STATUS OF WATER QUALITY AND PROBLEMS RELATED TO CORROSION IN COOLING TOWER OF FERTILIZER INDUSTRY

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ABSTRACT

The intend of the current study was carried out to analyse the water samples of cooling tower of fertilizer industry. During the study water samples were collected from ammonia plant and utility plant cooling towers of deck and basin in a plastic sealed bottle for the analysis. The water samples collected from both the locations was analyzed for the various physico-chemical parameters contributing to corrosion in cooling towers of fertilizer industry. For the samples analyzed and data collected various stastical tools like averages graphs and photographs was applied to make the study worthier, informative and useful. The work also helped to suggest what kind of imitative measures could be adopted along with the present practices carried out in fertilizer industry.

Key Words: Physico-chemical parameters, Corrosion, Ammonia, Utility plant, Fertilizer industry.

INTRODUCTION

Cooling towers are generally giving out heat to the atmosphere mainly through one or more processes. It's a very important factor of an integrated cooling system. Cooling tower consist of other structures like pumps, valves and recalculating waster piping and it also provides large amount of thermal energy and heat.

In cooling tower the cooling effect is only due to evaporation of the recirculation of cooling water. For this purpose there is a need of continuous supply of water or the make up water for the loss of water during evaporation. Due to evaporation the water is lost and there is a formation of concentrated dissolved solids in cooling tower¹ because dissolved solids is already present in make up water of municipal water. If the dissolved solids is not cleared then it will lead to the formation of sludge and finally leading to scaling in the cooling tower. In order to avoid such problems more make up water is required.

The recalculating water is also lost from windage or drift owed to put back of entrained water droplets in the mass flow of exist air. It will vary according to the green environment, tower safeguarding, management of chemical range, and the hard work of each producer to reduce drift by providing drift removal. The problems raised in the cooling tower may differ like where the cooling tower is installed and also depends on the make up water used in the cooling tower. The amount and excellence may differ and the discharge from the blow down may also differ according to the area and time².

Cooling tower water consists the main branch of the use of industrial water. In each plant large amount of water is consumed but in cooling tower
water is very often reused to save the cost and water. As the cooling tower water is reused problems related to corrosion, scale and slime is caused due to the presence of soluble salts in the system, evaporation and emissions from the cooling water therefore a proper management strategy should be adopted to have a safer and corrosion free cooling tower.

Make up water is the water which is reused again and again in the cooling tower. A day to day or monthly analysis of cooling tower water samples should be carried out in order to check the water quality parameters. Make up water is added in the system to recompense for loss of water due to evaporation, emission or blow down. Concentration of ratio is the ratio of the quality of circulated water to that of make-up water.  

STUDY AREA

The study area preferred for the research was ammonia plant and utility plant cooling tower of fertilizer industry. Both the cooling towers are of closed circulating system and its commonly found in most of the industries. The MIDC water is used as a make-up in both the cooling towers. The most important factor of the tower is to expose the maximum level of water to the maximum flow for longer period. The Cycle of Concentration of both the towers ranged from 4 to 5 per week and the make-up water quality is 1500 -1600 m$^3$/day.

MATERIALS AND METHODS

Collection of cooling tower water samples and the study period

Monthly sampling was carried out at the cooling towers of both ammonia plant and utility plant from deck and basin. The main aim of sampling was to study the water quality parameters of cooling tower. Cooling tower water samples from both the locations were collected from April 2010 to April 2011. The samples were collected in plastic cleaned containers. The procedures followed for the analysis was as per the prescribed standard methods in R.K. Trivedy (1986) and APHA and were also compared with the stream standards/super chill Australia standards. The samples collected were analyzed for the various physico-chemical parameters such as pH, conductivity, TDS, total hardness, chloride, total alkalinity, iron, phosphate, sulphate and nitrate as per the standard methods.

RESULTS AND DISCUSSION

The quality of water was analyzed from both cooling towers of ammonia plant and utility plant from deck and basin for the parameters like temperature, pH, conductivity, TDS, total hardness, chloride, total alkalinity, iron, phosphate, sulphate and nitrate as per the standard methods.

pH

The pH value of cooling tower water of ammonia plant (i.e. both deck and basin) samples varied between 5.76 to 8.12 and 5.92 to 8.16 where as the cooling tower water of utility plant (i.e. both deck and basin) ranged between 4.5 to 7.9 and 5.6 to 7.9.

In the both the towers the value of pH was found to be slightly alkaline due to the presence of bicarbonates and carbonates. The system may have heavy deposition of scale due to calcium.
magnesium and silica at the values of pH where it is high. The parts which are used in the cooling tower are of metals and corrosion may occur if the pH value is low. Hence the value of pH should be controlled.  

**Conductivity**

The conductivity value of cooling tower water of ammonia plant (i.e. both deck and basin) samples varied between 1.24 to 2.12 and 1.28 to 2.18 where as the cooling tower water of utility plant (i.e. both deck and basin) ranged between 0.87 to 2.09 and 0.87 to 2.16. The conductivity value of both the towers water samples was found to be within the permissible limit. If the value of conductivity exceeded then it would have lead to scale formation. In fact the salts which are soluble may have a vital role in the corrosion and scale deposition. The water which is used as make-up water and if it has low conductivity value then it would increase the concentration ratio of water circulated in the system and the water lost will also be reduced. The conductivity can be easily measured and it will help to control the quality.

**Total dissolved solids**

The total dissolved solids of cooling tower water of ammonia plant (i.e. both deck and basin) samples varied between 1140 to 1240 mg/L and 850 to 1220 mg/L where as the cooling tower water of utility plant (i.e. both deck and basin) ranged between 1140 to 1240 mg/L and 860 to 1220 mg/L. The total dissolved solids value of both the towers water samples was found to be within the permissible limit. If exceeded the solids which are dissolved may lead to the formation of scale in the cooling tower.

**Total hardness**

The total hardness of cooling tower water of ammonia plant (i.e. both deck and basin) samples varied between 303 to 475 mg/L and 315 to 476 mg/L where as the cooling tower water of utility plant (i.e. both deck and basin) ranged between 336 to 506 mg/L and 336 to 514 mg/L. The total hardness value of ammonia cooling towers water samples was found to be within the permissible limit whereas the utility plant cooling tower water sample has exceeded the value of permissible limit. Hardness is the sum of calcium and magnesium which indicates...
the components of scale when pH and methyl-red alkalinity combines. In cooling equipments the scale is deposited on the heat conductors and it would lead to reparation like reduction in the high temperature conductivity.

Chloride
The chloride content of cooling tower water of ammonia plant (i.e. both deck and basin) samples varied between 214 to 367.7 mg/L and 203 to 450 mg/L where as the cooling tower water of utility plant (i.e. both deck and basin) ranged between 190 to 323.3 mg/L and 233.6 to 316.6 mg/L. The chloride value of both the tower water samples was found to be within the permissible limit. The important factor of corrosion is chloride ion. If exceeded it would lead to corrosion to pipes or equipments.

Total alkalinity
The total alkalinity of cooling tower water of ammonia plant (i.e. both deck and basin) samples varied between 214 to 367.7 mg/L and 203 to 450 mg/L where as the cooling tower water of utility plant (i.e. both deck and basin) ranged between 190 to 323.3 mg/L and 233.6 to 316.6 mg/L. The total alkalinity value of both the cooling tower water samples was found to be within the permissible limit. If exceeded then it will indicate the increase in concentration of bicarbonate ion with calcium and magnesium hardness would lead to reparation by generating scale of calcium carbonate.

Iron
The iron content of cooling tower water of ammonia plant (i.e. both deck and basin) samples varied between 2.3 to 4.3 mg/L and 2.1 to 2.5 mg/L. The iron value of
both the cooling tower water samples was found to be within the permissible limit. If the values of iron exceeded it would lead to reparation of the deposition in the cooling water structure and the scale of iron would also cause minor deterioration. **Phosphate** The phosphate content of cooling tower water of ammonia plant (i.e. both deck and basin) samples varied between 2.4 to 2.5 mg/L and 2.4 to 2.6 mg/L where as the cooling tower water of utility plant (i.e. both deck and basin) ranged between 2.4 to 2.6 mg/L and 2.2 to 2.9 mg/L. The phosphate value of both the cooling tower water samples was found to be within the permissible limit. If exceeded it may lead to the growth of algae in the system. **Sulphate** The sulphate content of cooling tower water of ammonia plant (i.e. both deck and basin) samples varied between 30 to 40 mg/L where as the cooling tower water of utility plant (i.e. both deck and basin) ranged between 30 to 42 mg/L. The sulphate value of both the cooling tower water samples was found to be within the permissible limit. If exceeded it may lead to corrosion.
sion in the mild steel of the cooling system.8

**Nitrate**
The nitrate content of cooling tower water of ammonia plant (i.e. both deck and basin) samples varied between 7.1 to 15.3 mg/L and 7.6 to 16.7 mg/L where as the cooling tower water of utility plant (i.e. both deck and basin) ranged between 11.1 to 15.3 mg/L and 9.1 to 17.2 mg/L. The nitrate value of both the cooling tower water samples was found to be within the permissible limit. If exceeded it may lead to corrosion in the mild steel of the cooling system like pipe line and the parts of cooling tower.7,8

**CONCLUSION**
The investigation completed on the cooling tower water quality revealed that the water quality of both the cooling tower water samples was found be within the permissible limit except for one parameter i.e. total hardness of the utility plant cooling tower water sample exceeded the permissible limit which has contributed to the scale formation. Calcium is mainly worrying because certain calcium salts show a converse solubility in water. Magnesium is generally not as much of a trouble except if the silica levels are also high. This could effect in magnesium silicate scale in the heat exchangers. Most of the salts in solution would become extra soluble with increase in temperature, calcium carbonate become less soluble with rising temperature. During the study algal growth was seen in the basin of both the cooling towers which may lead to harm the system.

In order to maintain the levels of parameters day to day analysis should be carried out and mitigative measures should be immediately taken whenever needed. For a successful treatment...
daily control is one of the best options.10-12

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REFERENCES