Experimental study of air velocity effect of heat transfer in distillation condenser

by A. Wibolo

IOP Conference Series: Materials Science and Engineering

Experimental study of air velocity effect of heat transfer in distillation condenser

To cite this article: A Wibolo *et al* 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1175** 012014

Experimental study of air velocity effect of heat transfer in distillation condenser

AWibolo[1], A A I Made[2], Sudirman[3]
[1,2,3]Bali State Polytechnic Badung,Indonesia

Email: wibolo@pnb.ac.id

Abstract. A cooling tower is a heat exchanger equipment that uses water splashing media to lower the temperature by extracting heat from the water and emitting it into the atmosphere. Wind speed or velocity of wind waves is a fundamental atmospheric quantity caused by moving air from high pressure to low pressure while wind is moving air. Air velocity has an effect on the value of heat transfer coefficient, the faster the air, the better the value so that the heat transfer that occurs is also better. Research was also carried out on the human body to see forced convection due to the movement of these parts of the body, resulting in that the faster the body moves, the better the heat transfer coefficient value, this is related to the air flow that occurs on the body surface. The test shows that the more blower rotation make faster the heat transfer that occurs. At 2500 RPM rotation shows higher heat transfer by producing an average of 29.210 watts, the displacement decreases when the rotation is lowered to 1700 RPM to produce an average of 20.677 watts. The effectiveness of the tool by increasing the rotation from 1700 to 2500 by 32%.

1.Introduction

Heat Exchanger is a means of transferring/exchanging heat between fluid and other fluids through a separation wall. Based on the direction of fluid flow, this heat exchanger is a Cross Flow type (transverse / perpendicular), then the hot air that will enter the drying room will be separated from the smoke produced by the fuel [1]. Hot air is flowed in the arrangement of pipes (Tube Sheet) and sucked by a blower which is then forwarded into the drying room, while fuel combustion is carried out under the arrangement of pipes so that hot air with smoke from the results of separate combustion [2]. A heat exchanger is a device used to exchange energy in the form of hot water fluid of different temperatures which can occur through direct or indirect contact. The heat exchanger functions to release heat into the surrounding air which is located at the back of the old model refrigeration and is an arrangement of wires and vessels [3].

A cooling tower is one of the heat exchanger equipment that uses water splashing media to lower the temperature by extracting heat from water and emitting it into the atmosphere. Cooling tower is a heat exchanger that cools water through the air by being sprayed which causes a small portion of the water to evaporate. Cooling towers use evaporation where some of the water is evaporated into a moving air stream and then discharged into the atmosphere. As a result, the remaining water is significantly cooled. Cooling towers can lower the water temperature more than equipment that uses only air to dissipate heat, such as radiators in cars, and is therefore more cost effective and energy efficient. The cooling tower has several main parts including a fan or blower that functions to circulate air.

Wind speed, or wind wave velocity, is a fundamental atmospheric quantity. Wind speed is caused by moving air from high pressure to low pressure, usually due to temperature changes, whereas wind is moving air (Wikipedia). The heat transfer rate increases with the increase in air speed. The flow of air outside the heat channel walls will cause forced convection [4]. Irvan Paramananda's research in 2014[5] by varying the air velocity on cooling with a radiator found that air velocity affects the effectiveness of heat transfer, the faster the air, the faster the heat transfer rate will be. Air velocity also has an effect on the value of heat transfer coefficient, the faster the air, the better the value so that the heat transfer that occurs is also better[6]. Research has also been carried out on the human body to look at forced convection due to the movement of these parts of the body. This research shows that the faster the body moves, the better the heat transfer coefficient value, this is related to the air flow that occurs on the body surface[7]. Some of these studies have stated that air velocity can affect the heat transfer that occurs.

This research will conduct an experiment on these results on a condenser cooling tower model distillation. This condenser has been made in previous research to produce good heat transfer due to changes in the cooling water flow rate [8]. Further research to further improve the effectiveness of the tool is to vary the blower air speed. The aim is to speed up heat transfer so that the phase change process becomes faster and will speed up the overall distillation time.

2.Research Methods

2.1.Design

Making tools has been done in previous studies, but redesign or shape changes are needed to readjust the tools to be installed according to the needs of the research being carried out. Several additional measuring instruments will also be installed to determine the phenomenon of temperature change data so that the heat transfer that occurs can be known significantly.

To determine the effectiveness of the cooling tower based distillation tube device, a test was carried out in the form of an analysis of the effect of air velocity on heat transfer so that it can accelerate the phase change. This test uses relevant theories and real data collection and refers to fixed variables that have been determined.

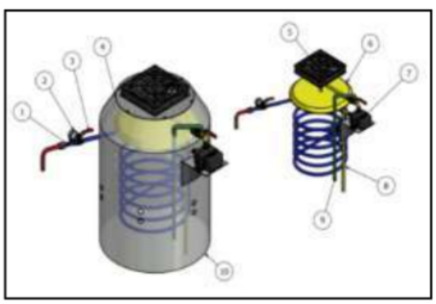


Figure 1. Distillation tool

1.Cooling pipe	6.Shower
2.Pressure gauge.	7.Water pump
3.Valve	8.Water pipe
4.Tube cover	9.Bypass pipe
5.Exhoust fab	10.Tube condenser

IOP Conf. Series: Materials Science and Engineering 1175 (2021) 012014 doi:10.1088/1757-899X/1175/1/012014

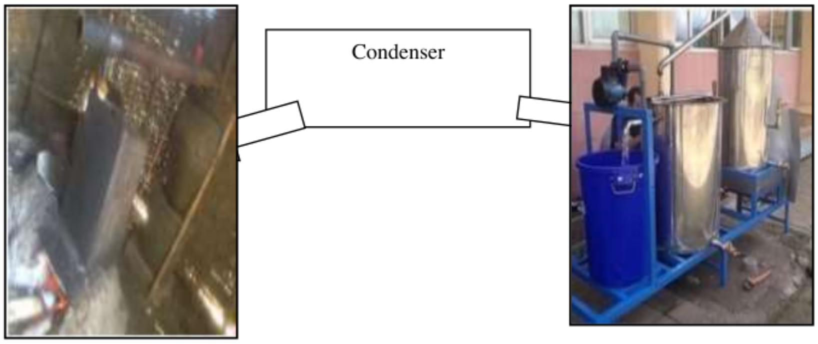


Figure 2. Condenser design

2.2.Research instrument

Tests are carried out based on the data that has been taken and fixed variables such as time and water discharge used. The test will be limited to only 5 attempts.

Measurements are made at several points to determine the heat transfer that occurs. The placement of the measuring instrument is carried out at several points to measure temperature. The measuring instrument sensor is placed at several points in accordance with Figure 3. The placement of the sensor is as needed. The T4 sensor inside the pipe is in a floating position to measure the temperature of the steam produced. The T3 sensor inside the pipe is attached to the wall to measure the temperature. The heat transfer from T4 to T3 is convection heat. The T2 sensor is placed outside against the pipe wall. The heat transfer from T3 to T2 is conduction heat. The sensor T1 is placed floating to measure the condenser room temperature. The heat transfer from T2 to T1 is convection heat. The total heat transfer is the sum of the three processes.

The data collection process is carried out by following the prepared flow. The reactor which has been filled with distillation material is heated according to the required temperature. After the temperature is reached (90 degrees C) the steam valve is opened. The test is carried out by varying the fan rotation to regulate the amount of air sucked from the condenser. Data were collected every 10 minutes in a span of 90 minutes.

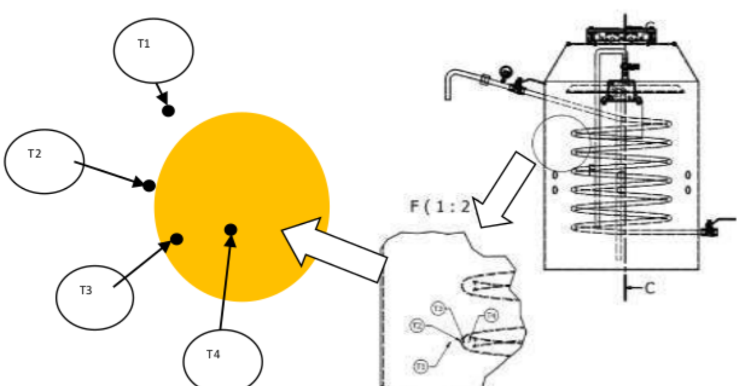


Figure 3. Location of data retrieval

IOP Conf. Series: Materials Science and Engineering 1175 (2021) 012014 doi:10.1088/1757-899X/1175/1/012014

3.Results

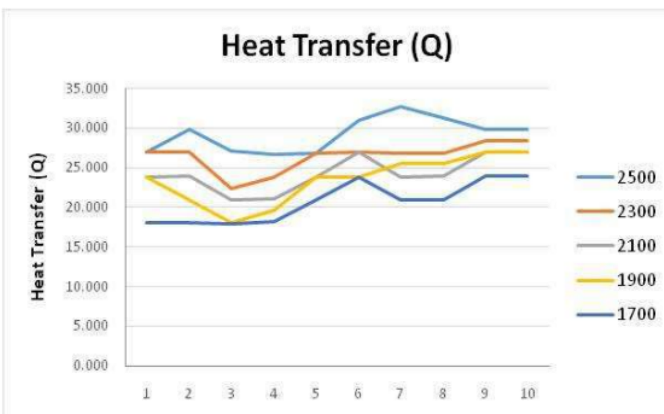
3.1.Result Of Data

The test is done by varying the blower rotation from low RPM to high RPM. Change using a potentiometer and rotation measured with a tachometer. The higher the RPM, the greater the volume of air flowing. The rotation is adjusted from RPM 1700, 1900, 2100, 2300 and 2500. Test result data are as in table 1.

Table 1. Test Result Data

No		Heat Transfer (Q)				
	RPM	2500	2300	2100	1900	1700
1		26.943	26.943	23.865	23.865	18.013
2		29.869	26.943	24.017	20.939	18.013
3		27.095	RPM 02	20.939	18.013	17.861
4		26.639	23.865	21.091	19.628	18.165
5		26.803	26.791	23.865	23.865	20.939
6		31.040	26.943	26.943	23.865	23.865
7		32.643	26.791	23.865	25.480	20.939
8		31.332	26.791	24.017	25.480	20.939
9		29.869	28.406	26.943	26.943	24.017
10		29.869	28.406	26.943	26.943	24.017
Rate of Q		29.210	26.428	24.249	23.502	20.677

Figure 4. Heat Transfer Graph



3.2.Descriptive Analysis

The test data shows that the higher the blower rotation, the faster the heat transfer occurs. At 2500 RPM rotation shows a higher heat transfer by producing an average of 29.210 watts, the displacement decreases when the rotation is lowered to 1700 RPM to produce an average of 20.677 watts.

This phenomenon occurs because the volume of flowing air increases. The air is flowed through the hole on the bottom side of the condenser through the steam pipe and then discharged at the top of the condenser. The air that flows uses room air where the condenser is placed at a temperature of 25 degrees C. The air is mixed with water which is a splash from the top of the condenser. Water uses a circulating pump. Water is sucked from the bottom of the condenser and then flowed upwards to be sprayed in the form of a splash. The water discharge is kept constant. The combination of flowing air and water gives a nice cooling effect to the designed condenser.

The effectiveness of the tool by increasing the rotation from 1700 to 2500 is 32%. The effectiveness states that the higher the blower rotation, the better the heat transfer.

Future, research will focus on the pressure in the condenser tube. The existing theory states that pressure give an affects the heat transfer. Changing the pressure is done by closing the air inlet and varying the fan speed. This can change the air pressure in the tube. Hopefully, the lower of the air pressure, the better the heat transfer that occurs. By increase of heat transfer will affect the rate of vapor phase change in the condenser pipe. This effort was made to obtain an effective condenser design and reduce energy use.

4. Conclusion

This research has resulted in changes that occur due to varying the rotation of the air fan. Expectations from this research have been derived from these changes. Several things need to be done again to increase the effectiveness of the condenser designed.

This research can give the following conclusions are :

1. The increase in blower rotation affects the heat transfer that occurs in the cooling tower model distillation condenser.
2. The increase in rotation can increase the effectiveness of the cooling tower model distillation condenser.

5. References

[**1**] Satish Kumar M V H 2016 Performance analysis of cooling tower. *International Journal of Engineering Trends and Technology (IJETT)* **38** 9

[**2**] Sulaeman 2014 Effectiveness analysis of heat exchanger. *Journal of Machine Technique Padang Technology Institute* **4** 1

[**3**] Putra T D 2014 Instrumentation system planning at the design of test equipment for wire and tube heat exchanger efficiency. *JRM Technique Faculty Surabaya University* **1** 2

[**4**] Chaibi M T 2013 Experimental analysis of the performance of a mechanical geothermal water cooling tower in South Tunisia. *American Journal of Energy Research- Institut National de Recherche en Génie Rural Eauxet Forets* **1** 1 (Ariana: Tunisia)

[**5**] Irvan Paramananda and Prabowo Prabowo 2014 Studi Eksperimen Pengaruh Variasi Kecepatan Udara Terhadap Performa Heat Exchanger Jenis Compact Heat Exchanger (Radiator) Dengan Susunan Tube Inline Sebagai Pemanas Pada Sistem Pengeringan Batubara. *Jurnal Tehnik ITS* **3** B-91

[**6**] Xiao, B., Wang, G., Wang, Q., Maniruzzaman, M., Sisson, R.D. and Rong, Y., 2011. An experimental study of heat transfer during forced air convection. *Journal of materials engineering and performance* **20** 7

[**7**] Oliveira, A.V.M., Gaspar, A.R. and Quintela, D.A., 2011. Dynamic clothing insulation. Measurements with a thermal manikin operating under the thermal comfort regulation mode. *Applied Ergonomics* **42** 6

[**8**] Adiaksa, I.M.A. and Wibolo, A., 2020, February. Experimental analysis of fluids discharge in cooling tower condenser distillation model. In *Journal of Physics: Conference Series* **1450** 1

Experimental study of air velocity effect of heat transfer in distillation condenser

ORIGINALITY REPORT

22%	16%	10%	11%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	academic-accelerator.com Internet Source	3%
2	eprints.uai.ac.id Internet Source	3%
3	moam.info Internet Source	2%
4	N Suzzi, G Croce. "Numerical simulation of dropwise condensation over hydrophobic surfaces using vapor-diffusion model", Journal of Physics: Conference Series, 2021 Publication	2%
5	www.hw.ac.uk Internet Source	2%
6	Submitted to Fiji National University Student Paper	2%
7	Submitted to Universitas Diponegoro Student Paper	2%

8	Shizhuang Li, Shukun Cao, Wenjing Meng, Lingran Ma. "Grain dryer temperature field analysis", IOP Conference Series: Materials Science and Engineering, 2017 Publication	2%
9	Submitted to Queensland Institute of Business and Technology Student Paper	1%
10	Andriawan, Harto Tanujaya, Abrar Riza. "Simulation and Study of Shell and Tube Type Heat Exchangers", IOP Conference Series: Materials Science and Engineering, 2020 Publication	1%
11	Submitted to Copperbelt University Student Paper	1%
12	coek.info Internet Source	<1%

Exclude quotes On
Exclude bibliography On
Exclude matches < 10 words

Experimental study of air velocity effect of heat transfer in distillation condenser

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6