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THE EFFECT OF TEMPERATURE AND WATER CONDUCTIVITY IN HOT BASIN TOWARD EFFECTIVENESS OF COOLING TOWER ON UTILITY UNIT PT. X

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ABSTRACT

PT X is one of the Reviews largest ethanol producing plant in Indonesia, PT X located ± 15 km the northeast of Solo or 110 Km to the south of Central Java, SeAprilang. Cooling Tower is a tower or building of water circulation directly or indirectly contact with hot water and then converted into cold water expected that a number of heat from a fluid to another fluid. The Cooling Tower operates According to the diffusion principle, where temperature changes can result in a difference in the rate of temperature displacement. From the process in the cooling tower unit there are Several variables contained in the cooling towers ranging from the temperature and water conductivity in the hot basin. Obtained from the variables can be used to analyze the effectiveness of the cooling tower unit. When the conductivity contained in the water in the basin of hot high then the effectiveness of cooling tower will Decrease, likewise vice versa. And the value of effectiveness Obtained range of 76.12% - 87.80%. Where the company's standard value is 75% effectiveness. There are Several factors Determining the high value of conductivity values such as chemical mixing, high temperature in the cooling tower, and the temperature around the cooling tower.

Keyword: *Cooling Tower, Conductivity, Temperature.*

1. INTRODUCTION

In the production process, the cooling system is very needed both in the production process as well to keep the temperature on the production machine in order to work optimally. Cooling systems are used one of which is a cooling tower. [1]
Cooling tower a system that combines heat transfer and mass transfer simultaneously. Cooling towers are widely used in industrial processes or as laboratory equipment, because was very precise cooling tower used to demonstrate both processes occur. Cooling Tower is a refrigeration system that releases heat into the air. Cooling Tower works by releasing heat into the air by providing contact between water and air. The large surface area of the water is formed by spraying water or splashing water down towards the seals (packing). The function of packing is to make the area of water in contact with air larger so that the heat transfer process will be even greater [10]
The cooling tower is often the forgotten component of a water cooling system when it comes to maintenance. Air is simultaneously forced or drawn through the tower, causing a small percentage of the water to evaporate. The evaporation process removes heat and cools the remaining water, which is collected in the tower's cold water basin and returned to the heat source (typically a water-cooled condenser or other heat exchanger). [8].

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2. LITERATURE REVIEW

2.1. Cooling Tower

Cooling Tower is a tower or building air circulation directly or indirectly contact predictably hot and cold water is then converted into expected or remove some heat from one fluid to another fluid. Cooling Tower operates according to the principle of diffusion, in which the temperature change may result in differences in the magnitude of the rate of mass transfer. The magnitude of the mass transfer rate is affected by the area of contact between the hot fluid and cold fluid. [2]
When water changes state from liquid to vapor or steam thermal energy input must take place known as latent heat of vaporization; This energy input must either be supplied from a fuel such as a boiler or extracted from the surroundings. Cooling tower to take advantage of these changes to the state by creating the conditions in which the water evaporates before moving air; in this way the heat from the water and transferred to the air and the process known as evaporative cooling. The principle is very simple but the heat transfer process is quite complex. [3]
Supply of cool water (cold) proper and continuous then the Cooling Tower as the Heat Exchanger tool can work in accordance with the specifications and conditions are expected, in addition to the costs incurred would be more effective and more efficient energy expended. [4]
The working effectiveness of the Cooling Tower is influenced by several factors, including the difference in vapor pressure between air and water, the surface area of the water and the duration of the process, and the speed of air flowing through the tower. [9].

2.2. Clasification of Cooling Tower

Cooling Toweris a building of wood usually cube- shaped or cone / cylinder using a suction fan / air blower. In making the task of cooling water to heat, to cool return water typically dihujankan back to the cooling tower, where parts of water in contact with inhaled air / blown by the fan.
There are many kinds of classifications cooling towers, but in general the classification is based on the circulation of the water contained therein. According to JR Singham cooling tower can be classified into three parts, namely:
1. Wet cooling tower
2. Dry cooling tower
3. Wet-dry cooling tower

2.2.1. Wet Cooling Tower

Wet cooling tower has a hot water distribution system that is sprayed evenly into the grille, holes or rods horizontally on the side of the tower called stuffing. Air enters from the outside of the tower through the lattice shaped horizontal cracks are fixed on the side of the tower. This gap usually leads angled downward so water does not come out. Therefore, there is a mixture of water and air occurs so that the heat transfer into cold water. The cold water that has gathered in the pond or basin at the base of the tower and from there forwarded to the condenser or thrown out, so now the heat and humid air out of the top of the tower.

2.2.2. Dry Cooling Tower

Dry cooling tower is a cooling tower circulation water flowed inside finned tubes by flowing air. All the heat is removed from the water circulation changed. Dry cooling tower designed to be operated in an enclosed space. There are two types of dry cooling towers.

A. Direct Dry Cooling Tower
Direct dry cooling tower is a combination between the condenser and the cooling tower. Steam turbine exhaust steam is inserted into the box through a large gutters that fall in pressure which is not too big and can be condensed as it flows down through a large number of tubes or finned coil. This tube is cooled by atmospheric air flowing in the atmosphere. Condensate flow due to gravity condensate

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receiver and pumped again into feedwater system installation with the aid of a condensate pump. There is also a system to get rid of gas and prevent freezing in cold weather.

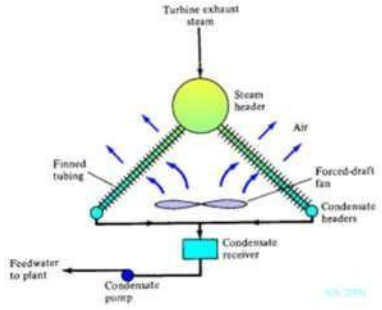

Figure 1. Direct dry cooling tower [5]

B. Indirect Dry Cooling Tower

Indirect cooling tower types can be divided into two types again. The cooling towers use a conventional condenser. Air circulation out of the condenser entering through finned tubes and air cooled by the atmosphere inside the tower.

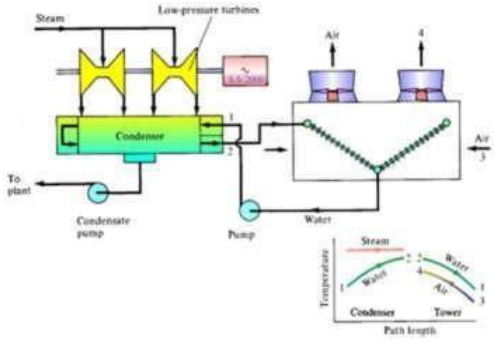

Figure 2. Schematic installation indirect dry cooling tower [5]

2.2.3. Wet-dry Cooling Tower

Wet-dry cooling tower (Wet-Dry Cooling Tower) is a combination of a cooling tower wet and dry cooling towers. The cooling tower has two parallel air lines and two air line series. The top of the tower at the bottom of the fan is dry parts that contain finned tubes. The lower part is a wide space which is a wet part consisting of fillers (Filling Materials).

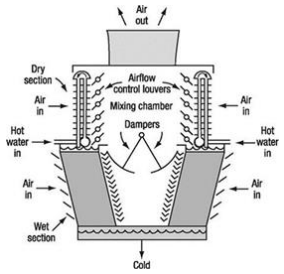

Figure 3. Wet-dry cooling tower [6]

Incoming hot water circulation through the head that is located in the middle. Air first flows up and down through the finned tubes in dry parts, and then left to dry section and fell to the field in the wet section towards the cold water tank. While the air is drawn in through the two streams of dry and wet. Both currents converge and mix in the tower before exiting. Therefore, the first current-heated dry out

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in dry conditions (low relative humidity) than the surrounding air, while the second current is usually saturated.

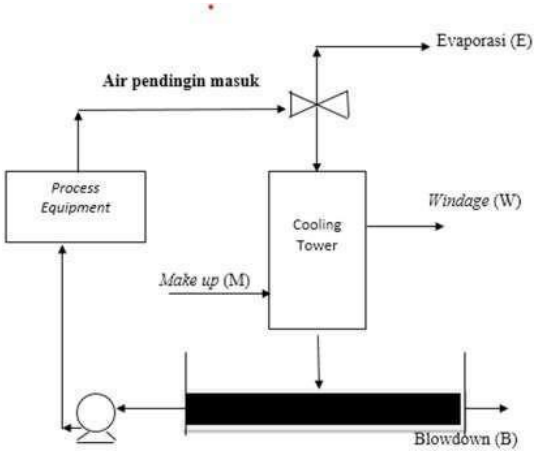

Figure 4. lay out proes cooling [5]

Diagram of Cooling System:

a. Make-Up (M) is an additional water to maintain the discharge to circulate to remain constant.
b. Evaporation (E) is the loss of water due to evaporation which is pure water. Evaporation typically around 0.2% of debit circulation for every drop in temperature of cooling water entering the Cooling Water for 10º F (5,6º C).
c. Windage (W) is carried by the flow of water loss due to the air, a small number is usually between 0.007% -0.2% of the recirculation flow. usually practically ignored in the calculation.
d. Blowdown B) is the removal of water to control the increasing concentration of solids due to the cyclic process.
e. Balance sheet total mass: Make Up = Evaporation + Windage + Blowdown

2.3. Cooling Water Quality

Cooling Water to determine the quality, the parameters in it should be reviewed periodically through laboratory analysis. By recognizing the value of these parameters, then the Cooling Water quality control can be done well.

Here are the parameters in the analysis of Cooling Water Treatment should be monitored periodically or regularly:

a. Turbidity : Shows the amount of suspended solids in the water.
b. pH: parameter that indicates the likelihood of corrosion and scale formation.
c. Electrical conductivity : Shows the amount of dissolved solids in the water.
d. M-alkalinity : Analyzed to predict the growth of calcium carbonate crust. M-alkalinity has a positive correlation with pH.
e. Calcium hardness : An important parameter in estimating the growth of the crust of c carbonate and is commonly used to calculate the Number of Cooling Water Cycle.
f. Magnesium hardness : Analyzed to estimate the crust growth arising from the magnesium ion to form magnesium silicate.
g. Chloride : Parameter which is used as an index for controlling Cooling Water Cycle Number. Cooling Water with a high chloride concentrations tend to be corrosive.
h. Sulfate Cooling Water with high sulfate concentrations tend to be corrosive.
i. Silica : Is one component of the crust forming on the equipment.
j. COD: Chemical Oxygen Demand is. High COD concentration accelerate the formation of Slime.
k. Ion Ammonium, Nitrate and Nitrite Ion Ion: Ion high ammonium concentrations accelerate the formation of Slime. Ammonium ions accelerate the corrosion process by forming a copper complex compound of copper-ammonium salts. When ammonia is transformed into nitrate by bacteria

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Nitrification acid, the pH of Cooling Water to be low and result in corrosion inhibiting chemicals (Corrosion Inhibitor) become dysfunctional.

l. Total Iron : Is one material Fouling in Cooling Water. Attachment of iron compounds (Iron) on the surface Tube Heat Exchanger can cause local corrosion (Local Corrosion) on the material type of Carbon Steel.
m. Residual Chlorine: Chlorine minimum concentration must be maintained in Cooling Water to create an anti-bacterial effect or Biocidal Effect.
n. Corrosion Inhibitor: Specific concentration or chemicals Corrosion Inhibitor corrosion inhibitor should be maintained in Cooling Water to keep the anti-corrosion effect. One example Corrosion Inhibitor is Phosphate, which is usually measured as total Phosphate.

Cooling water that will be used principally to circulate cooling water systems must meet the water quality requirements so as not to disturb the cooling process subsequent one example of a cooling water quality requirements are generally served in the table below:

Table 1. General Parameters Air Conditioning (Setiadi, 2007)

No.	Parameter	Score
1	Conductivity umhos / cm	< 1000
2	Turbidity, ppm	< 10
3	Suspended solids, ppm	< 10
4	Total hardness, ppm CaCO3	< 100
5	Total iron, ppm	< 1
6	The residue clorine, ppm Cl_2	0,5 - 1, 0
7	Silica, ppm SiO_2	< 150
8	Total Cromat, ppm Cr_2O_4	1,5 - 2,59
9	pH	6,5 -7,5

2.4. Type of Tower

Cooling towers are designed and manufactured in several types, with numerous sizes (models) available in each type. Not all types are suitable for application to every heat load coniguration. Understanding the various types, along with their advantages and limitations, can be of vital impor tance to the prospective user, and is essential to the full understanding.

Atmospheric towers utilize no mechanical de- vice (fan) to create air low through the tower.The small atmospheric tower depicted in Figure 4 derives its airlow from the natural induction (aspiration) provided by a pressure-spray type water distribution system. Although relatively in- expensive, they are usually applied only in verysmall sizes, and are far more affected by adverse wind conditions than are other types. Their use on processes requiring accurate, dependable cold water temperatures is not recommended and as such has become rarely used. [6]

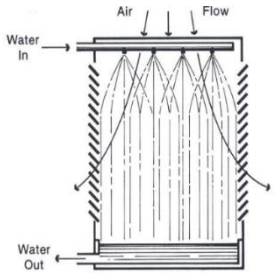

Figure 5. Atmospheric spray tower.

2.5. Understanding Hot Water Basin

Hot Water Basin catchment basins in the cooling tower, serves to accommodate the water from the production process that has a temperature above 45 Celcius. In the tub do some mixing chemicals to

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eliminate microorganisms and chemicals that neutralize the evaporation process can be quick and fast cooling pula.setelah new mixing materials already done with fan cooling process. Then water that has been cooled fall on the cold tub basin and ready to be supplied to the system or heat exchanger.

2.6. Chemicals for Cooling Towers

Chemicals are injected aiming to prevent corrosion (Corrotion inhibitor), eliminating Mikriorganisme, and neutralize chemicals. This chemical is a liquid consisting of Sodium Hydroxide, natriun Hydroxide, Sodium Brobide, Polypropylene Glycol.

2.7. Temperature

Temperature is a measure of heat-coldness of an object. Hot-cold of an object associated with the thermal energy contained in the object. The Thermis more energy, the greater the temperature. Temperature is also called temperature. Temperature indicates the degree of heat objects. Simply, the higher the temperature of an object, the more heat the object. Microscopically, the temperature shows the energy possessed by an object. Each atom in each of an object moving, be it in the form of displacement or movement in the form of vibration. The higher energy the atoms making up the object, the higher the temperature of the object.
A cooling tower could be used as a reliever heat in the process thermodynamics conventional cooling or power generation steam or used in various processes in which water is used for heat exchangers and this is good or desirable to create a repellent heat in the air atmospherics, dissipates heat into the air atmospherics and cooled and circulated in the system to produce an economical operation.

2.8. Conductivity

The ions contained therein. Ion has its own characteristic in electric current. Thus the electrical conductivity value only shows the total ion concentration in the solution. The number of ions in the solution are also affected by dissolved solids in it. The greater the amount of dissolved solids in solution then it is likely the number of ions in solution will also increase, so that the value of the electrical conductivity will also increase. (Irwan: 1) [5]

2.9. Effectiveness

Effectiveness is a condition that indicates the level of success or achievement of a goal that is measured by the quality, quantity and timing in accordance with a predetermined plan for the desired range of effectiveness ranging from 70-90% .Rumus of effectiveness [7] is is:

$$\text{Effectiveness (\%)} = \frac{\text{Range}}{\text{Aproach} - \text{Range}} \text{ x } 100\% \quad (1)$$

Information:
Range = Incoming water temperature (Tin, water) - the temperature of the water out (Tout, water)
approach = The water temperature out (Tout, water) - wet bulb temperature (TWB)

3. METHODOLOGY

Data collection operations related to the title that has taken on a unit of utility. Especially on Cooling tower unit. And the data was acquired on April 2022 in Unit Utilities at PT X.

4. RESULT AND DISCUSSION

4.1. General

Cooling tower or cooling tower is a device used to cool the process water with the help of air medium. Cooling towers are divided into 7 pieces cell (room). Each cell consists of an ID-fan-power 11 KW. Wherein the cooling water temperature when cooling is planned 280C while the hot water back 390C.

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The water source of the water needs are taken from underground water (ABT) a depth of 150-200 meters with a view to maintaining a good quality of water produced and berdebit large, in addition to keeping the surface of the water cycle (wells, river, pool, etc.).
Water cooling system at PT X using a type of open recirculating cooling water. Cooling water that has absorbed heat in the plant process equipment will then be channeled back to the cooling tower to be cooled. Water flowed into the top of the cooling tower and then dropped down and will be in contact with the air stream which is inhaled by induce draft (ID) fan.
From contact with the air flow occurred making process heat from the water by air and also a process of partial evaporation of water by releasing latent heat will cool the water that falls down. Water that has become cold can be accommodated in the basin and can be reused as cooling water. Cooling water flowed into the coolers factory processed using the cooling water pump.
In an open circulatory system, the condition of the cooling water is strongly influenced by the latent heat / thermal evaporation. Approximately 1000 BTU heat will be lost from each pound of water evaporation or it can be said that any difference temperature 100F (50C) will evaporate the 1% of the capacity of circulation.
Because of the vaporised purified water then the minerals in the water circulation will remain high, so that over time the mineral will increase when compared with the make-up water. Density is called the Cycle of Concentration or Cycle Number (N). Cycle Number is a price to determine changes in water quality during the process of circulation and of course show the method is effective in the management of the cooling water system. Cycle Number is influenced by several variables: the volume of make-up water (M), evaporation loss or loss due to evaporation (E) and blow down loss loss for blow down..

4.2. Chemicals for Cooling Towers

4.2.1. Sodium Hidroxide, 3D TRASAR (3DT129)

Function:
For Dissolving and Stabilizing Crust Carbonate and phosphate form a continuous film.
characteristics:
1. Organic chemicals, environmentally friendly
2. Presented in the form of liquid, multifunctional, easy to use in the field.
3. To prevent the crust and corrosion

Identification : corrosive, can cause tissue damage.

4.2.2. Sodium Hydroxide , 3D TRASAR (3DT404)

Function:
For Dissolving and control crust of calcium phosphate characteristics:
1. Organic chemicals, environmentally friendly
2. Presented in the form of liquid, multifunctional, easy to use in the field.
3. To prevent the crust and corrosion of the copper.
4. Containing polymer dispersand Identification:

Against corrosive metal. Can cause skin burns and eye damage.

4.2.3. Sodium Bromine, ACTI-BROM (7342)

Function:
To control microbiological growth characteristics:
1. Oxidizing biocides, environmentally friendly, is presented in liquid form, and has a pungent odor.
2. To prevent the occurrence of slime, and other microorganisms in the system.
3. Injection System: combination with clorine into the system.
4. Identification:
5. Corrosive, can cause tissue damage.

4.2.4. Polypropylene Glycol, NALSPERSE (7348)

Function:
To Dissolves organic film layer on the surface of the cooling system.
characteristics:

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1. Organic chemicals, environmentally friendly
2. Presented in the form of liquid, multifunctional, easy to use in the field.
3. To disperse the bio film layer on the surface of metal.
4. When inserted into the basin is likely to arise due to the effects of cleaning foam.

Identification : Corrosive, can cause tissue damage

4.3. Cooling Water Quality in Want

Here is a table Cooling Water Quality (Cooling Water) desired by PT. X:

Table 2. Cooling Water Quality in want

No.	Parameter	Unit	Score
1	pH	-	7,5 - 8,5
2	Conductivity	µs / cm	Max 1500
3	Ca Hardness	ppm	100-300
4	Total Hardnes	ppm	Max 350
5	Chloride (Cl)	ppm	Max 350
6	Phosphate (PO_4)	ppm	4 - 9
7	Silica (SiO_2)	ppm	Max 180
8	Cycle of cone-silica		2,5
9	Iron (Fe)	ppm	Max 2
10	Total Aerobic Bacteria	Cfu/mL	1 x 10^6
11	Free Residual Halogen	ppm	0,2 - 0,4
12	M Alkalinity	ppm	150 - 400
13	O-PO_4		Max 2
14	COD	ppm	Max 100
15	Former Slime Bacteria	Cfu/mL	5 x 10^5

4.4. Data Processing

Processing of data in the form of data results indicate the conductivity and temperature influence on the effectiveness of the cooling water in the cooling tower. Data retrieved average shift every 3 times a day within 10 days:

Table 3. Temperature and Conductivity Data

Date	Conduc-tivity	(Tin, water)	(Tout, water)	(TWB)
		°C	°C	°C
09-April-22	1585	36.57	28.80	27.5
10-April-22	1442	35.30	27.67	26.6
11-April-22	1521	36.67	26.97	25.4
12-April-22	1667	34.43	28.00	26.6
13-April-22	1858	34.53	27.73	25.6
14-April-22	1588	35.00	28.23	27.1
15-April-22	1389	34.87	27.43	26.4
16-April-22	1634	36.30	28.23	26.7
17-April-22	1653	36.87	27.07	25.1
18-April-22	1459	35.50	27.63	26.5

Above obtained from Table 3 the data for the calculation of the effectiveness of the formula in the above equation. and Effectiveness Calculation examples can be seen in the Appendix. For the calculation results are listed in table 4:

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Table 4. Data Calculation Results

Date	Range	Approach °C	Effectiveness
	°C	1:30	(%)
09-April-22	7.77	1:07	85.66
10-April-22	7.63	1:57	87.74
11-April-22	9.70	1:40	86.09
12-April-22	6:43	2:13	82.13
13-April-22	6.80	1:13	76.12
14-April-22	6.77	1:03	85.65
15-April-22	7:43	1:53	87.80
16-April-22	8:07	1.97	84.03
17-April-22	9.80	1:13	83.29
18-April-22	7.87		87.41
Average			84.59

From the above table is obtained graph of Conductivity and Temperature influence on the effectiveness of the cooling tower as follows:

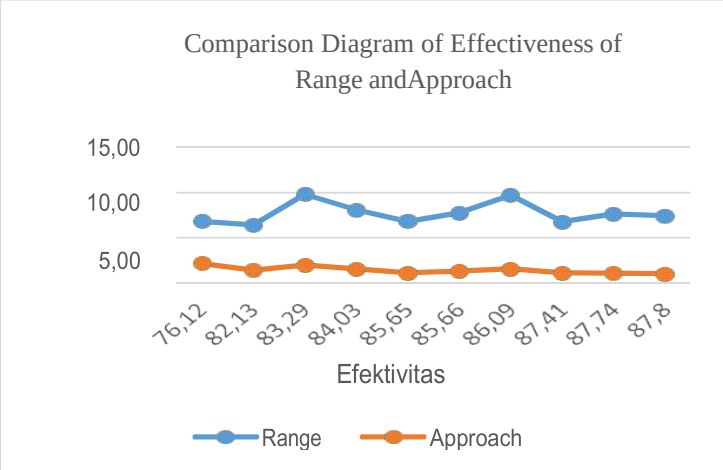

Figure 6. Against Range Comparison Chart Effectiveness and approach

In figure 6 shows that Range and is directly proportional to the effectiveness of the approach, This is because the range and approach is a variable in the calculation of the effectiveness of the cooling tower. Although when seen in the graph range has a value of more volatile

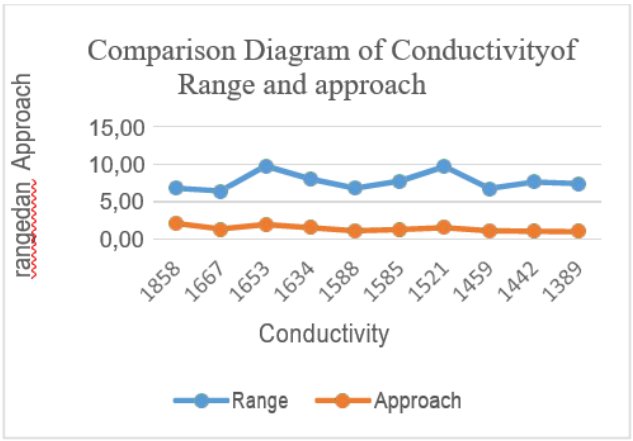

Figure 7. Conductivity Comparison Chart Of Range and Approach

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In Figure 7 shows that Range and approach directly proportional to the conductivity, This is because the range and approach is a parameter determining whether the cooling towers working properly or not. If the high range and approach the conductivity will be high and vice versa.

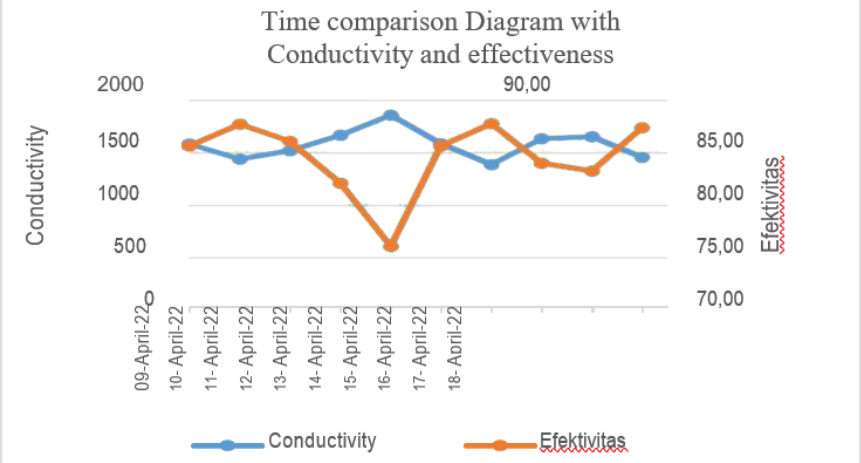

Figure 8. Time Comparison Chart with Conductivity and Effectiveness

And the third graph obtained readings that Conductivity and Effectiveness versus Reversed. This is because when the conductivity contained in the basin of hot water at high then the effectiveness of the cooling tower will also decrease, and vice versa. This is because when a high conductivity, it can be indicated still a lot of chemical and biological substances contained in the water in the hot basin. And it will affect the long decline in water temperature due to the evaporation process will also be hampered.
in Figure 6 and 7 obtained the same linear, and it can be concluded that the range and approach affect the effectiveness and the cooling tower conductivity indicator. This is because the effectiveness is influenced by the temperature of incoming and outgoing temperature in the cooling tower. Beside that also the surrounding air temperature was also influential in this aspect of the effectiveness of cooling tower. This argument is also strengthened by the Journal belongs Nimas 2014 issue page 7 to 5 says that In the current state of work less than the maximum cooling tower due to the temperature of water entering the cooling tower is high, or high temperature environments. This argument is also strengthened by the book Energy Efficiency Guide for Industry in Asia, it says that temperatures Wet Bulp Wet is an important factor in the performance of equipment Cooling tower, because the lowest temperature to which water can be cool wet bulp cooling tower determines the level of the minimum operating temperature throughout the plant, process, or system.
From the data obtained an average effectiveness of 84.59% which determined the effectiveness of the company by 75%. This indicates that the cooling tower is still functioning properly.

5. CONCLUSION

From the observation and data collection can be concluded that:

1. Observations obtained from the variables that are in the process of cooling tower from the temperature into the hot basin, the air temperature around the cooling tower, water flows into the cooling tower, and pH. Besides, there are also chemicals that are useful to assist in cooling towers, ranging from Sodium Hidroxide , Natrium Hydroxide, Sodium Bromine, Polypropylene Glycol.
2. If the content of conductivity in the water in the hot basin is high then the effectiveness of the cooling tower will decrease. vice versa, if the content of conductivity in the lower basin of hot water in the cooling tower effectiveness will be high.
3. In the calculation of the effectiveness of the above obtained range at 76.12% - 87.80% This is due to factors in the water conductivity, water temperature, and the temperature around the cooling tower.

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