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DESIGN AND FABRICATION OF PARALLEL AND COUNTER-FLOW HEAT EXCHANGER TRAINER FOR LYCEUM OF THE PHILIPPINES UNIVERSITY- CAVITE FOR MECHANICAL ENGINEERING LABORATORY

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***Abstract*: The purpose of this study is to design and fabricate a heat exchanger trainer that has the capacity to alter it type of flow from parallel to counter flow and vice versa. the scope of this study is to fabricate a heat exchanger for the mechanical engineering laboratory of the lyceum of the Philippines University - Cavite. the procedure heat exchanger must undergo several trials. actual data from the testing will be compared with the theoretical values to determine the accuracy of the trainer. The limitation of the study is that cross-flow heat exchanger is not included. the researchers used water as the working substance. this study contributes to the students in providing a deeper understanding about heat exchangers. the study may also be significant to other researchers who would like to improve the research.**

***Keywords*: heat exchanger, parallel flow, counter-flow.**

I. INTRODUCTION

With the increasing standard for academic level set for all universities. Lyceum of the Philippines University-Cavite campus must constantly improve it quality of teaching to keep up with other prestigious universities. A way to improve the quality of teaching is to provide equipment or trainers that can help the students understand certain principles and theories for their future professions and attain global competitiveness. Students learn the actual results of applying theories with experimentations that are only possible if the students provided with trainers. They learn all actual factors that affect certain processes that are explained before by theories alone. Through trainers, students will also be familiar with industrial equipment that they will eventually encounter in their workplace. To help the mechanical engineering students of the lyceum of the Philippines University-Cavite campus and understand the concept of heat convection and conduction, the researchers came up with a study to design and fabricate a heat exchanger trainer.

A heat exchanger is a device used to transfer heat between one or more fluids. The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. The classic example of a heat exchanger is found in an internal combustion engine in which a circulating fluid known as engine coolant flows through radiator coils and air flows past the coils, which cools the coolant and heat the incoming air. There are three primary specifications of heat exchangers according to their flow of arrangement. In parallel-flow heat exchangers, the fluids enter the exchanger at the same end, and travel in parallel to one another to the other side. In counter-flow heat exchangers the fluids enter the exchanger from opposite ends. The counter current. Design is the most efficient, in that it can transfer the most heat from the heat medium per unit mass due to the fact that the average temperature difference along any unit length is higher. In a cross-flow heat exchanger, the fluids travel roughly perpendicular to one another through the exchanger.

II. LITERATURE REVIEW

Heat exchanger are devices designed to enhance or facilitate the flow of the heat. Countless examples are found in everyday life, for every living thing is equipped in some way with a type of heat exchanger. Synthetic heat exchangers are found in all facets of our lives. Boiling water or frying an egg requires a heat exchanger. Refrigerators operate on vapor compression cycle using two heat exchangers. Building heating and cooling systems involve the use of heat exchangers. Electricity is generated in base load electric power stations that depends on heat exchanger for generating and condensing the steam used to drive the turbine powered alternators. Oil refineries and chemical processing plant use many different heat exchangers.

It is evident that heat exchangers exist in great number, widely distributed throughout industry and commerce. They are found in enormous range of heat transfer capacities. The smallest [>2 Btu/h (>1W)] are included in miniature cryo coolers for infrared thermal imaging, heat-seeking missile guidance, or superconducting electronic applications. The largest [<6x10^9 Btu/h (<2GW)] are the boilers, condensers, and condenser cooling water air coolers on base-load electric power stations.

SYNTHESIS

A heat exchanger is a device used to transfer heat between two or more fluids. The fluids can be single or two phase and, depending on the exchanger type, may be separated or in direct contact. Devices involving energy sources such as nuclear fuel pins or fired heaters are not normally. Many of the particles involved in their design are the same.

In order to discuss heat exchangers it is necessary to provide some form of categorization. There are two approaches that are normally taken. The first considers the flow configuration within the heat exchanger, while the second is based on the classification of equipment type primarily by construction.

III. METHODOLOGY

The researchers include the most important thing in creating a study. They announced that they should have follow the objectives to obtained the expected result, which is a good thing in creating a study

The schematic design of the design is well presented according to the system of heat transfer, where the flow of different pumps takes place in the given working substance and equipment.

The following materials were the materials used to create the device:

- pump - a device used to move the fluid inside the heat exchanger
- containers - used to store the fluids before and after entering the heat exchanger
- copper tube - where the how fluid will flow in the heat exchanger
- steel shell - where the cool fluid will flow in the heat exchanger
- thermometer - used to measure the temperature of the fluid

Data Gathering Procedure

In this study, different resources and procedures are used to collect data including books, catalogues, internet, experimentation and observation.

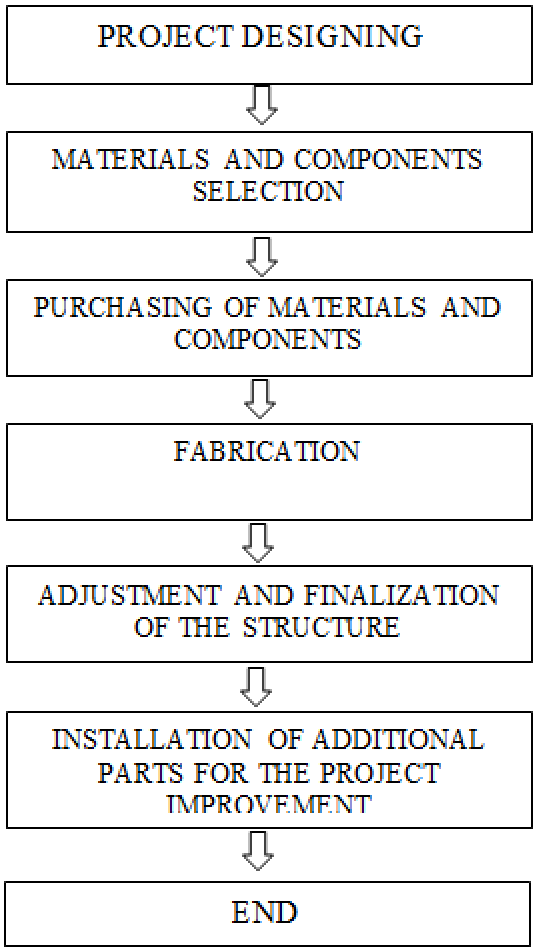
Testing Procedure

Before the assembly of the system, it is important to test whether the components are in good working condition. connections are to be checked for leaks to ensure the safety of the users.

Evaluation Procedure

the system if evaluated according to the rate of heat transfer, total heat rejection/addition, and the temperature characteristics between shell and tube passes with the variation of heat exchanger fluid flow. The researchers measure the temperatures with a thermometer and the total mass of fluid transferred with the measurement in the container. after that, the researchers will compute for the rate of heat transfer with the use of logarithmic mean temperature difference. the user will be able to identify and be familiarized with the relationship of the parameters of the system with the variation of the fluid flow

A. Project Construction Procedure



IV. RESULT AND DISCUSSION

Presenting all the materials that will be using and their specification. The system design allows parallel flow and counter flow of fluids to further increase the number of applications of heat exchanger trainer. In this process the group must checked whether all the materials are good working condition before the test starts. During the performance test the hose, connected to the tap water line is attached first to the inlet of the reservoir. Once the reservoir is full the heater is now submerged inside and the heating process begins. After that we gathered data during the performance test of the Parallel Flow to Counter Flow Heat Exchanger Trainer. The Validation of the results is the testing of the proto type on the trainers output accuracy if the data gathered with the trainer is realistic and close enough to the expected or computed results. The data gathered using the trainer were the temperature of the substance used in the heat exchanger at the inlet, outlet and every ass of the tube. These data are used to plot the curve of the temperature flow arrangement of the heat exchanger. The test showed similarity to the theoretical curve of a counter flow heat exchanger. This means that the data output of the heat exchanger trainer at counter flow setting is accurate and realistic

Table 4.1.1 list of Materials and their specification for the parallel and counter flow heat exchanger

Quality	Specifications
Pump (Viva QB-60)	1 pc, 0.5hp, 2.1 m^3/hr, head 35m
Tube for the heat exchanger	Copper tube ½ nominal size, 3.164m in length, k=401 w/mK, A=1262.3 cm^2
Shell for the heat exchanger	
	3 mm thickness steel sheet
Steel pipe with connectors and union patent	
Reservoir	½ nominal size steel pipes
Heater	
	1pc. 12 gallons steel tank
Temperature gauge	
Ball valves	1pc. 600 watts
Check valves	
	12pcs. Digital gauge -50 ^{0}C -150 ^{0}C
	7 pcs lever type, ½ nominal size
	1pc. ½ nominal size

The data above shows the specification of the parallel flow and counter-flow heat exchanger trainer with a pump of 0.5 horsepower and 2.1 m3/hr volumetric flow rate. the shell is made of 3mm thick steel plates with the length, width and height of 24in. 2¾ , and 10 in respectively. the copper tube inside the shell is of ½ nominal size, 3,164 in length which is divided into 5 passes and has a thermal conductivity of 401 w/mK. hot water is to be pumped from a 12 gal reservoir.

V. CONCLUSION

The heat exchanger design made by the researchers is capable of altering the destination flow of the hot fluid though the use of valves. The difference between the parallel flow and counter-flow heat exchanger is the location of the hot fluid inlet. Parallel flow heat exchanger's hot fluid inlet is located close to the inlet of the cold fluid, thus forming a parallel flow with each other. The counter-flow heat exchanger's hot fluid inlet is located close to the outlet of the cold fluid, thus this time; the fluids were in a counter-flow manner. The design uses a set of valves that will be used to force the hot fluids to flow to a different path if the valve is closed. The change in the path of the hot fluids flow determines whether the inlet will be located close to the inlet or the outlet of the cold fluid. The prototype is fabricated based on the design made by the researchers. It is composed of steel plate shell, copper tubes, steel tubes, pipe fittings and valves. There are six (6) valves used in the prototype to alter the flow if the hot fluid.

The testing is done and both parallel and counter-flow heat exchanger trainer is successful. The researchers started to gather the data to validate the trainer's output accuracy. Using these data and comparing it to the computed values and expected diagram results, the researchers are able to start the validation of the trainer to validate the trainer's accuracy with its heat transfer capacity, the actual heat transfer capacity is determined with the outlet and inlet temperatures of the tubes, mass flow rate of the water and the water's specific heat and is compared to the expected heat transfer capacity which is determined with the use of the heat exchanger's specification which will be a constant with every tests conducted. The actual result is less than the expected result but their values were almost the same. The validation also includes the comparison of the actual temperature flow arrangement and the expected one. Using the data gathered with the trainer, the user will be able to plot the actual temperature flow arrangement and be able to compare to the expected diagram. The results during the tests showed similarities to the expected temperature flow arrangement. These concludes that the system is effective.

VI. RECOMMENDATION

The trainer shows accurate data but further upgrades can produce a better result. The trainer uses only digital thermometers which might eventually cause difficulties in data readings. A program that will gather all the data from the trainer and displays it will greatly help the user to conserve time and energy. The trainer uses an unpressurized reservoir that causes difficulties on priming the pump. A pressurized tank with a heater attachment will reduce the risk of pump damage. It is also recommended to use water pumps with higher temperature capacities to increase the range of data that can be collected. There is also a theory about the temperature flow arrangement that emphasized the difference of the fluid's density and specific heat. Difference in density and specific heat causes changes in the temperature flow arrangement. The testes used only water as the working substance, resulting to an equal specific heat and density, which is while the expected curves and the actual curves were almost like mirrors between hot water and cold water. It is highly recommended to use the trainer for this kind of testing to widen the range of the trainer's purpose or uses.

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