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Influence of variation fluid flow towards the performance of cooling tower type induced draft counterflow cooling tower

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Abstract. This research aims to improve the competence of students in the field of Cooling Tower. With product research is a simulation of Cooling Tower. The type cooling tower is Induced Draft Counter flow Cooling Tower. The need of simulation cooling tower for Refrigeration and Air Conditioning Program Study student will be met.Simulation of the Cooling Tower to be created, the load of cooling tower from 2 x 4 kW heater to heat the water that will be circulated to the cooling tower . The pump will circulation water heated by the heater into the cooling Tower. Discharge of water circulated will be varied, then the hot water circulated or which will be cooled in a cooling tower, also will be varied, to see a performance of a cooling tower that was made. The performance of the cooling tower is sought is the value of the temperature range, the temperature value approach, the effectiveness of the average cooling towers, the rate of evaporation of water into the air, cooling capacity (cooling load).

1. Introduction

One of the main components in central air conditioning other than chiller, AHU, and ducting is cooling tower. Its main function is as a means to cool hot water from condenser by direct contact with air by force convection using fan.

Processes that occur in chillers or cooling units for central air conditioning systems with vapor compression systems comprise the process of compression, condensation, expansion and evaporation. This process occurs in a closed cycle that uses a working fluid in the form of a refrigerant that flows in a piping system connected from one component to another. The condenser in the chiller is usually a water-cooled condenser that uses water for the refrigerant cooling processAnother section of your paper In general the shape of the construction of shell & tube where water flows into the shell / tube and superheat refrigerant vapor flows in the tube inside the tube so that the heat exchange process occurs. The superheated refrigerant vapor turns the phase into a liquid that has a high pressure flowing into the expansion device, while the water coming out has a higher temperature.

Because this water will be used again for condenser cooling process then of course the temperature must be lowered back or cooled on cooling tower. The first step is to pump the hot water into the cooling tower through the piping system which at the end has many nozzles for the spraying stage or bursts. The hot water coming out of the nozzle directly makes contact with the surrounding air which forcibly moves due to the influence of the fan / blower installed on the cooling tower.

Two factors that determine the rate of heat transfer from hot water to coolant air are contact time and surface area between phases (water and air). By giving the fill (filler) on the tower, then the two factors above enlarged (Qian et.al., 2012).

Susanto (2010) examined the characteristics of cooling towers using several types of arrangement of pipes as a liquid distributor. Mulyono and Baskoro (2000) examined the characteristics of cooling towers

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with corrugated plastic stuffing materials. Jamilah (1999) examines the performance of cooling tower with aluminum plate as a flow distributor. Ramli (1998) examined the characteristics of cooling tower with plate as a liquid distributor.
Refrigeration and Air Conditoning Program Study, Department of Mechanical Engineering State Polytechnic of Bali, practicing for students in accordance with real conditions that occur in the field, and always trying to develop tools or machines used for student practice. One of the practice tools that do not yet exist in the laboratory of Air Conditioning is the Cooling Tower.

This research activity aims to develop the tools of practice that exist in the Lab. Tata Air PS TPTU, especially the Cooling Tower Simulation tool, as well as practical teaching materials for this cooling tower. With the simulation of cooling tower later, the competence of students will increase, they will be able to audit the cooling tower in the field, as well as can improve the cooling tower performance, if there is a decrease in cooling tower performance studied in the field.

2. Methodology

The location of the research is in Lab Mekanik and Lab. Tata Air Department of Mechanical Engineering PNB.Lab. Mechanical will be used as a place of fabrication and assembling of tools to be made, while the Lab. Tata Air is the location where the process of taking the necessary data.The type of this research is research experimental research (true experimental research), which is doing direct observation to know the cause and effect relationship, after done a change (there is a special treatment) to the variables studied.

The research to test the performance of Induced Draft Cooling Tower is done by varying the water temperature at the water reservoir, varying the water debit to and varying the data retrieval time in every 30 minutes to 1 hour, so it will know the maximum range of cooling tower works optimally.

Measuring tools that are needed and exist in Refrigeration and Air Conditioning Laboratory of Engineering Program of Cooling and Air System of Mechanical Engineering Department are: Thermostat Digital, Thermocouple sensor, Thermocouple Display, Stop Watch, Anemometer, Thermocontrol

The data obtained from the research will be processed according to the formulas below, so get the quantities that show the performance of the cooling tower, that is:

2.1Temperature range.

Range is the difference between the inlet and outlet temperature of the cooling tower. High range means that cooling tower has been able to decrease water temperature effectively and its performance is good. The formula is as follows.

Range (° C) = inlet temperature (° C) - outlet temperature (° C) _*(2.1)*

The range is not determined by the cooling tower, but by the process it serves. The range of a heat exchanger is determined entirely by the heat load and the rate of water circulation through the heat exchanger and into the cooling water. The cooling tower is specifically designed to cool a certain flow rate from one temperature to another at a certain wet bulb temperature

2.2Temperature approach (A)

Approach is the difference between cold water temperature out cooling tower and ambient wet bulb temperature. The lower the approach the better the cooling tower performance. Although the range and approach should be monitored, however, the approach is a better indicator of cooling tower performance.

A(°C) = water temp.out (°C) - wet bulb temp. (°C) *(2.2)*

2.3 Effectiveness of cooling (Ec).

Cooling effectiveness is the ratio between temperature approach,and range. The higher this ratio, the higher the cooling effectiveness of a cooling tower.

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$$\boldsymbol{E_c}(\%) = \mathbf{100}\% \times \frac{water\ in\ temp. - wet\ bulb\ temp.}{water\ in\ temp. - \ water\ out\ temp.} \quad (2.3)$$

2.4Cooling Capacity (cooling load)

The cooling capacity of a cooling tower is equivalent to the cooling tower's ability to discharge heat into the environment. The coolingh capacity can be calculated by the following formula.

While the specific cooling capacity of the uniform cross-sectional area of the cooling tower can be calculatedby the following formula.

$$q = \dot{\mathrm{m}}\ x\ C_p\ x\ \Delta T\ \left(\frac{kJ}{s}\right) \quad (2.4)$$

Where ,

Q = cooling capacity (kW)
$\dot{m}$ = water discharge (kg/s)
Cp = heat specific of water (KJ/kg°C)
ΔT = difference of inlet and outlet water temp. (°C)
A_{tower} = wide cross section of the cooling tower (m^2)

Product of this research is a cooling tower. Figure 1. under is the product of Cooling Tower Type Induced Draft Counterflow Cooling Tower.

Figure 1. Induced Draft Counterflow Cooling Tower.

This cooling tower is tested by varying the motor rotation of the pump so that the flow of flowing water will vary as well. Motor rotation variation is obtained by changing the frequency input of the inverter. The flowing water discharge is varied at 1.8 to 3.9 m3 / h. The water temperature to be cooled is made about 34 - 35 oC by using Thermocontrol.

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3. Result

The test results data are processed by the formulas presented front, then presented in graphical form below.

3.1 *The relationship between variation flow of water with temperature range*

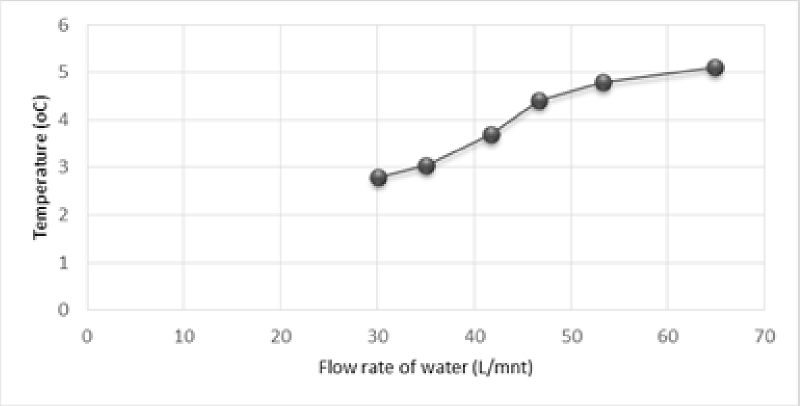

Figure 2 Flow rate of water to temperature Range

Changes in the flow of water into the cooling tower, the greater the water discharge is applied then the temperature range will be greater. This means that the water temperature that comes out will be cooler if the amount of water discharge into the cooling tower the higher.

3.*2 The relationship between variation flow of water and temperature approach.*

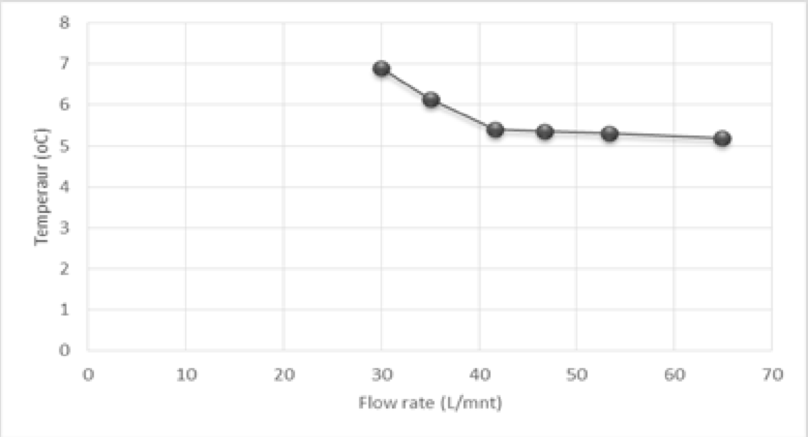

Figure 3. Flow rate of water to temperature approach

Changes in the flow of water into the cooling tower, the greater the water discharge is applied then the temperature approach will decrease. This means that the temperature of the water coming out cooling tower will approach the wet air temperature of the environment.

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3.3 *The relationship between variation flow of water and effectiveness cooling*.

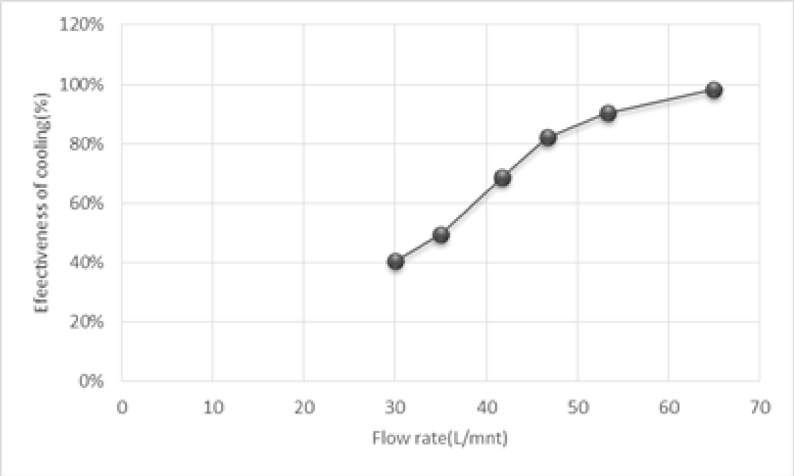

Figure 4 Flow rate of water to effectiveness cooling

Changes in the flow of water into the cooling tower, the greater the water discharge applied then the cooling effectiveness will be greater. This means that the cooling tower will be more effective with the greater the flow of water into the cooling tower the higher

3.4 *The relationship between variation flow of water and cooling capacity.*

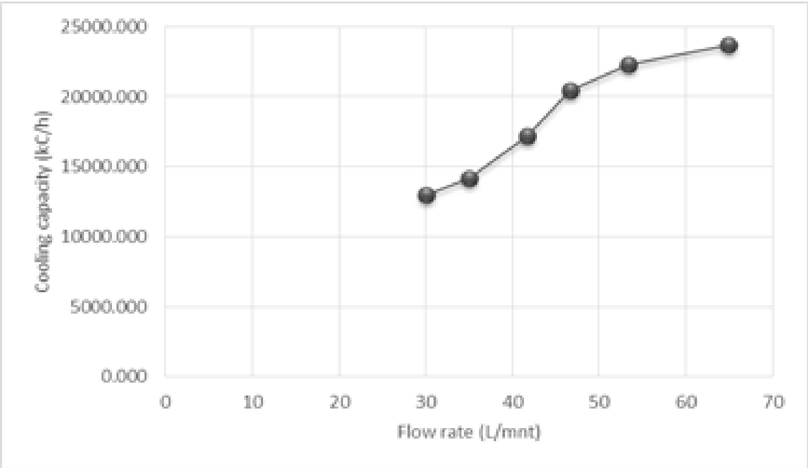

Figure 5 Flow rate of water vs cooling capacity

Changes in the flow of water into the cooling tower, the greater the water discharge is applied then the cooling capacity will be greater.

4. Conclusion

With variations of flow discharge applied 30, 35, 41, 46.7,53.3, 64.9 (lt / min) yielded

1. Temperature range is increasing, ie 2.8 / 3.05 / 3.7 / 4.4 / 4.8 / 5.1 (^{o}C)
2. The approach temperature is lower, ie 6.9 / 6.15 / 5.4 / 5.35 / 5.3 / 5.2 (oC)
3. Higher effectiveness of 41% / 50% / 69% / 82% / 91% / 98%
4. Cooling capacity is higher: 13,022,335 / 14,185,040 / 17,208,085 / 20,463,670 / 22,324,010 / 23,719,250 (kC / h)

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