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Experimental Analysis of the Effect Addition Heat Cover in Distillation Reactor

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***Abstract*—Distillation is a process of separating two or more components of a liquid based on the boiling point. In simple terms, distillation is done by heating/evaporating the liquid then the vapor is cooled back so that it becomes liquid with the help of a condenser. Various studies on the distillation column or reactor have been carried out to improve the distillation system. However, this research is still concerned with the reactions that occur due to heating and the final result of the distillation process. In terms of thermodynamic analysis, several methodologies based on the first law of thermodynamics have been developed. In the distillation tower the temperature at the heat source is always greater than the temperature at the heat sink, so the heat source line will always be higher than the heat sink line, where the area between the two is energy. loss. To complement the shortcomings of the analysis, an analysis based on the second law of thermodynamics is developed, known as exergy analysis. With this analysis, information about thermodynamic efficiency and locations that have low energy efficiency can be obtained so that targeting for energy savings can be carried out. This study also only analyzes the level of energy differences that occur without providing a solution to overcome these deficiencies. The existence of the distillation column as one of the vital tools at the separation stage, the distillation reactor planning which is very important to note is the manufacture of the reactor. This research was conducted to reduce the heat losses that occur by adding a heat protection layer (heat cover) to the distillation reactor. Heat protection material must be easy to find and easy to maintain because this designed distillation device will be implemented for rural communities and there is also a prototype tool which is the application of appropriate technology. The use of an alloy of 3 cm jute on the inside and 3 cm glass wool on the outside gave the highest heat transfer value, namely 7864.21 watts. The increase was 43% from those who only used burlap and 37% from those who only used glass wool and 3% from the alloys of 3 cm glass wool on the inside of 3 cm of jute on the outside. This effect is due to the heat that has been blocked by the burlap is inhibited by the glass wool which has high thermal conductivity.**

***Keywords*—heat, exchanger, distillation, cooling, tower**

I. Introduction

Distillation is a process of separating two or more components of a liquid based on the boiling point. distilled (reactor) in which there is a filter containing the material to be evaporated. The reactor is tightly closed so that no steam comes out of the lid and connection pipe. The temperature will gradually rise to the maximum that it can evaporate water as well as oil which then flows through the connecting pipe and undergoes a process of condensation / phase change from vapor to liquid when it enters the spiral pipe.

Heat transfer in a moist granular or porous material such as snow, however, does not take place by pure conduction as in a solid [1]. The material under study is composed of ice, air and water vapor, each of which contributes to the overall flux. Heat may be transferred by conduction through the ice network, conduction in the interstitial pore space and water – vapor flux across the pore. In this addition to these mechanisms, convection and radiation may occur, but the are not considered significant in the development presented. Research on the distillation column or reactor has been carried out to improve the distillation system. However, this research is still concerned with the reactions that occur due to heating and the final result of the distillation process. Methodologies based on the first law of thermodynamics have been developed, such as introducing thermodynamic analysis using availability diagrams by drawing the heat load Q as the x-axis and Carnot's efficiency, 1-T0 / T as the y-axis (Umeda, 1979). The temperature distillation tower at the heat source is always greater than the temperature at the heat sink, so the heat source line will always be higher than the heat sink line, where the area between the two is energy loss [2]. This research still requires a lot of energy and energy losses in the distillation reactor that is made. To complement the shortcomings of the analysis, an analysis based on the second law of thermodynamics is developed, known as energy analysis. This analysis obtains information about thermodynamic efficiency and locations that have low energy efficiency so that targeting for energy savings can be carried out. This study also only analyzes the level of energy differences that occur without providing a solution to overcome these deficiencies.

The existence of a distillation column as one of the vital tools at the separation stage is an almost always present part of the complete process design. Specific understanding of this tool is considered very important and important [3], so in the planning of a distillation reactor that is very important to pay attention to is the manufacture of the reactor. Distillation Efficiency 11% with 20% Technical Efficiency shows that the energy used in the distillation process has a greater percentage than the energy that can be produced, in this case it is related to distilled oil [4]. Seeing this research, it can be categorized that the energy requirement to produce distillates is still very large.

The thermal insulation effect of a plastic greenhouse was evaluated based on air and cover surface temperature changes and U values [4]. When the greenhouses with and without thermal curtains had similar indoor and outdoor air temperatures, the greenhouse with thermal curtains exhibited a greater inner and outer cover surface difference than that without thermal curtains. Regarding the outer cover surface temperatures, the temperature of the greenhouse with thermal curtains was almost uniformly 1.9 _C lower than that without thermal curtains at night during the experimental period. The greenhouses with and without thermal curtains reached maximum air and cover surface temperatures that were between 12:20 and 13:30, and minimum air and cover surface temperatures at 7:20–7:50, demonstrating a particular need for heating during this period. The minimum inner cover surface temperature of the greenhouse with thermal curtains occurred at 08:30, the moment when the thermal curtains were rolled up. Energies 2018, 11, 578 10 of 11 The U values had an important role in determining the heating energy consumption in the greenhouse, and the U value and fuel usage rates were closely correlated, which was 2.76Wm-2 degree C-1 with thermal curtains and 3.85 W m-2 degree C-1 without thermal curtains. Regarding energy consumption and U values in the greenhouses with and without thermal curtains, the energy consumption decreased by 70.8 kWh with a 1-W m-2 degree C-1 decrease in U value. Installing thermal curtains is an effective method to promote heating savings, and the use of thermal curtains in greenhouses at night could yield energy savings of 28.7%, which is similar to the difference in the U values between greenhouses with and without thermal curtains. Therefore, thermal curtains are an effective method for decreasing U values by increasing thermal insulation. The results of this study are particularly applicable to greenhouses commonly used in Korea; however, they can be applied to similar set-ups in similarly harsh climates. This proves that the use of heat protection can have a significant effect on the heat transfer that occurs.

Ten years' hourly measurements of air and ground temperature values at various depths below bare and short grass soil at Dublin Airport have been used in order to investigate the impact of different ground surface boundary conditions on the efficiency of a single and a multiple parallel earth-to-air heat exchanger system [5]. The heating potential of both these systems buried under bare soil has been assessed and compared with the heating potential of the same systems buried under short-grass-covered soil. The results of this comparison revealed that soil surface cover might be a significant controllable factor for the improvement of the performance of earth-to-air heat exchangers. The heating system consists of a single pipe or multiple parallel pipes laid horizontally, through which ambient or indoor air is propelled and heated by the bulk temperature of the natural ground. The dynamic thermal performance of these systems during the winter period and their operational limits have been calculated using an accurate numerical model. Finally, a sensitivity analysis was performed in order to investigate the effect of the main design parameters, such as pipe length, pipe radius, air velocity inside the tube and the depth of the buried pipe below the earth's surface, on the system heating capacity. Cumulative frequency distributions of the air temperature at the pipe's exit have been developed as a function of the main input parameters. This proves that soil and grass can provide a good heat protection effect against heat transfer that occurs in the planted pipe.

Heat protection affects the temperature difference on the thermosyphon cover [6]. Other researcher have studied the thermal performance of a floor heating system and related topics by means of computer simulation. Analytical expressions for the steady – state heat loss from any rectangular core and the perimeter regions of a slab floor in two – and three dimensional geometry, as a function of the dimensions of the core and the perimeter regions, the wall thickness, ground conductivity, and average surface conductance. Kilkis et al, developed a composite plate fin model to predict the steady – state heat transfer in a panel composed of layer with different thermal conductivity. The addition of a carpet to the room has an effect of reducing the temperature by 20 C on the ceramic floor in the room [7]. The insulator material in this research is glass wool and fiberglass which has a small thermal conductivity value [8]. Purpose of research to determine the effect of using glass wool and fiberglass insulators on: (1) oil and water outlet temperature, (2) LMTD heat transfer rate, (3) effectiveness heat by comparing the effectiveness of research results and design designs NTU, (4) to determine the maximum thickness of the insulator which has an effectiveness value the highest. This research was conducted in two stages of testing, namely heat testing exchanger without insulator then heat exchanger using insulator, and then after the finish is replaced with a fiberglass insulator with each test using a variation of the thickness of the insulator 2.5 cm, 5 cm, 7.5 cm with each the research was repeated 3 times data collection. From the results of this study, it was found that the temperature ratio came out of the oil and the water in the two insulators, namely fiberglass, has a temperature difference value smaller than on the glass wool, even when the conditions without an insulator are smaller and fiberglass glass wool has a value greater than the condition without an insulator. Rate LMTD heat transfer is obtained, the thicker the insulator used is will decrease its heat transfer rate and will increase effectiveness heat transfer that occurs, the value of the heat transfer rate at a thickness of 5 cm the glass wool is bigger than fiberglass, which is 6.04 W while fiberglass 5,37 W.

This research becomes a reference for adding a heat cover to the reactor. This research will be conducted to determine the heat transfer that occurs. The method is done by adding a heat protection layer (heat cover) to the distillation reactor which is the most important part of the system. The concept of environmentally friendly and appropriate technology is used in the selection of this heat protection material. Heat protection material must be easy to find and easy to maintain because the designed distillation device will be implemented for rural communities and later there will be a prototype tool which is the application of appropriate technology.

II. Research Methods

A. Design

The application of traditional distillation tools is to make alcoholic drinks using coconut tree sap or palm tree sap as raw material. To obtain 1 liter of alcoholic drink, it takes at least 16 liters of palm sap, while the need for heating the raw materials to become steam is around 3 to 4 hours, this takes a relatively long time because of heat transfer that occurs high heat losses in the reactor.

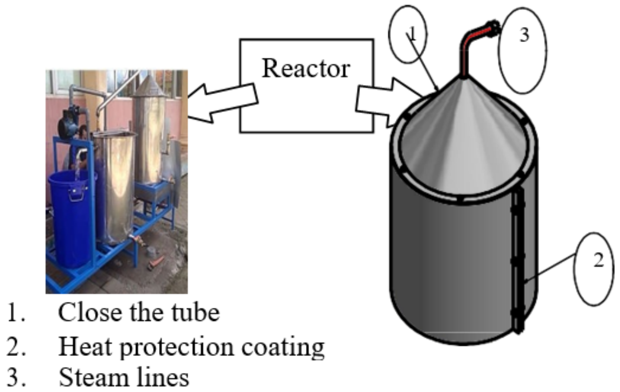

Fig. 1. Distillation tool.

The idea emerged to make a distillation tube that could insulate heat. A heat-protected distillation design was created.

This tool is expected to be more efficient in production time by using heat protection. Variations were made on the use of heat covers between gunny sacks and glass wools. This heat cover is chosen besides being easy to obtain, it also has a relatively low heat transfer coefficient value (0.034 W per meters degree C glass wool and 0.035 W per meters degree gunny sack).

The working principle of the distillation device with heat protection is by heating coconut sap in the reactor tube. The tube is tightly closed so that no steam can escape. Gradually the temperature will rise to evaporate ethanol which then flows through the connecting pipe and experiences a condensation/ phase change from vapor to liquid when it enters the spiral pipe. This tool is designed in such a way without leaving the rules of the traditional model. The tool is made in such a way as to make it easier to operate. Appropriate technology patterns are applied in the system to implement science to rural communities.

The dimensions of the tool are made with an inner tube diameter of 40 cm and a height of 60 cm to accommodate a maximum of 20 liters of sap. The volume is made that much because a farmer can produce that much sap in a day. The cap of the tube is made in the shape of a cone with the aim of facilitating the flow of steam to the pipeline towards the condenser. The distribution pipe is made with a diameter of 2 inches with the aim that steam can flow without pressure resistance. Heating the tube using a stove with LPG gas fuel. The stove uses a high-pressure model so that it speeds up the heating process. The gas flow is controlled using a thermocouple which corresponds to the temperature in the tube. The thermocouple will adjust the solenoid valve so that the gas flow to the stove can be controlled. The purpose of this control is that the temperature in the tube can be maintained at 90 degrees Celsius. This temperature is to get the final product in the form of alcohol vapor which will be cooled in the condenser. The process was carried out for 90 minutes according to the research plan. After the process is complete, the sap waste in the tube will be removed through the drain valve. The sap which will be processed next be fed through the input valve. This is done so that the tube seal is not damaged quickly due to frequent opening. Each data collection process uses 20 liters of sap and 1.5 kg of LPG gas fuel.

B. Research Instrument

The test is carried out by varying the thickness of the heat shield used. Heat protection materials using glass wool and sacks. The thicknesses used are 4 and 6 cm. The combination of protectors is also carried out by changing its position. The combination is done back and forth between the glass wool and the sack. The thickness of the variation made is same as for example at a thickness of 4 cm, the combination of thickness is 2 cm glass wool and 2 cm sack, and vice versa. This combination is also evenly thick when the heat shield is 6 cm. The outer heat protection material still uses a stainless-steel plate. Temperature measurement at each predetermined point is carried out every 15 minutes. Temperature measurements are carried out from the time there is an increase in temperature due to heating from the stove.

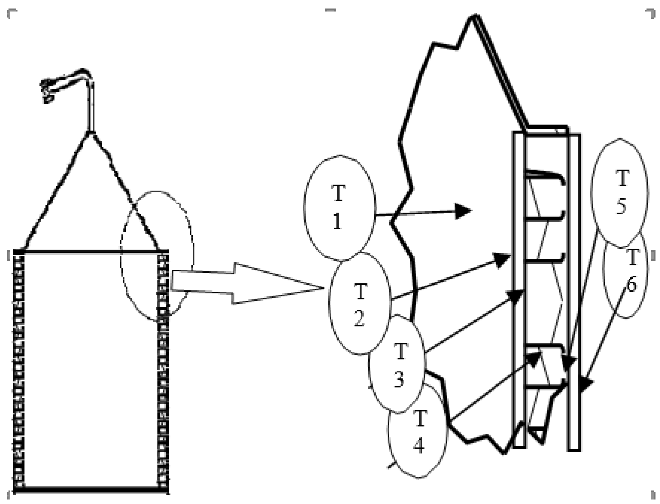

Fig. 2. Location of data retrieval.

III. RESULTS

A. Result of Data

The test was carried out by varying the thickness and heat protection material used. Heat protection is selected from materials that are easy to find and easy to maintain. The materials used are glass wool and burlap. The thickness and type are varied between 4 cm and 6 cm. The data obtained are as in table 1.

TABLE I. RESULT OF EXPERIMENTAL DATA

	Heat Transfer							
Time	*4cm Glasswoll*	*4cm Jute*	*2cm Glasswoll, 2cm jute*	*2cm jute, 2 cm Glasswoll*	*6cm Glasswoll*	*6cm Jute*	*3cm Glasswoll, 3cm Jute*	*3cm Jute, 3cm Glasswoll*
(min)	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*
15	1130.54	1769.34	3754.31	3498.17	827.67	634.78	4231.19	4161.58
30	4327.30	3057.60	5129.38	4704.63	2136.92	877.36	5415.93	5337.00
45	8595.16	4433.69	6682.55	6498.53	6036.66	1628.66	7335.53	8189.64
60	7081.76	4532.79	9972.47	9149.16	8485.84	3303.01	10715.41	10916.46
75	6772.19	8657.05	9527.75	8854.45	7862.65	8546.09	10108.69	10238.27
90	5589.50	7850.73	9023.64	8808.16	6950.15	7147.84	9318.96	9410.06
105	4401.42	7167.30	8075.96	7832.10	5745.92	6488.28	8755.46	8921.82
120	3724.94	6633.02	7656.04	7343.44	4754.10	6166.77	7781.49	7947.37
135	3186.22	5683.89	6623.69	6366.34	3630.55	5339.09	6742.97	7224.95
150	2692.24	4941.31	5310.75	5389.66	2740.27	4835.31	5519.68	6295.00
RATE	4750.13	5472.67	7175.65	6844.46	4917.07	4496.72	7592.53	7864.21

The data is then graphed to make it easier to analyze the phenomena that occur when variations are made. This variation can be illustrated as in Figure 3.

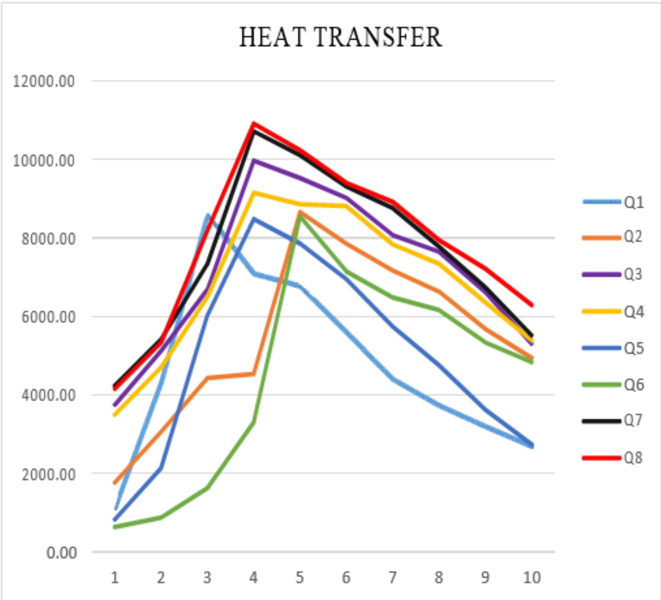

Fig. 3. Heat transfer graph.

B. Descriptive Analysis

Figure 3 shows a graph of the heat transfer that occurs due to the addition of a heat protector to the reactor. The variation in using different alloys of materials provides a significant heat transfer effect. The heat protector thickness also providesa significant temperature difference so that it affects the heat transfer value. The use of an alloy of 3 cm jute on the inside and 3 cm glass wool on the outside gave the highest heat transfer value, namely 7864.21 watts. The increase was 43% from those who only used burlap and 37% from those who only used glass wools and 3% from the alloys of 3 cm glass wools on the inside of 3 cm of jute on the outside. This effect is due to the heat that has been blocked by the burlap is inhibited by the glass wools which has high thermal conductivity.

IV. CONCLUSION

- Good design for the reactor using a heat protection alloy gunny on the inside and a glass wool on the outside.
- Heat protection can affect the heat transfer that occurs inthe distillation reactor.

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