Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 6 (2011) 467–476

Energy Procedia

MEDGREEN 2011-LB

Performance and Evaluation of Aqua Ammonia Auto Air Conditioner System Using Exhaust Waste Energy.

Khaled S. AlQdah *

Tafila Technical University, Zip code: 66110, Tafila, Jordan.

Abstract

This work presents an experimental study of an aqua-ammonia absorption system used for automobile air conditioning system, this system using the exhaust waste heat of an internal combustion diesel engine as energy source. The energy availability that can be used in the generator and the effect of the system on engine performance, exhaust emissions, auto air conditioning performance and fuel economy are evaluated. Because automotive air conditioning is one the most equipment that heavily uses CFC compounds and the leakage of CFCs from such air conditioners impact on the environment. The main purpose of this investigation to explore the feasibility of using waste energy to design the absorber and generation since these components are the most important components of absorption and they are directly influence the performance of the whole system. It has been found that the aqua -ammonia concentration effect the cooling capacity. The estimated cooling load for the automobile found to be within acceptable ranges which are about 1.37 ton refrigeration. The obtained results show that the coefficient of performance (COP) values directly proportional with increasing generator and evaporator temperatures but decrease with increasing condenser and absorber temperatures. Measured values for generator, absorber, and evaporator and condenser temperature were recorded and the coefficient of performance of the system varied between 0.85 and 1.04.

The main components of the absorption cycle were designed and fabricated for optimal performance and could be rapidly transfer to the industry, The system was found to be applicable and ready to produce the required conditioning effect without any additional load to the engine. The proposed system decreases vehicle operating costs and environmental pollution caused by the heating system as well as causing a lower global warming.

Key Words: Absorption; Performance; COP; Waste heat; Aqua –Ammonia; Generator.

* Corresponding author. Tel.: 00962 3 22 50 326; fax: 00962 3 22 50 002
E-mail address: kqdah@ttu.edu.jo

1876–6102 © 2011 Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
doi:10.1016/j.egypro.2011.05.054

Nomenclature

A: Cross sectional or surface area (m^2)
COP: Coefficient of Performance;
D: Diameter (m)
g: Gravitational acceleration (m/s^2)
H: Specific enthalpy (kJ/kg)
h: Convective heat transfer coefficient of tube (W/m^2k)
K: Thermal conductivity (W/m^2)
m: Mass flow rate (kg/hr)
M: Mass flow rate for the mixture (kg/hr)
Nu: Nusselt number
Pr: Prandtls number
P: Pressure (bar)
Q: Heat gained or lost in a certain device (kW)
Qg: Heat gained in the generator (kW)
T: Temperature (°C)
Toe: Ton oil equivalent
TR: Ton Refrigeration
U: Overall heat transfer coefficient (W/m^2k)
ρ: density (kg/m^3)
ΔTLMTD: log mean temperature difference (°C)
Subscripts
a: ammonia
g: gas
i: inside
l: liquid
o: outside

1. Introduction

In 2009, Jordan local crude oil and natural gas production was nearly 163 thousand toe, i.e. 3.3% of Jordan's total energy needs. In view of the limited production of local resources, Jordan has depended on imports to meet its energy needs. Crude oil and oil products imported in 2009 were around 4557 thousand toe as shown in figure 1[1]. Jordan is relatively poor in conventional energy resources as illustrated in figure 2 which represents the primary energy resources and usage for the year 2008.

Therefore, the long term security requirement of Jordan is to reduce the dependence on imported oil and natural gas and move towards use renewable energy sources. Moreover, the extensive fossil fuel exploitation results in atmospheric and environmental pollution and lead to some undesirable phenomena represented by global warming, greenhouse effect, climate change, ozone layer depletion and acid rain. It is therefore unlikely that that any future scenario for Jordan will not include a significant proportion of its energy to come from other sources such as renewable energy and other alternative energy resources such as waste energy. Much of an internal combustion engines heat from combustion is discarded out of the exhaust or carried away via the engine cooling water. All this wasted energy could be useful. The common automobile, truck or bus air conditioner uses shaft work of the engine to turn a mechanical compressor. Operating the mechanical compressor increases the load on the engine and therefore increases fuel consumption, emissions and engine operating temperature. Nowadays all the scientists and car manufacturers in the world search to solve two main problems in vehicles. The first problem is fuel economy and the reduction of fuel consumption, the second problem is fuel emissions and environmental impact.