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Degree in Bachelor of Mechanical Engineering (Thermal-Fluids)”

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DEVELOPMENT OF SOLAR COLLECTOR FOR
HOT WATER SYSTEM

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This report for Projek Sarjana Muda is submitted in partial fulfillment for Bachelor of
Mechanical Engineering (Thermal-Fluids)

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“I hereby, declare the content of this report is the result of my own research except as cited in the reference”

Signature :

Authors :

Date :

For my beloved mother and father and my family

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ABSTRACT

A solar collector system is the main parts of the hot water system which operates by absorb the heat generated from the sun light. There are varieties of solar collector available in the market such as flat plate and evacuated tubes. It is considered to be more environmentally clean alternative to the others energy and reduced the electricity usage. As a result, it can also reduce the cost of living which keeps increase every year. Solar collector has other material attached to it to make the solar collector operates at high efficiency and can heat up the water quickly. This report is made to mainly focus on the investigation on the effect of series and parallel types of solar collector for hot water system. In addition, this report will cover the comparison and analyze the data through several experiments. Besides, this study will recommend the best solution to improve the efficiency of the solar collector. This report also afterwards might be useful in further studies of the hot water system usage and reliability.

ABSTRAK

Sistem penyerap tenaga matahari merupakan satu sistem yang penting dalam sistem pemanasan air yang beroperasi dengan menyerap tenaga dihasilkan dari sinaran cahaya matahari. Terdapat banyak jenis alat penyerap cahaya matahari di pasaran seperti plat rata dan juga tiub vakum. Penggunaan tenaga solar ini merupakan salah satu alternatif untuk menggantikan bahan tenaga sedia ada seperti tenaga elektik. Ini juga akan dapat mengurangkan kos sara hidup yang semakin meningkat. Selain itu, paip pengumpul tenaga solar ini biasanya di tambah dengan bahan lain unuk meningkatkan kecekapan fungsi dan dapat memanaskan air dengan kadar yang cepat. Laporan ini dibuat untuk membezakan kesan pengumpul solar yang mempunyai susunan paip selari dan paip siri dalam sistem pemanasan air. Ia juga merangkumi perbandingan dan analisis data melalui beberapa eksperimen. Selain itu, pembelajaran ini akan mengusulkan cara terbaik untuk meningkatkan kecekapan sistem pemanasan air.

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LIST OF SYMBOL

U:	Conductance.
Q:	Flow rate, m ³ /s
A:	Internal surface area of pipe, m ² .
ΔT :	Temperature difference, (°C)
R:	Resistance, Ohm
Δx :	Distance
\emptyset :	Angle of deflection
T _{in} :	Inlet water temperature (°C)
T _{out} :	Outlet water temperature (°C)
C _p :	Heat capacity, W/m ² .k
N _u :	Nusselt number
R _e :	Reynolds number
P _r :	Prandlt number
T _w :	Water temperature, (°C)

T_{su} :	Surrounding temperature, ($^{\circ}\text{C}$)
T_{in} :	Water in temperature, ($^{\circ}\text{C}$)
T_o :	Water out temperature, ($^{\circ}\text{C}$)
T_{so} :	Outside surface temperature, ($^{\circ}\text{C}$)
T_{si} :	Inside surface temperature, ($^{\circ}\text{C}$)
h :	Heat transfer coefficient, $\text{W}/\text{m}^2\cdot\text{K}$
k_w :	Thermal conductivity coefficient, $\text{W}/\text{m}\cdot\text{K}$
m :	Mass flow rate, (kg/s)

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CHAPTER 1

INTRODUCTION

1.1 Introduction to solar energy

Solar energy is a clean and abundant energy resource that can be used to supplement many of energy needs. Solar energy can be utilized as a form of heat, such as solar water heating, and as electricity, such as solar photovoltaics.

Water heating is one of the most cost-effective uses of solar energy, providing hot water for showers, dishwashers and clothes washers. Every year, several thousands of new solar water heaters are installed worldwide.

A solar water heater reduces the amount of fuel needed to heat water because it captures the sun's renewable energy to heat up water instead using water heater. This solar water heating systems include storage tanks and solar collectors. There are two types of solar water heating systems: active, which have circulating pumps and controls, and passive. Solar water heaters can also be used in other applications, for example, car washes, hotels and motels, restaurants, swimming pools, and laundry mats.

There are many possible designs for a solar water heater. In general, it consists of three main components:

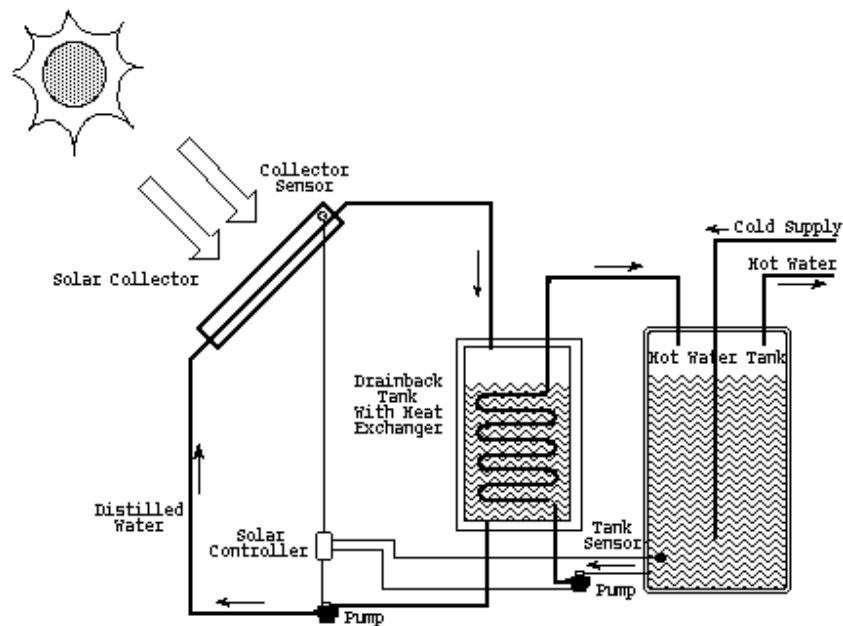


Figure 1.1: Components of hot water system

(Source: <http://images.google.com>, retrieved on 4th August 2008)

1. Solar collector, which converts solar radiation into useable heat.
2. Heat exchanger/pump module, which transfers the heat from the solar collector into the portable water.
3. Storage tank to store the solar heated water.

1.2 Background Research

In order to reduce the waste of energy usage and reduce the air pollution, there are many research about the solar collector have been done by scientist and engineers as an alternative way replacing the used of energy such as electricity, wind and nuclear. The use of solar energy is more economic because it is renewable energy which we can get almost every day in our life.

Many researchers have been done to improve the quality of solar collector tube. This can be done by using good material which can absorb maximum energy generated from the sun. One of the current research is to develop solar collector tube at low cost and it can operates automatic depend on the weather. As a result, this method can save cost of electricity used and also the used of pump system.

For this project, the objective is to investigate the effects of series and parallel types of solar collector for hot water system/thermal energy storage system. In terms of that, two types of solar collector tubes have to be fabricated and also different technique and procedures are being used to investigate the effect of series and parallel solar collector tubes because it is important in energy transfers processes.

The flow for PSM is illustrated below:

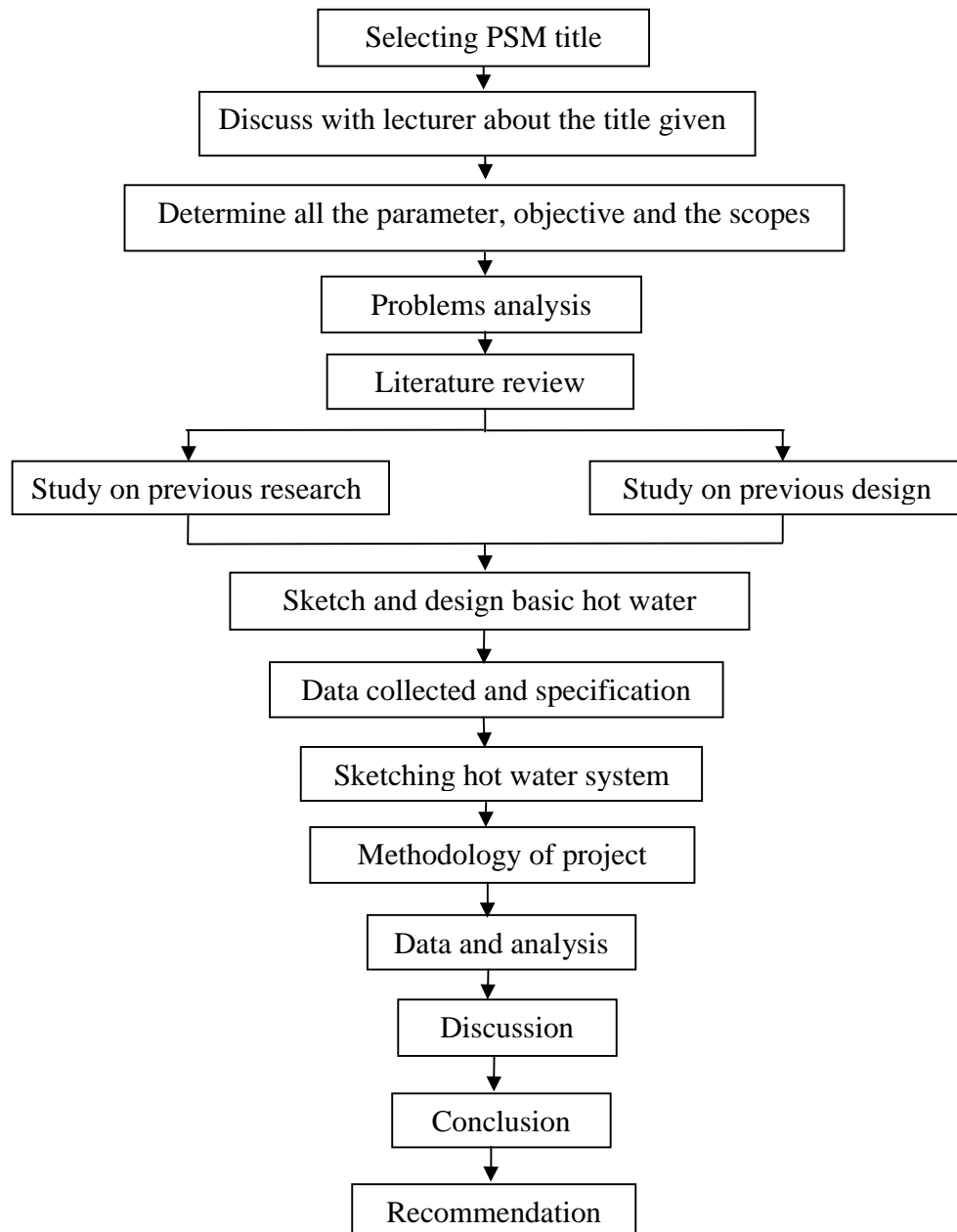


Figure 1.2: Flow chart of PSM

1.3 Objective

- a. The objective of this project is to investigate the effect of series and parallel types of solar collectors for hot water system or in thermal energy storage system.

1.4 Scopes

- a. Literature review on heat transfer process, solar collector systems, thermal energy storage and etc
- b. Design and fabrication of series and parallel solar collector systems by using PVC pipe.
- c. Conduct experiments to investigate the difference between both types of solar collector.
- d. Conduct data and analytical analysis to show the difference both types of solar collector.

1.5 Problems statement

This project is to determine the effects of series of parallel tubes solar collector on hot water system. There are many types and variety of solar collector in our markets which use to absorb the heat generated from the sun light and to heat up the water for daily use and it can save living costs. This solar energy also important in other application such as engineering and automotive, but there are a few research conduct on the solar collector tubes which affect the energy absorption and to determine if the original PVC pipes can heat up the water same as the other solar collector in the market which is have more complicated design and have good material.

Furthermore, the difference in the pipes arrangement in series or parallel pipe may cause some changes to the heated water. The water flow rate used is constant but the actual flow inside the tubes is depending on the types of solar collector which may cause the head loss or pressure loss in the tube. These losses caused by the internal friction or maybe have some leaking from assembly fitting.

From general equation, the flow of water give great influence on the performance of solar collector whether the flow of water will occupied all tubes area or occupied half of tubes area which can give difference in water temperature. By do this project, the heat transfer rate to the water can be determined and give overall overview about convection process which occurs between pipe surfaces to the water inside tubes.

- a. In the past time, we used electric current to run the water heater. For now, to save cost we have to use solar energy from heat which generated from the sun.
- b. To find the effect of heat absorption between parallel and series of pipes