INVESTIGATION OF TEMPERATURE VARIATION ON THERMAL ICE STORAGE BY USING PROPYLENE-GLYCOL AND 100% WATER

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY
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**A thesis submitted
in fulfillment of the requirements for the degree of
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DECLARATION

I declare that this Choose an item. entitled "Investigation of Temperature Variation On Thermal Ice Storage by using Propylene-Glycol and 100% Water" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

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Date : 25/01/2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Of Mechanical Engineering Technology (Refrigeration and Air Conditioning System) with Honours.

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Date : 27.01.2022

DEDICATION

Every challenging during all the work needs stronger self effort as well as guidance of elders especially those who were very close to our heart. My humble effort I dedicate to my sweet and loving parent

RAJA ADNAN BIN RAJA ABDULLAH and **RAKIAH BINTI ANANG**

That support me all the time during hard time since me in journey study and also my respected supervisor **TS. DR. AMIR ABDULLAH BIN MUHAMAD DAMANHURI,** one of the important person that always advised me, support me and keep give me spirit to keep strong. End of my word Thank You all my guardian.

ABSTRACT

Thermal energy storage systems (TES) can store heat or cold for later use, under different variables such as temperature, location or power. Sensitive heat, latent heat and thermochemical systems are classified into three different categories of TES systems. For each TES system and identifies the requirements for each technology and application. TES systems may successfully meet energy redistribution requirements for cooling or heating. By using the stored thermal energy from TES units, peak load demand may be moved to off-peak hours. As a result, compare the variation of temperature on compressor, evaporator and water temperature in between 100% water and propylene-glycol mixture water. This research is focus to thermal ice energy storage that using 100% water for system or propylene glycol mixture water in system to determine the cop and range temperature for both medium. System will be running for 16 hours in other to collect the data. In this project, refrigeration R134a will use as main refrigeration in system. The lowest temperature in water achieved is 2.3ºC. For this project, the COP for 100% water and propylene-glycol is different which is system use propylene-glycol mixture water has better result of COP with 3.61, meanwhile COP for 100% water is 3.38 lower than propylene- glycol.

ABSTRAK

Sistem penyimpanan tenaga termal (TES) dapat menyimpan panas atau sejuk untuk kegunaan kemudian, di bawah pemboleh ubah yang berbeza seperti suhu, lokasi atau kuasa. Haba sensitif, haba pendam dan sistem termokimia dikelaskan kepada tiga kategori sistem TES yang berbeza. Terdapat gambaran keseluruhan jenis sistem dan penerangan mengenai aplikasi khusus dan baru. Sistem TES berjaya memenuhi keperluan pengagihan semula tenaga untuk penyejukan atau pemanasan. Dengan menggunakan tenaga haba yang tersimpan dari unit TES, permindahan haba yang tinggi dapat dipindahkan ke waktu malam hingga keesokkan pagi.Perbandingan variasi suhu pada pemampat, penyejat dan suhu air di antara 100% air dan air campuran propylene-glycol. Penyelidikan ini tertumpu kepada penyimpanan tenaga ais terma yang menggunakan air 100% untuk sistem atau air campuran propilena glikol dalam sistem untuk menentukan suhu cop dan jarak bagi kedua-dua medium.Penyelidikan ini difokuskan kepada penyimpanan tenaga termal yang menggunakan 100% air semula jadi didalam sistem penyimpanan tenaga termal atau cecair propylene glycol yang dicampur dengan air ke dalam sistem untuk menentukan kecekapan sistem dan perbezaan suhu untuk kedua-dua medium.Sistem ini akan beroperasi selama 16 jam bagi mengumpul data yang diperlukan.Dalam projek ini,bahan pendingin R134a akan digunakan sebagai bahan pendigin utama.Suhu terendah yang dicapai melalui eksperiment ialah 2.3ºC.Dalam penyelidikkan ini, COP sistem telah diperolehi dimana COP untuk sistem yang menggunakan propylene glycol bercampur air mempunyai COP yang lebih baik iaitu 3.61 jika dibandingkan dengan COP 100% water yang sedikit rendah iaitu 3.38

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LIST OF SYMBOLS AND ABBREVIATIONS

TES	-	Thermal Energy Storage
SHS	-	Sensible Heat Storage
LHS	-	Latent Heat Storage
HTM	-	High Temperature Material
PCM	-	Phase Change Material
ITES	-	Ice Thermal Energy Storage
HDPE	-	High Density Polyethylene
°C	-	Celsius
°F	-	Fahrenheit

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CHAPTER 1

INTRODUCTION

1.1 Background

Thermal energy storage system (TES) one of the method for storing energy dependent on a temperature change. The hot water or cold water thermal energy system can be conventional energy. Thermal energy storage systems, such as temperature, location or power, can store and use heat or cold later (Cabeza et al., 2015). Generally, the energy is converted from natural sources of energy to a difference temperature in the water used during times of heavy energy demand. The energy of TES systems is provided to a subsequent storage system that has three step charge, storage and discharge, providing a full storage cycle.

Thermal energy storage for construction and process cooling is used in two main sensitive and latent forms. Each shape has its pros and drawbacks. Water is now the most common storage medium used for cooling, using solid or liquid phase alteration for latent storage, and cooled liquid water for sensible storage (Fe- & Corps, 2014).

Usually, this medium use in system that have storage to store it. For example, central type air-conditioner use for a large cooled area and suitable to use glycol as a refrigeration medium. Furthermore, for thermal storage has three (3) type which is sensible heat storage, latent heat storage and thermo chemical storage (Diaz, 2016).

1.2 Problem Statement

In the developed world, the majority of countries that are already seeing fast urbanization and population growth today. In the past few decades, electricity demand in these countries has increased dramatically. For example, Malaysia's national demand for energy in the last two decades has grown fivefold, while over the last 30 years, the overall population has doubled from 10.4 million in 1970 to 22.2 million for 2000. In several countries, especially in the developing world has been studied intensively for reduce the power consumption during using a HVAC system in term to maintain the temperature. In additional, propylene-glycol has the lowest freezing point than the water in HVAC system. Nowadays, many building use system chiller or thermal energy storage in order to reduce the consumption of power electric. The energy usage will have the greatest influence on the overall performance of the HVAC system. However, A high level of loss efficiency might reduce the amount of time required to cool the area around the location. As theoretical, It is possible to use the certain fluid as a refrigerant. The air that is utilized in an air cycle refrigeration system can be considered a refrigerant as well.

1.3 Research Objective

The main aim of this research is to determined either propylene-glycol mixture with water or 100% water has more efficiency with comparison of coefficient of performance (COP) system.

i. To compare the different temperature variation with 100% water and propylene-glycol mixture with water at thermal ice storage trainer unit.
ii. To compare coefficient of performance (COP) for 100% water and propylene-glycol mixture with water to the thermal ice storage.

1.4 Scope of Research

The scope of this research are as follows:

i) Ice thermal storage system with capacities 45 liters water.

ii) Charging mode process for thermal storage with 150 liter ice store.

iii) Mixture propylene glycol and water in storage system with ratio 2:1 water glycol (propylene glycol 33%).

iv) Size of the system that using thermal energy storage based on needed cooling capacity.

v) Storage material (steel, concrete and plastic).

vi) Circulation pump type UPS 25-80 with pump capacity 140 L/min.

vii) Electric motor with 0.37 kW and 50Hz with 2800 rpm.

viii) Refrigerant use in thermal ice storage system is R134a.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of Thermal Storage

In today's modern society, energy efficiency is very making some building have a higher power consumption. So, for reduce the power consumption some of the building use storage system to keep and hold the temperature during a night. Thermal energy storage is a system that stores or keep thermal energy by heating or refreshing a storage medium in order to use it for heating, cooling, and power generating applications at a later time. Thermal Energy Storage systems are generally use in a big buildings and industrial processes (Monde et al., 2018).

In additional, the most important for design the Thermal Energy Storage must high another word for energy density in a storage medium is storage capacity. Besides that, it also must be suitable and compatibility of the storage medium with the container medium such as glycol (Cabeza et al., 2015).

2.2 The Classified of Thermal Storage System

For Thermal Energy Storage it has are three type of TES systems which is a form of sensible heat storage that relies on heating or chilling a liquid or solid storage medium to store thermal energy (Diaz, 2016). Secondly is latent heat storage that based on phase change materials or PCM and last is thermo-chemical storage (TCS) using chemical reactions to store and release thermal energy. Sensible heat storage system is based on storing thermal energy by heating or cooling a solid or a liquid storage medium. The increases of refrigeration medium or removal of heat can cause a temperature variation. For Sensible heat storage system, the cheapest refrigeration to use as a cooling medium is water.

Meanwhile, for latent heat storage it dependent on phase change (PCMs). The intensity here is on the consumed or emissions of energy when a phase shift occurs. Temperature fluctuations are ignored in a latent heat storage system. Conversion from the solid to the liquid state is an example of phase transition. Chemical- energy storage based on chemical reaction to store and release the thermal energy (Diaz, 2016).

2.3 Sensible Heat Storage System (SHS)

According to article written by (Diaz, 2016) which is the principal theme of a method of sensible heat storage (SHS) is thermal energy storage, which occurs by a increasing of the temperature of a solid or liquid substance. This approach makes advantage of the heat potential of the material throughout the loading and unloading operation, as well as the temperature change during the process. The difference of temperature, the special thermal content and storage materials have a significant impact on the amount of heat that is retained. The store material used plays a major role in constructing an efficient store (Diaz, 2016). The main requirements of a store material can be summarized as follows

i. Ability to bear charging/discharging cycle without change in structure, reduction in storage capacity and loss in performance
ii. Ease of accessibility, ease of handling and capability of storage in simple container
iii. Less expensive.

2.4 Latent Heat Storage System (LHS)

The center of latent heat storage systems is the changing of material (PCM). The chemical bond in the PCMs collapses and the substance undergoes transformation in stage where the source temperature increases (Diaz, 2016). In solid-liquid PCMs this transformation is from solid to liquid. This step is an endothermic mechanism as heat is required. In the process, the PCM absorbs heat. When the changing process is completed, the heat is trapped in the storage tank, and the material begins to melt. Until the melting process is completed, the temperature remains constant. (Diaz, 2016). Latent heat can be described as the heat which is stored during the change of phase process, in this situation the melting process is happen. Advantage from this system are

i. It has a high storage density.

ii. Small temperature changes can result in storing large amount of heat

iii. Ability to apply at a precise operating temperature, since they may work with high storage density in isothermal setting.

2.5 Thermo Chemical Storage System

Thermal energy storage seen as a technique that supports a wide range of applications. This covers the creation and disposal of energy waste, as well as the utilization of solar heat. Thermal storage materials provide high storage capacity per mass or volume compare to SHS and LHS. Thermochemical energy conservation is divided between chemical reactions and the mechanism of sorption (absorption and adsorption considered as a single process). High energy storage density and reversibility of materials is needed for chemical reactions (Diaz, 2016).

2.6 Ice-Cold Storage System

Ice-cool TES has been designed and make use of many years now, generally called an Ice -Thermal Energy Storage (ITES) system. In order to efficiently comply with the need for cooling load and energy redistribution in buildings, ITES depends on the operating mode either full or partial storage, storage type and charge-and-discharge properties (Lago et al., 2019). One of the most important components of this system is a primary chiller facility that use for maintain cold water in a storage tank while reducing the temperature of the latent heat, causing the cooled water to change to the ice. During the water-to-ice transition, cold thermal energy is stored (charged) and the same was released (discharged) when the solid ice is converted into water (Lago et al., 2019). Figure 2.1 shows the of ice thermal energy storage.

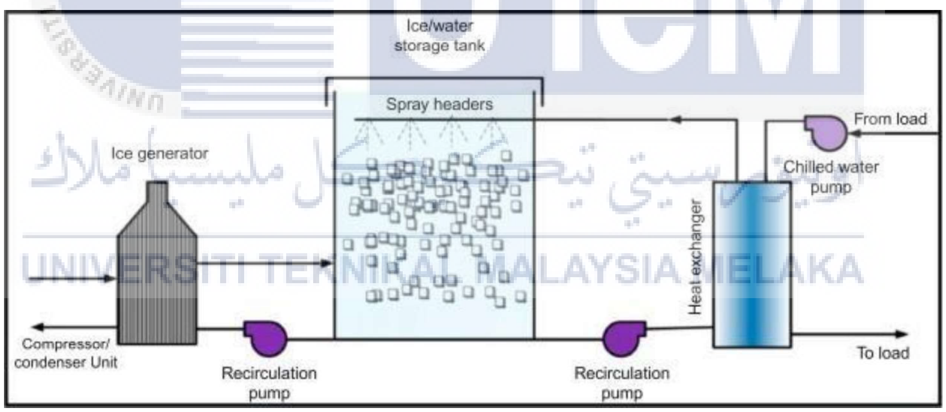

Figure 2.1Ice thermal energy storage (Lago et al, 2019)