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Design And Development of Mechanized Dissolved Salt Concentration Regulator

K. Naveena Latha[1], Dr.P. Ram Reddy[2], Dr. D. V. Ravi Shanker[3], P. Venkateshwar Reddy[4]
[1, 3, 4]*(Department of Mechanical Engineering, TKR College of Engineering & Technology, INDIA)*
[2]*(Department of Mechanical Engineering, Former registrar,JNTUH, INDIA)*

Abstract: *This paper describes an alternative, non-chemical cooling water treatment system that has proven to be effective in controlling of scaling, corrosion and bacteria growth in cooling towers by "Mechanized Dissolved Salt Concentration Regulator "(MDSCR). The unit works primarily on the principles of Hydrodynamic Cavitation (HC). The HC technology destroy microbial cell walls and converts dissolved calcium and bicarbonate ions into calcium carbonate (CaCO3) , when cooling water is supplied through the HC unit. The separation unit is used to remove the precipitated calcium carbonate and other suspended solids. The severe problem of scaling in the cooling towers is an important problem. The continuous evaporating of water in a cooling tower leads to increases in the dissolved salts concentration. The problem of choking filling material requires frequent replacements. The cost of filling material is 30% of the total cost of cooling tower; the maintenance cost is considerable problem for the industry.*

Keywords: *Air Compressor, Dissolved Solids (TDS), Different flow rates, MDSCR, Total Hardness of water (caco$_3$), and Tangential flow in the nozzle.*

I. Introduction

The cooling tower can be used to remove heat from various sources such as machinery or heated process material, industrial system used cooled tower is to remove the heat absorbed in the circulating water used in power plants, petroleum refineries, petrochemical plants ,natural gas processing plants, food processing plants, semi-conductor plants, and other industrial facilities[1].

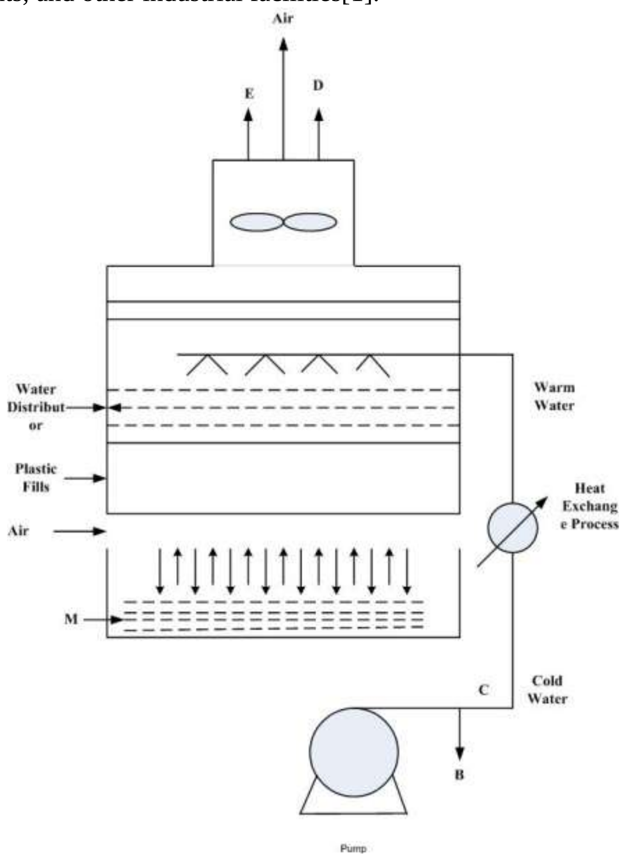

Figure 1. Cooling Tower

1.1. Working principle of MDSCR

For enhancing precipitation formation, MDSCR appears to be most suitable non chemical method of removing precipitates from the cooling tower water [1].

As illustrated below, the MDSCR technology system is tangential treatment. It includes two parts: a nozzle unit and filtration tank.

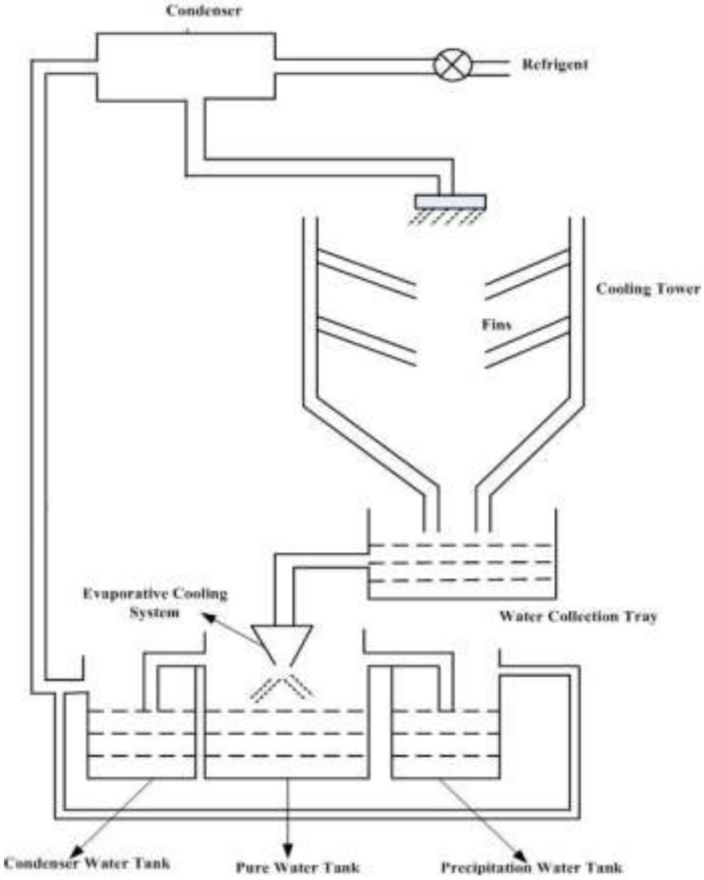

Figure 2. Schematic Diagram of a Modern Cooling Tower With MDSCR Mechanism

The filtration system is used to remove the precipitated calcium carbonate and other suspended solids from the circulating cooling water. The system works on the principle of Hydrodynamic Cavitation (HC). This hydrodynamic cavitation is referred by Evaluation of Non Chemical Treatment Technologies for Cooling Towers at Select California Facilities.et al. (February 2009).

In turbulent liquids, and at high velocity, hydrodynamic cavitation will occur. Cavitation is the dynamic process in a fluid where micro-sized bubbles form, grow, and collapse [3]. When pressure decreases to a low values, cavities are formed in the liquid [4]. When pressure increases, the cavities cannot sustain the surrounding pressure, and consequently, collapse creating localized points of extreme high pressure and temperature. As the bubble collapses, the pressure and temperature of the vapour within it increases. The bubble will eventually collapse to a minute fraction of its original size, at which point the gas within dissipates into the surrounding liquid via a rather violent mechanism, which releases a significant amount of energy in the form of an acoustic shock-wave and as visible light. At the point of total collapse, the temperature of the vapour within the bubble may be several thousand Kelvin, and the pressure several hundred atmospheres. Resulting in the chemical reaction settling in and will release co_2 and other dissolved gases from the solution. By this technology we can allow the formation of precipitation of calcium carbonate, and other micro organisms.

II. Methodology

The design parameters of the tangential nozzle/filtration tank is given below

Inlet of nozzle Diameter	=	75mm
Water Inlet Diameter	=	30mm
Length of Nozzle	=	75mm
Out Nozzle Diameter	=	12mm
Cover Plate Diameter	=	75mm
Height of the cover plate	=	20mm

2.1 Design parameters of filtering tank:

Length	=	130cm
Width	=	130 cm
Height	=	130 cm

2.2 Mechanism of tangential flow MDSCR:

The Inlet

If the water enters at the middle of the top hits the water around the inside of the spout. The patented nozzle forces the water in to three Dimensional motions. It gives a circular motion before the area ends up in the Vortex.

Vortex Chamber

In the vortex chamber the water rotating around the flow axis. Because of that force the water exit the outside of the vortex chamber

Out Side

The vortex area made of reliable environmentally friendly materials to ensure the stability and desired shape.

Inside

If the water to rub against the vortex surface, Electrons are drawn this creates a positive field. And these particles of water are extracted at the surface and accumulate at the centre of the vortex.

The Vortex

When the water flows through the vertex chamber, i.e. reducing are of the nozzle, there it forces the water to spin faster, so that a vacuum pressure is generated at the centre of the vortex. By the forces that occur on the water, it broken the structure of water.

Vacuum Column

The micro and nono bubbles float towards the center of the vertex i.e. towards the middle and connect the bubbles with other bubbles and may not return to their initial positions. The positive changed particles moves to the center of vortex.

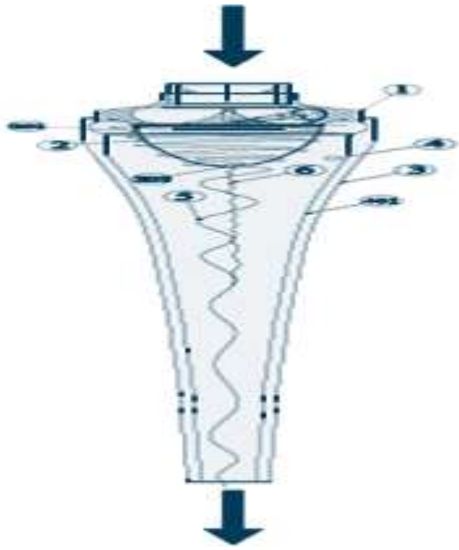

Figure 3. Vortex Mechanism

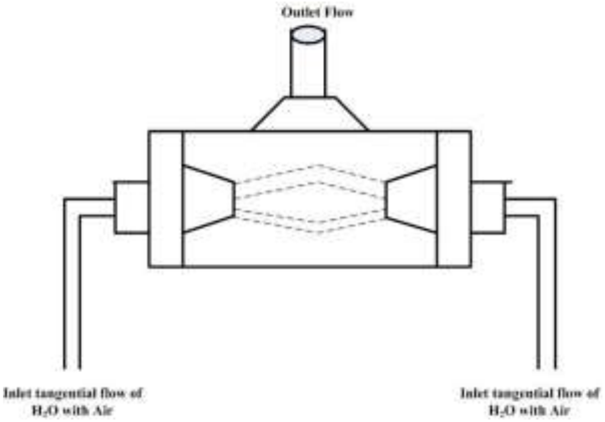

Figure 4. Schematic Diagram of Tangential Flow MDSCR Mechanism

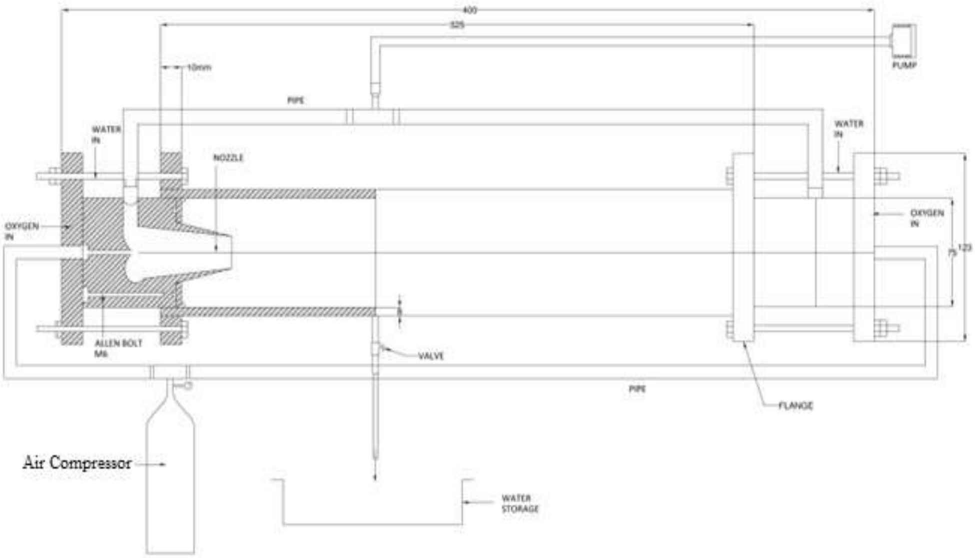

Figure 5. Layout Diagram of Tangential Flow Nozzle

2.3 Modelling Of A Nozzle(MDSCR):

Initially in experimental work, a tangential opposite holes of a nozzle is designed. Nozzle designs are shown in the figs

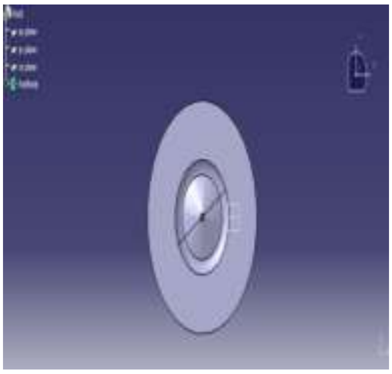

Figure 6. Top View

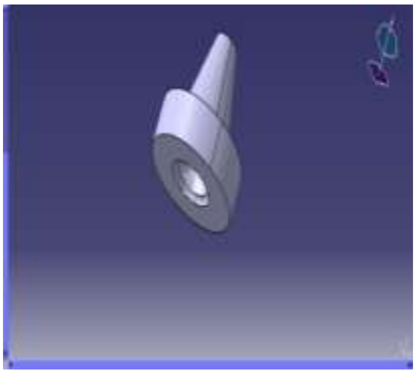

Figure 7. Isometric View

Figure 8. Nozzle with Top Plate

2.4 Assembly of MDSCR with Filtration Tank:

The equipment consist of two nozzles and these set up is immersed in a tank so that the water can be re-circulated in the tank.1HP motor is connected to circulate water from tank to nozzles, and all pipe fittings are made properly, A flow meters connected to the nozzles and fitted properly to the tank. An air compressor at a capacity of 8bar is attached to the nozzles, and the flow can be regulated through the values.

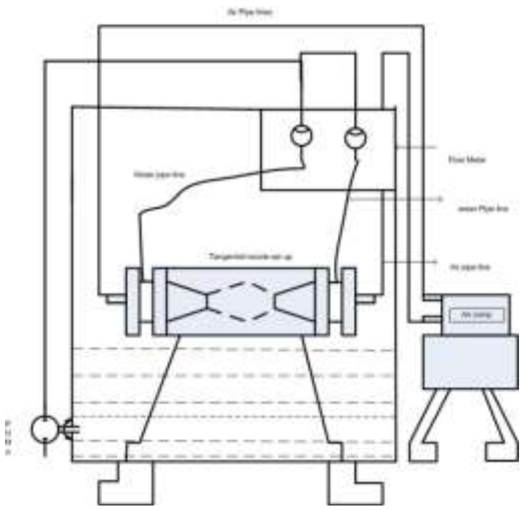

Figure 9. MDSCR Assembly Layout

III. Results And Discussion

Ground water sample is collected, and water analysis has done as per IS: 10500:2012, the results obtained are

Sl. No.	Characteristic	Test method	Results	Acceptable Limit
1	Total Dissolved Solids, mg/l	IS:3025(pt-16)	946	< 500
2	Total Hardness as $CaCo_{3,}$ mg/l	IS:3025(pt-21)	528	< 200
3	Calcium as Ca, mg/l	IS:3025(pt-40)	121.6	< 75
4	Magnesium as Mg, mg/l	IS:3025(pt-46)	53.8	< 30

3.1 Experiment of Water at Pressure 1 bar

At Air Pressure 1 Bar ,Water Circulating Through A Tangential Nozzles is 30min And Flow Rate of Nozzles at Initial Readings Are Q_1= 69 Kilo/Ltres Q_2=74 Kilo/Ltrs

Now collect water samples for every 30, 60, 90, 120, 150 Mins, the results obtained for water analysis

Table 1 Analysis of Water at 1 Bar

.S. No.	Settling Time, Min	TDS, mg/l	Hardness $Caco_3$	Ca, mg/l	Mg, mg/l
1	30	786	440	102.4	44.2
2	60	784	424	99.2	42.2
3	90	770	416	96.8	41.8
4	120	756	400	92.8	40.3
5	150	790	432	101.6	42.2

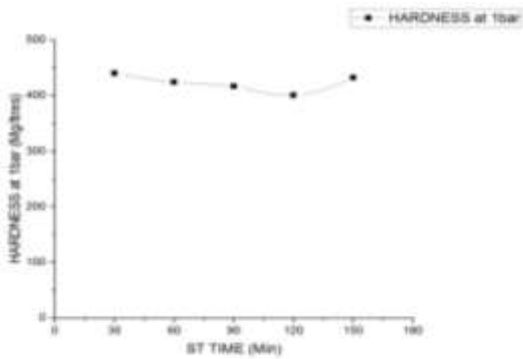

Figure 10. Effect of Hardness mg/ltres

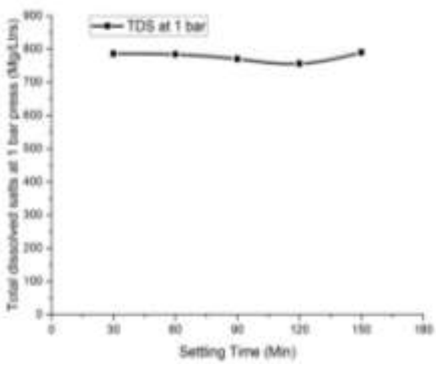

Figure 11. Effect of TDS mg/ltres

The results of Hardness, TDS, Magnesium and Calcium obtained are shown in Table no.2, Here in this study we observed that the values of Hardness, TDS, Magnesium and Calcium are decreasing upto some time (i.e, for 120 mins).And again it will increases if the settling time increases**.**

3.2 Experiment of water at 1.5 bar

At air pressure 1.5 bar ,water circulating through a tangential nozzles is 30min and flow rate of nozzles at initial readings are Q_1= 151 Q_2= 141

Now collect water samples for every 30, 60, 90, 120 and 150 Mins, the results obtained for water analysis

Table 2 Analysis of Water at 1.5 Bar

SI.NO.	Settling Time, Min	TDS, mg/l	Hardness $Caco_3$	Ca, mg/l	Mg, mg/l
1	30	760	440	102.4	44.2
2	60	778	424	98.4	42.2
3	90	776	420	97.6	42.7
4	120	748	400	93.6	39.8
5	150	782	408	96	40.3

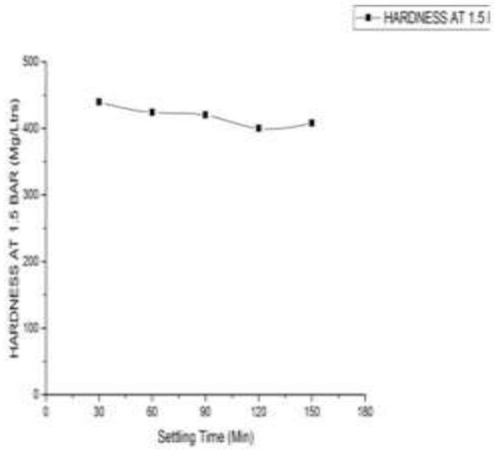

Figure 12. Effect of Hardness mg/ltres

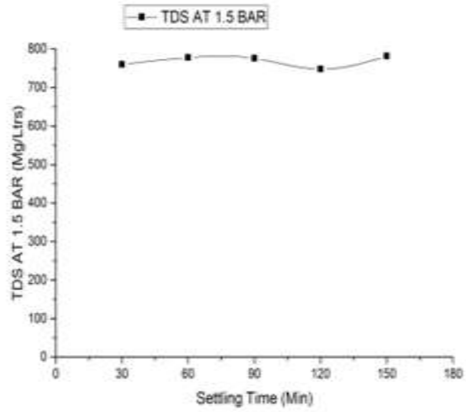

Figure 13. Effect of TDS mg/ltrs

When the water flows at an air pressure 1.5 bar the results are shown in Table no.3, here we obsevered that the results of Hardness, Magnesium and Calcium are even more decreasing for some extent (i.e.120mins).

3.3 Experiment of water at 2 bar

At air pressure 2 bar ,water circulating through a tangential nozzles is 30min and flow rate of nozzles at initial readings are Q_1= 183 kilo/ltrs Q_2 =169 kilo/ltrs.
Now collect water samples for every 30, 60, 90, 120, and 150 Mins, the results obtained for water analysis

SI.NO.	Settling Time, Min	TDS, mg/l	Hardness $Caco_3$	Ca, mg/l	Mg, mg/l
1	30	744	432	100.8	43.2
2	60	734	416	97.6	41.3
3	90	722	412	96	41.3
4	120	754	408	96	40.3
5	150	740	400	93.5	39.8

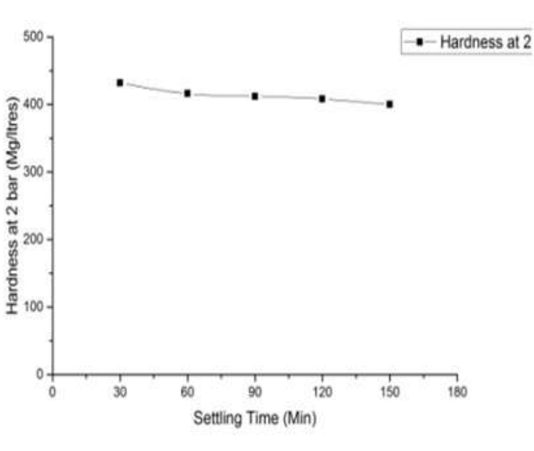

Figure 14. Effect of Hardness mg/Ltrs

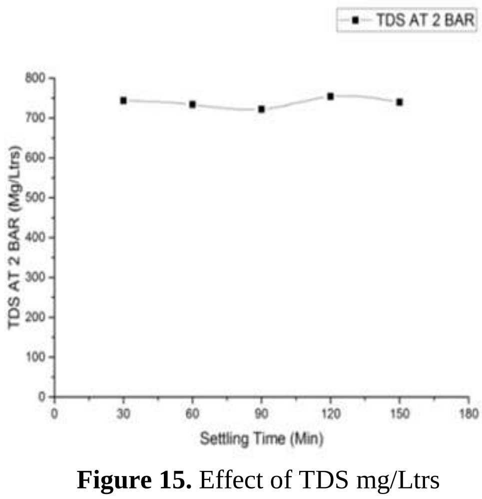

Figure 15. Effect of TDS mg/Ltrs

When the air pressured is increased to 2 bar the results obtained are shown in Table no.4, here the results are decreasing more for 120 mins . but after 120 mins if the water flow continuous the results of Hardness, TDS, Magnesium and Calcium are continued to increasing but the values of them are less than the values which we got from sample ground water test.

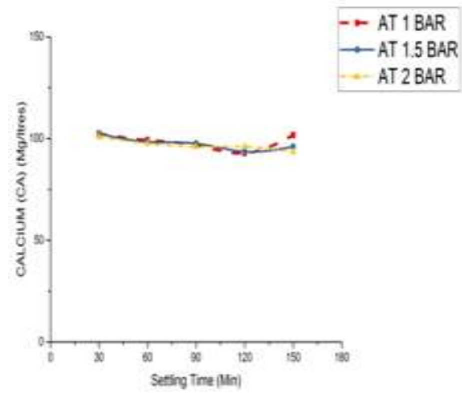

Figure 16. Effect of Calcium (mg/lt)

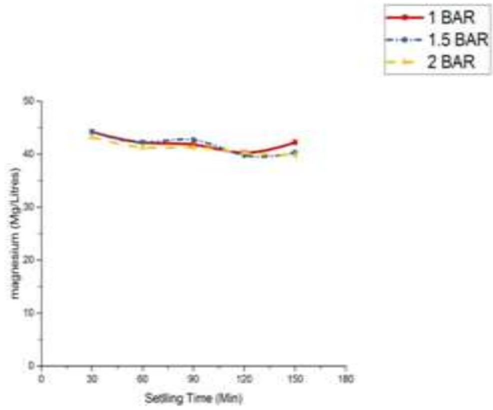

Figure 17. Effect of Magnisum (mg/lt)

IV. Conclusion

In this study we conclude that water cannot be settled continuously for more than 2 hours. Because chemical reactions will start again in water which results the increase in values Hardness and TDS. So we increase the air pressure also the hardness and TDS values will be reduced.

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