Faculty of Mechanical and Manufacturing Engineering Technology

DESIGN AND SIMULATE WATER VAPOR FLOW IN HEAT EXCHANGER BY VARYING PITCH

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Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

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NOOR IZZATI BINTI ABDULLAH

This report submitted in fulfillment of the requirements for the Bachelor of Mechanical Engineering Technology (Automotive technology) with Honors

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ABSTRAK

Tajuk projek ini ialah “Reka bentuk dan Simulasi Aliran Wap Air dalam Penukar Haba dengan Mengubah Pitch”. Kajian ini akan lebih banyak memberi tumpuan pada parameter model penukar haba untuk mengoptimumkan jumlah penyulingan. Kajian ini adalah untuk mengkaji dah menganalisis simulasi aliran wap menggunakan CFD dan CATIA. Selain itu, kajian ini turut menumpukan perhatian kepada peningkatan pemindahan haba bagi penukar haba dengan mengunakan reka bentuk gegelung heliks. Melalui proses kaedah pemilihan dan pengutusan, bahan,saiz dan reka bentuk yang sesuai untuk penukar haba telah dipilih mengikut faktor-faktor tertentu. Penambahbaikan reka bentuk penukar haba yang mempunyai pemindahan haba yang lebih tinggi adalah hasil daripada projek ini.

ABSTRACT

The title of this project is ‘Design and Simulate Water Vapor Flow in Heat Exchanger by Varying Pitch’. This study will be more focus on parameter of the heat exchanger model to optimize the amount of distillate. This research is to study and analyse the simulation of the water vapor flow using CFD and CATIA. Besides that, this study also focus on increasing the heat transfer rate of heat exchanger using helical coil design. Through selection and decision method the suitable type of material, size and heat exchanger design for the heat exchanger was decided. The improvement of the heat exchanger design of heat exchanger that have higher heat transfer rate will be the result of this project.

DEDICATION

This dissertation is decided to all my family members and friends. To my parents Mr Abdullah bin Abd Ghani and Mdm Rokiah binti Saad who nurses me with moral support whenever any challenges gets tougher. All my fellow friends are deserved to be partnership in my success of the project especially my housemates. They have provided me a lot of motivational and support. I also want to dedicate this dissertation to my supervisor Mr. Muhammad Nur bin Othman who willing to teach and assist me.

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U	-	Overall heat transfer
A	-	Area
Δt	-	Temperature difference
Cp(t)	-	Liquid specific heat tube side
Cp(s)	-	Liquid specific heat shell side
P	-	Pitch
D	-	Diameter
L	-	Length
ρ	-	Density
v	-	Velocity
μ	-	Dynamic viscosity
Re	-	Reynold number

LIST OF ABBREVIATIONS

UTeM	Universiti Teknikal Malaysia Melaka
CFD	Computational fluid dynamics
LMTD	Log mean temperature difference

CHAPTER 1

INTRODUCTION

1.1 Introduction

The reason for this study is to design and simulate water vapor flow in heat exchanger by varying pitch. The heat exchanger is an important part as it will play an important role in order to be able optimizing the total amount of distillate. The selection and design of heat exchanger will include comparison between a few designs of heat exchanger to select suitable heat exchanger to be simulated.

1.2 Background of Study

Nowadays numerous communities, especially in developing countries still don't approach fundamental needs for example food, drinking water and shelter. The absent or scarce of this basic needs will certainly cause difficulties for the communities to continue their living. Among the basic needs, water is the most plenteous assets on earth. Even though generally 75% of the world's surface is water there are still lot of problem develop due to lack of water resource. Approximately, human manage to survive more than three weeks without food but without water human can only survive for a week. Unfortunately, one week is a generous average. Typically human can only survive only for three to four days. This is due to the human body were made with more than 60 percent of water. Every cell in human body needs water to keep functioning. However, there are limited source of

the clean water due to the nowadays environment and the increasing number of human population.

To overcome this problem, several method of producing the clean water are created. From the early of century, human try to develop many ways to produce distilled water using concept of evaporation and condensation. Unfortunately the existing methods are mostly very difficult and expensive. Recently, a new method to produce a distilled water was invented by using a solar energy. Direct sunlight would boil the water to achieve its boiling point and from this process the vapor will be produced. The vapor then will be condense using a heat exchanger and collected in a reservoir.

This research is to study the flow of vapor analysis in the heat exchanger using Hyperworks to analyze. Heat exchanger was created to transfer heat from one medium to another. There are many type of heat exchanger and factors that will influence the efficiency of the output. The heat exchanger materials divide the mediums being used and transfer the heat by conduction and convection. Which means heat passes through the tube wall by conduction and into the flowing fluid by convection. Process involved in distillation were evaporation and condensation, hence the distillate is produced. Every day there are new improvements on heat exchanger design. Every improvement main priority is to invent something which can make the heat exchanger to produce maximum amount of distillate.

The radiator coils inside the internal combustion engine will circulate the coolant through it to cools the coolant is an example of a heat exchanger is found in an internal combustion engine. The heat exchanger was created to transfer thermal energy between fluids at different temperature and there are typically no external heat and work involve. The efficiency of the heat exchanger is usually depends on the geometric parameter (Edwards, 2008).

The flow of vapor in heat exchanger will occur and are affected by the heat exchanger design. When the flow detaches, the vapor flow will condense. The condensation process involve the heat transfer of the vapor. The heat transfer rate of the heat exchanger is also depends on the heat exchanger design. Because of that, this study also focus on optimization of the heat exchanger. Heat exchanger being design into several difference shapes with CATIA software and analyze it with Hyperworks (AcuConsole) software

1.3 Problem Statement

Water is the basic needs of human, unfortunately there are limited source of the clean water and the present methods to produce clean water are very difficult. Aramayo et al. (2015) found that nowadays there are many technological advances being develop however it is still remains as a challenge to produce clean water that is accessible for all human beings. This world is plenteous with water but it is difficult for human to have access to clean water. There are also some place that the closest water source almost 5 miles away to obtain drinking water even though according to Grady et al. (2014) a convenient distance to get water access should be less than 200m from the residence. There are many water distiller available but very expensive and not accessible to everyone. The present designs also are very complicated and need a lot of installation. To overcome this problem, an improvement on heat exchanger design that can optimize the total amount of distillate need to be taken.

1.4 Objectives

The objective of the present research are as follows:

1. To design heat exchanger that will optimize the rate of heat transfer

2. To simulate and study water vapor flow in heat exchanger with different pitch size

1.5 Work Scope

In this project, there are several scopes to be considered in order to achieve the objectives. The following important element that must be followed:

a) Redesign heat exchanger using Catia V5R21.

b) To study the water vapor flow in heat exchanger with difference pitch size and use Hyperworks (AcuConsole) to analyze.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews about heat exchanger where will be used as a converter of the steam that would be produced from the process of boiling would then be distilled and collected in Fresnel Lens Water Distiller. Distillation is the method of purifying a water by a process of heating and cooling. This means that the water is heated beyond the boiling point, and then the steam is collected and condensed back into a liquid after passing through the heat exchanger. A heat exchanger is a device for heat transfer from one medium to another. There are many type of heat exchanger and factors that will influence the efficiency of the output such as size, material, length and design.

2.2 Changes in Distillation Process

It is by and large acknowledged that the distillation process is a method to separate the liquid by evaporation and condensation process. It is an age-old process that originate from latin term, 'de-stillare' which means drip down. The non-volatile solids is the substance that does not evaporate easily into gas can be parted from liquids by distillation process. By definition, heating and cooling process is the method in distillation. Figure 2.1 shows that the liquid is heated beyond the boiling point, and then the steam is collected and condensed back into a liquid. This implies the liquid is heated past the boiling point, and afterward the steam is collected and condensed once again into a liquid (Aramayo et al., 2015) .

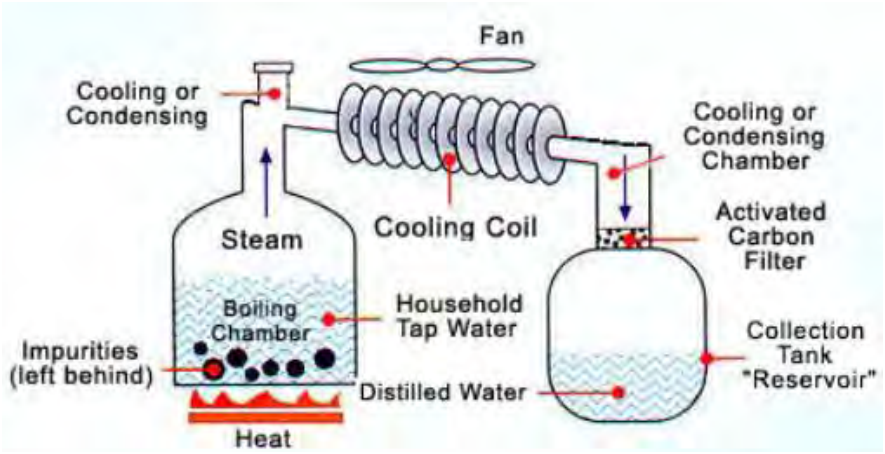

Figure 2.1 : Distillation Process (Aramayo et al., 2015)

The distillation from sea water happened since at least about AD 200, Alexander of Aphrodisias was clearly explained and distinguished about the distillation of water as a passage in Aristotle's Meteorological (II.3, 358b16). B.C. Aristotle also stated in Meteorological the opportunity of distillation when he says that vaporization process can made the sea water to be drinkable

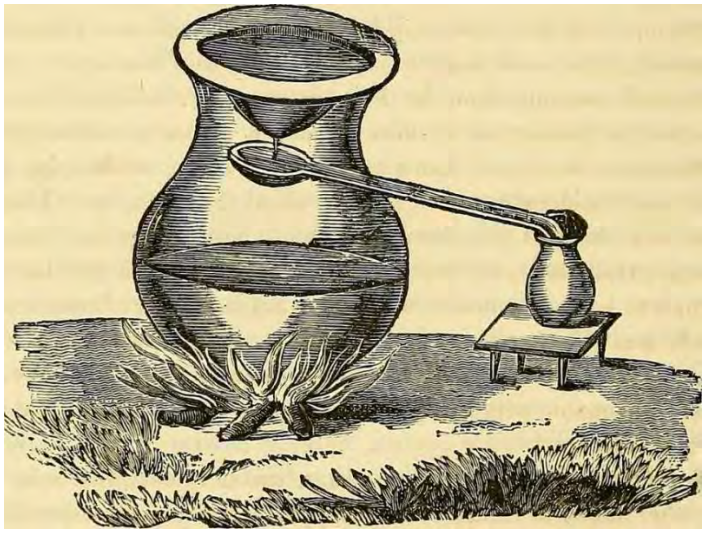

Figure 2.2 : Ancient Form of Still used by the Peruvians (Fairley, 1907)