UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND FABRICATE MINI HEAT EXCHANGER FOR WATER COOLING SYSTEM

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive) with Honours.

By

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This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive) with Honours. The member of the supervisory is as follow:

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MUHAMMAD NUR B. OTHMAN

ABSTRAK

Di Malaysia, terdapat beberapa kes di mana segelintir pulau-pulau kecil pasti bergantung kepada air sebagai sumber utama air bersih. Tujuan kajian ini adalah untuk merancang dan menghasilkan penukar haba mini untuk sistem penyejukan air yang menjimatkan masa dan kos. Penyulingan yang menggunakan sumber solar yang beroperasi dengan kanta Fresnel untuk melaksanakan sistem penyulingan. Terdapat tiga reka bentuk konsep penukar haba yang telah dibangunkan menggunakan CATIA V5. Yang pertama ialah penukar haba gegelung heliks piawai dan yang kedua adalah penukar haba heliks dimpled. Prototaip itu diuji dengan menggunakan dua syarat yang berbeza iaitu suhu dalaman dan suhu luar. Ia juga berbeza-beza mengikut saiz padang yang berbeza dan terdapat dua jenis penukar haba yang telah direkabentuk. Setiap prototaip menghasilkan masa yang berbeza untuk menghasilkan 20ml air bersih dan suhu akhir yang berbeza bagi air bersih.

ABSTRACT

In Malaysia, there are some cases where a handful of small islands rely surely on water as a major source of clean water. The purpose of this study is to design and fabricate mini heat exchanger for water cooling system that save time and cost.There are three concept design of heat exchanger that has been developed using CATIA V5. The first one is standard helical coil heat exchanger and the second one is dimpled helical heat exchanger. The prototype was tested using two different conditions which are indoor temperature and outdoor temperature. It also be varied by different size of pitch and there are two types of heat exchanger have been design. Each of prototype produce different time to produce 20ml of clean water and different final temperature of clean water.

DEDICATION

I dedicate this report to my cherished guardians Mr. Komaruddin bin yaacob and Mdm Rohimah binti Jusoh. Not forgot to my supervisor, Mr. Muhammad Nur bin Othman and my automotive laboratory technician , Mr Khairul Fitri bin Zainal that give me chance to use laboratory under his supervision and also give solution to my problem when running the experiment. I also want to dedicate this dissertation to my friends for giving the assistant and underpins in completing this study.

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First of all, I would like to thanks and appreciation my supervisor Mr. Muhammad Nur bin Othman for his guidance to finish this final year project. Special thanks also dedicated to Mr. Khairul Fitri bin Zainal for help me during the progression of this study and encouragement towards the completion of this study.

From bottom of my heart, my deepest gratitude is expressed to my beloved father Mr. Komaruddin bin Yaacob and my beloved mother Mdm Rohimah bt Jusoh and all my friends.

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LIST OF SYMBOLS

D, d	-	Diameter
F	-	Force
g	-	Gravity = 9.81 m/s
I	-	Moment of inertia
1	-	Length
m	-	Mass
N	-	Rotational velocity
P	-	Pressure
Q	-	Volumetric flow-rate
r	-	Radius
T	-	Torque
Re	-	Reynold number
V	-	Velocity
w	-	Angular velocity
x	-	Displacement
z	-	Height
q	-	Angle

LIST OF ABBREVIATIONS

HOQ	**House of Quality**
T1	**Temperature 1**
T2	**Temperature 2**
T3	**Temperature 3**
T4	**Temperature 4**
T5	**Temperature 5**

CHAPTER 1

INTRODUCTION

1.1 Background

Distillation is one of many processes available for water purification, and fire is one of the several forms of heat energy that can be used to power that process. To dispel a common belief, it is not necessary to boil water to distill it. Simply elevating its temperature, short of boiling, will adequately increase the evaporation rate. In fact, although vigorous boiling hastens the distillation process it also can force unwanted residue into the distillate, defeating purification. Furthermore, to boil water with sunlight requires more costly apparatus than is needed to distil it a little more slowly without boiling. The apparatus that used to boil water is using Stove, cooling coil, Reservoir tank, Water container, Universal pipe, and Frame. This equipment most costly depends on the size and materials.

Many levels of purification can be achieved with this process, depending upon the intended application. Sterilized water for medical uses requires a different process than that used to make drinking water. Purification of water heavy in dissolved salts differs from purification of water that has been dirtied by other chemicals or suspended solids. The present cost distilled drink water is several times that of water provided by most municipal utilities, but it costs less energy-wise.

For people concerned about the quality of their municipally supplied drinking water and unhappy with other methods of additional purification available to them, solar distillation of tap water or brackish groundwater can be a pleasant, energy efficient option. These solar energy distilling plants are relatively inexpensive, low technology systems, especially useful where the need for small plants exists.

1.1 Problem Statement

About 70% of the planet is covered in water, yet of all of that, only around 2% is fresh water, and of that 2%, about 1.6% is locked up in polar ice caps and glaciers. So of all of the earth's water, 98% is saltwater, 1.6%is polar ice caps and glaciers, and 0.4% is drinkable water from underground wells or rivers and streams. And despite the amazing amount of technological progress and advancement that the current world we live in has undergone, roughly 1 billion people, or 14.7% of the earth's population, still does not have access to clean, safe drinkable water.

According to Water Partners International, waterborne diseases and the absence of sanitary domestic water is one of the leading causes of death worldwide. For children less than 5 years old, waterborne disease is the leading cause of death, and at any given moment, roughly half of all hospital beds are filled with patients suffering from water-related diseases. Clearly, having affordable potable water readily available to everyone is an important and pressing issue facing the world today. Other than that, for place places such as islands or beach, the clean water is limited and it is so difficult to get drinking water. So, the solar desalination will take place. Desalination refers to the process where salt and other minerals are removed from water. For this process, the Sun heats and evaporates water, which at the same time is separated from salt, dirt or anything else for

that matter. When the temperature and pressure is right, the water molecules reforms and returns to liquid. The solar is the main part in this distillation water and the heat exchanger system in the last process in distillation of water. It changes phases from vapor to liquids. When the water temperatures exceed 100^0, the water starts to change the phases from liquid to vapor. It separated from salt (condensation process), dirt or anything to produce only clean vapor. After that, the vapor entered the heat exchanger system and it changes the phase from vapor to liquids. Other than that, heat exchanger also cools the hot vapor into cool liquids.

1.2 Objective

There are several objectives for the design and development a solar still water distiller. Below are the listed objectives for this project:

1. To design and develop heat exchanger.
2. To make sure heat exchanger can cool the hot vapor.

1.3 Scope

This study will focus on the design and development of solar still for water distiller. Below are the listed scopes of this project:

1. The mini heat exchanger will be design using CATIA.
2. This mini heat exchanger will be test at two condition which is indoor and outdoor.
3. Reservoir tank will be used at mini heat exchanger to produce cool water.
4. Mini heat exchanger will combine with flexible hose and reservoir tank.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews about the heat exchanger that is function to convert the steam that produces when boiling process of water then it will be distilled and collect clean container. Distillation is the method of isolating the components or substances from a fluid mixture by particular boiling and condensation. The distillation of water by solar power can be defined as measures to separate and extract clean water by vaporization process. The heat exchanger materials divide the medium being used and transfer the heat by conduction and convection. It means that water is heated to its boiling point, and then the steam produced is collected and condense back into liquid form when passing through the heat exchanger. There are many factors that will affect the efficiency of the amount of distillate which are design, diameter, material, size and length.

2.2 Condensation

Condensation is the change of the physical state of matter from gas phase into liquid phase, and is the reverse of vaporization. The word most often refers to the water cycle. It can also be defined as the change in the state of water vapor to liquid water when in contact with a liquid or solid surface or cloud condensation nuclei within the atmosphere. When the transition happens from the gaseous phase into the solid phase directly, the change is called deposition (or desublimation. The field of condensation owes its current state to the pioneering work of Nusselt (1916), who predicted, from a simplified theoretical analysis, the HTC of stationary pure vapor

in film condensation on a vertical flat plate. Improvements and modifications to Nusselt's theoretical solution have been made by a number of researchers. For example, Bromley (1952) assumed a linear temperature distribution in the liquid film model. Subsequently, Rohsenow (1973) and others considered the effect of interfacial shear stress on both condensation flow and the characteristic of vapor velocity diminishing along the length of a tube. These investigations were concerned with condensation of pure vapor. In many industrial operations, some amount of non-condensable gas may exist in vapors. It was well recognized that the presence of non-condensable gas in vapors could greatly reduce condensation heat transfer and deteriorate the performance of devices. Seminal studies on this topic were conducted by Sparrow and Lin (1964), Minkowycz and Sparrow (1966) and Sparrow, Minkowycz and Saddy (1967). They explored analytically the condensation of gases containing non-condensable gases in forced convection flow along a horizontal flat plate.

2.3 Cooling system

According to (Liu, Ma, Feng, & Wang, 2018) Heat exchanger network and cooling water system are two major elements of energy systems in processing plants. Such two subjects have a very close interaction with each other. However, most of current researches firstly synthesize heat exchanger network and then design cooling water system. To overcome this limitation of traditional methods, in present paper a simultaneous methodology is introduced to integrate heat exchanger network and cooling water system as a whole system. Unlike conventional approaches, the methodology treats cooling water as a special cold stream whose mass flow rate, initial and final temperatures are all unknown variables and require to be optimized. The methodology mainly makes use of a modified stage-wise superstructure that covers most possible configurations for integrating heat exchanger network and cooling water system.

2.3.1 Solar-Wind Water In Distillation System

The system proposed consists of two main parts, the wind water heater (WWH) is the first one and the simpler solar still is second part. The first part deals with wind energy, converts it into frictional heat by interpose of a thin layer of oil filled in an annular gap placed in between two concentric cylinders with different diameters, the outer cylinder rotating around the fixed inner cylinder, this rotational kinetic energy generates heat that transfer into the inner cylinder that is linked to the heat exchanger. Heat exchanger comes out hot water and pumped to storage tank which is has to be well

thermally insulated. Conventional solar is the second part of this system. However, the