UNIVERSITI TEKNOLOGI MARA

HEAT TRANSFER ANALYSIS FOR AMMONIA-WATER MIXTURE HEAT EXCHANGER FOR ORGANIC RANKINE CYCLE OF AN ENERGY RECOVERY SYSTEM

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ABSTRACT

Transportation is one of the largest energy consumers and the biggest contribution is dominated by the internal combustion engine (ICE). The performance efficiency of the ICE is 30 % for gasoline and 45 % for diesel with almost 65 % of the combusted energy is wasted through the exhaust gas. This exhaust gas is classified as a low grade energy thus recovering it is very challenging. A reliable and feasible recovering system is required to recover this kind of energy. In this study, Organic Rankine Cycle (ORC) is adopted to the powertrain system in order to increase the thermal efficiency. This study evaluates the performance of a condenser that is using ORC in order to achieve 3 kW of heat load. The condenser is also incorporated with ammonia-water mixture as the working fluid to maximize the heat transfer performance. The study focused on characterization of ammonia-water mixture by its thermo- physical properties. In this study, the characterization of ammonia-water mixtures was divided by mol fraction spanning from 0.05 mol to 0.3 mol. The mixtures were identified with six concentration levels which are 5:95, 10:90, 15:85, 20:80, 25:75 and 30:70. The thermo-physical properties of these mixtures, which includes specific heat capacity, thermal conductivity, dynamic viscosity and density, were measured. The test bench was then designed and fabricated according to the specification and limitation of the mixture. Design operating condition was established by obtaining a suitable mass flow rate using the ORC calculation with 25 % and 70 % of thermal and turbine efficiency; respectively. Based on the theoretical thermodynamic calculation, 3 kW heat load was achieved by 36 extruded finned tubes combined with air-cooled condenser design. It was found from the experimentation value that the highest condenser of heat load was only 2 kW at 0.3 mol fraction with 17 % of thermal efficiency. A rapid vaporization of the ammonia was found to be the main factor of the low thermal efficiency.

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CHAPTER ONE
INTRODUCTION

1.1 Background of Research

The level of energy consumption is directly proportional to the economic development and total number of population in country as referred to the socio-economic perspective. Between 2010 to 2020 energy demand is expected to increase approximately 11 % with population growth [1]–[3]. Figure 1.1 shows a table of percentage values for transportation sector in 2012 with 37 % of total energy consumed in the Malaysian transportation sector [4]. Transportation industries have received much attention because it contributes the highest energy usage in Malaysia. The energy used are contributed by various types of transportation from personal and commercial vehicles. The large energy growth is caused by growing number of passengers, operating time of vehicle and increasing in trip length due to demand [5]. Construction and manufacturing sectors contribute towards the industrial sector and they consume about 30% of energy used. This factor is caused by a high demand of technologies development.

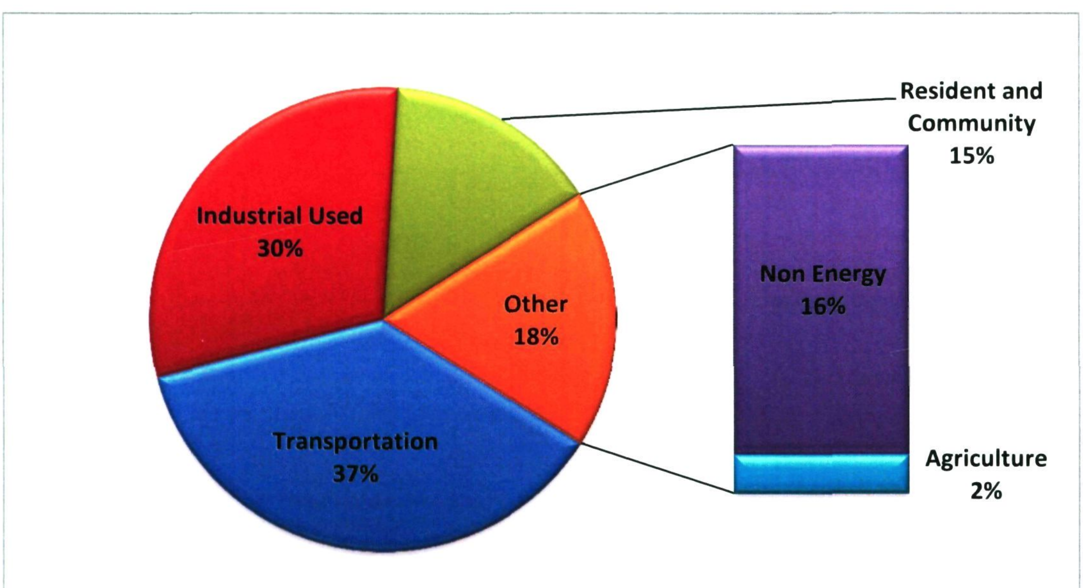

Figure 1.1 Figure Energy usage by the main sector in Malaysia in 2012 [4]