion, fouling, fouling and microbiology, cause a loss of efficiency in the systems, energy losses and a significant impact on the environment

The relevant environmental impacts due to poor management of a system are reflected in the discharges with high chemical, toxic, short-term deterioration of the equipment, process failures and production losses. When the system operates at more than 4 concentration cycles, it can be costly and not very representative in saving water. These systems in some cases simply do not count on any treatment, so as to maintain continuous maintenance.

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