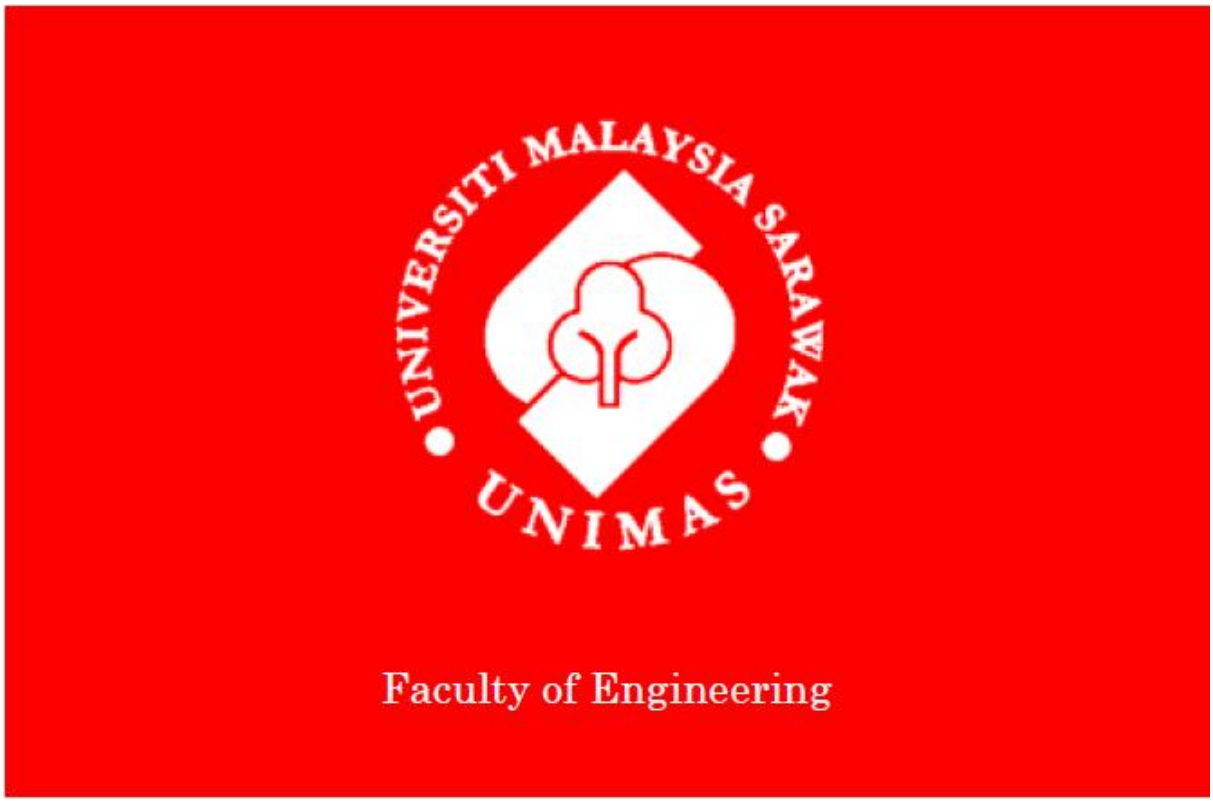

WASTE THERMAL HEAT PUMP

Nicholas Han Tin Huat

Bachelor of Engineering with Honours

(Mechanical and Manufacturing Engineering)

2010

UNIVERSITI MALAYSIA SARAWAK

R13a

BORANG PENGESAHAN STATUS THESIS

Judul: **WASTE THERMAL HEAT PUMP**

SESI PENGAJIAN: 2009/2010

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APPROVAL SHEET

The following final year project:

Title: Waste Thermal Heat Pump

Author: Nicholas Han Tin Huat

Matrics Number: 16822

Is hereby read and approved by:

_____ _____

En.Iskandar bin Jobli (Supervisor)

Date

WASTE THERMAL HEAT PUMP

NICHOLAS HAN TIN HUAT

Thesis is submitted to

Faculty of Engineering, University Malaysia Sarawak

In Partial Fulfillment of the Requirements

For the Degree of Bachelor of Engineering

With Honours (Mechanical and Manufacturing Engineering) 2010

To my beloved family and friends

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q	-	rate of heat production (W)
M	-	mass of composting material (kg)
C_p	-	specific heat of composting material (cal per g per °C)
T	-	rate of temperature change (°C per h)
COP	-	coefficient of performance
T_H	-	sink temperature
T_L	-	source temperature
Q_H	-	heat from hot reservoir
Q_C	-	heat from cold reservoir
W	-	work input from the compressor
M_n	-	moisture content (%) of material
W_W	-	wet weight of the sample
W_d	-	weight of the sample after drying
$\triangle W$	-	change in grass weight
W_i	-	weight of grass before decomposition

W_f - weight of grass after decomposition

dQ/dt - heat transfer rate (kJ/s)

m - mass flow rate (kg/s)

Cp - constant pressure for the refrigerant kJ/kgK

T_{out} - water temperature at the outlet (ºC)

T_{in} - water temperature at the inlet (ºC)

ABSTRACT

The objective of this experiment is to develop a heat exchanger system that used the biomass decomposition process heat as the source of energy. The system will be design and construct based on the operating principles of geothermal heat pumps and the feasibility and flexibility of the system will be analyzed. The design is comprised of a heat exchanger coil that is placed at the bottom of the container with water circulates through the coil to extract heat from the decomposition process. The proposed system will be compared to a control system, a system without heat exchanger coil to see the effect of heat exchanger coil on the biomass temperature and also its decomposition rate. This experiment also introduced the double stage heating system to increase the temperature difference of the water between the inlet and outlet of the system. The moisture content of the grass in the first cycle is 71.5% and 74.8% for the second cycle. The average power output per kg dry matter produced from the double stage heating for the first and second cycle is 0.41 Watt/kg and 0.47 Watt/kg.

ABSTRAK

Objektif eksperimen ini adalah bagi membangunkan sistem penukar haba yang menggunakan proses penguraian biojisim haba sebagai sumber tenaga. Sistem itu akan direka dan dibina berdasarkan prinsip operasi pam haba geoterma dan sistem praktikal serta kelonggarannya akan dianalisis. Reka bentuk meliputi satu gegelung penukar haba yang terletak di dasar bekas dengan air mengalir dalam gegelung untuk mengekstrak haba daripada proses penguraian. Sistem yang dicadangkan akan dibanding dengan satu sistem kawalan, satu sistem tanpa gegelung penukar haba untuk melihat kesannya terhadap suhu biojisim dan juga kadar penguraiannya. Eksperimen ini juga memperkenalkan sistem pemanasan peringkat berganda untuk meningkatkan perbezaan suhu air antara serokan dan kedai sistem. Kandungan lembapan rumput untuk kitaran pertama ialah 71.5% dan 74.8% untuk kitaran kedua. Output kuasa purata setiap kg bahan kering yang dihasilkan daripada pemanasan peringkat berganda untuk kitaran pertama dan kedua ialah 0.41 Watt / kg dan 0.47 Watt / kg.

CHAPTER 1

INTRODUCTION

1.1 Introduction to Biomass

In this 21st century, the evolution of technolgy and population growth has increased the demand for power supply. Hence energy has become one of the most important issue to be discussed in this project. Energy can be divided into two main types which is renewable energy such as biomass, hydro, geothermal and wind energy. The another type is non-renewable energy such as petroleum, natural gas and coal. The inadequate of energy supply, the fluctuating of foreign fossil fuel and also the environment conditions have force us to exploit for alternatives energy sources available on our planet.

In the mean time, biomass energy is one of the options available to support and sustain the the expanding energy demand from the users. The word ‘biomass’ tell us this form of energy is derived from a biological materials derived from living or recently living organisms. Actually, biomass substance such as plant matter, garbage, crops, landfill and biofuels have a chemical energy which can be converted into heat energy by various means to produced heat to generate electricity. Biomass energy is derived from three distinct energy sources for exmaple wood, waste and

alcohol fuels **(Wikipedia, Biomass, 2009).** Biomass is a renewable energy because its supplies are continously and not limited.

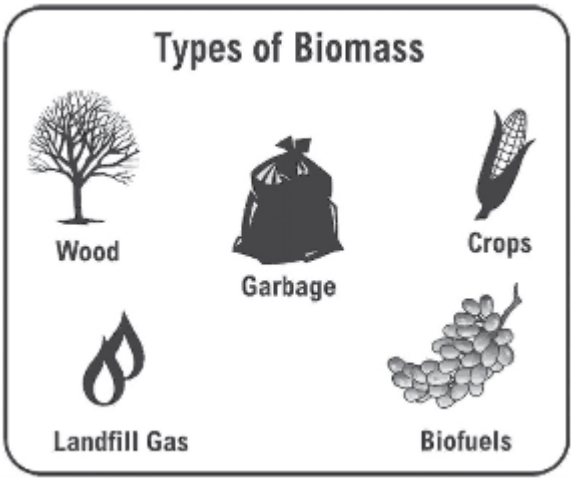

Figure 1 : Types of Biomass Sources **(Biomass, 2008)**

1.2 Introduction to Heat

Energy can exist in numerous forms such as thermal, mechanical, kinetic, potential, electric, magnetic, chemical and nuclear which their sum constitutes the total energy E of a system. The first law of thermodynamic states that energy can be neither created or destroyed during a process where it can only change forms. This law also known as the conservation of energy principle **(Cengel & Boles, 2006, p. 70).**

Heat energy is transferred between two systems if there is a temperature difference between them. In case if both systems is at the same temperature, no heat transfer will take places and this is called adiabatic process. A process can be adiabatic if the system is well insulated or both the system and the surroundings are

at the same temperature but the energy content and the temperature of the system may still changed by others mean such work**(Cengel & Boles, 2006, p. 61).**

Heat is transferred by three mechanism for example conduction, convection and radiation. Conduction is the mode of heat transfer in which energy exchange takes place from the region of high temperature to that of low temperature by the kinetic motion or direct impact of molecules. Convection is the transfer of energy between a solid surface and the adjacent fluid that is in motion. Radiation is the transfer of energy due to the emission of the elctromagnetic waves known as photons **(Ozisik, 1985, p. 2).**

1.3 Introduction to Heat Pump

Heat is a form of energy that is transfer between two systems by virtue of a temperature difference **(Cengel & Boles, 2006, p. 60).** Heat can only be transfer between two system from a higher temperature medium to a lower temperature medium and impossible to exist for the vice versa condition. This heat transfer process occurs in nature witout require any devices.

To enable a heat to transfer from a low-temperature medium to a high-temperature medium, a special devices called heat pumps is required to allow this process to take place. In fact heat pump is a reverse cycle of a heat engine that moves heat from a low temperature heat source to a higher temperature heat sink using mechanical work. The common examples are food refrigerators and freezers, air conditioners and reversible-cycle heat pumps for providing thermal comfort **(Wikipedia, Heat Pump, 2009).**

A heat pump is similar to a conventional air-conditioning system where it function is to transfer heat from low to a higher temperature medium. The difference of heat pump compare to air-conditioning is this system can reverse its running cycle. When the system is operating in reverse direction, heat are absorbs from the outside and releases it inside the building **(Langley, 1989, p. 2).** The systems consist of a compressor, condenser, expansion valve and evaporator which is the four main components in heat pumps system.

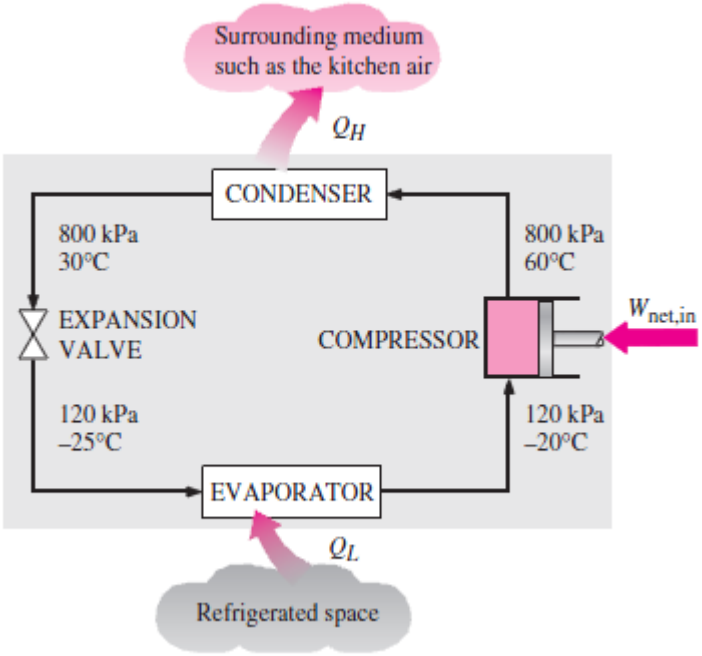

Figure 2 : A Heat Pump System **(Cengel & Boles, 2006, p. 288)**