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PERFORMANCE AND EVALUATION OF AQUA AMMONIA AIR CONDITIONER SYSTEM IN AUTOMOBILES USING EXHAUST WASTE ENERGY

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Abstract - *This paper presents the experimental study of the aqua-ammonia vapour absorption system used for automobile air conditioning system, this method is victimization of the exhaust waste heat of an inside combustion ICE as an energy source. The energy accessibility which will be employed in the generator and also the result of the system on engine performance, exhaust emissions, auto air conditioning performance, and fuel economy are evaluated. As a result of automotive air-con is one of the foremost instrumentations that heavily uses fluorocarbon compounds and also the outpouring of CFCs from such air conditioners impact on the surroundings. The main purpose of this investigation to explore the feasibleness of victimization waste energy to style the absorbent material and generation since these parts are the foremost necessary parts of absorption and that they directly influence the performance of the whole system. It has been found that the greenish blue -ammonia concentration affect the cooling capacity. The calculable cooling load for the car found to be among acceptable ranges which are about 1 – 1.5-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. The COP of the vapor absorption refrigeration system mainly depends upon the heat extracted at refrigeration cabin to the heat supplied at the generator. Observed values for the generator, absorber, an evaporator and condenser temperature were recorded and also the constant of the performance of the system varied between 0.8 - 1.*

The main parts of the absorption cycle were designed and made-up for best performance and could be chop-chop transfer to the business, the system was found to be applicable and prepared to supply the required acquisition result with none extra load to the engine. The proposed system decreases vehicle operational prices and environmental pollution caused by the heating plant further as inflicting lower global warming.

***Key Words*:** *Aqua-ammonia refrigeration, Vapour absorption system - VAR, Vehicle Refrigeration system, Exhaust heat, exhaust gas recirculation.*

1. INTRODUCTION

It is accepted that energy shortage and environmental pollution became international problems with a common concern. Because the most generally used supply of primary power for machinery vital to the transportation, construction and agricultural sectors, the engine has consumed over hr of crude oil. On the opposite hand, the number of greenhouse gas discharged from the engine, only for transportation applications, makes up twenty-fifth of all activities connected greenhouse gas emissions. Thus, energy conservation on the engine is one among the best ways that to affect these issues since it will improve the energy utilization potency of the engine and reduces emissions [1]. Waste heat recovery technologies in engines: during this section, a brief review of the technologies for warmth transfer from engines is bestowed. Within the current standing of the globe, the need for energy is increasing particularly for transportation applications, that the usage of fossil fuels and consequently harmful inexperienced house gases (GHG) can increase. Researchers arrange to cut back the necessity of fossils fuels by victimization the waste heat recovery from engines. Also, now, six technologies area unit bestowed for engines waste heat recovery of that Saidur et al. [2] have performed a whole review of 4 of them. These six technologies area unit thermoelectrical generators (TEG), Organic temperature unit Cycle (ORC), six-stroke engines, turbocharging, exhaust gas recirculation (EGR) and exhaust heat exchangers (HEXs). Given the importance of accelerating energy conversion potency for reducing each the fuel consumption and greenhouse gas emissions of the engine, scientists and engineers have done innumerable flourishing analysis aimed to enhance engine thermal potency, together with supercharge, lean mixture combustion, etc. However, altogether the energy saving technologies studied, engine exhaust heat recovery (EHR) is taken into account to be one among the foremost effective means that and it's become an exploration hotspot recently [1].

1.1 REFRIGERATION

Refrigeration is that the method of removing heat from an enclosed area, or from a substance, and moving it to

an area wherever it's unobjectionable. The first purpose of refrigeration is lowering the temperature of the space or substance so sustaining that lower temperature as compared to surroundings. Cold perpetually takes place because of the absence of warmth, thus so as to decrease temperature.

During recent years analysis geared toward the event of technologies that may provide reductions in energy consumption, peak electrical demand and energy prices while not lowering the specified level of comfort conditions has intense. By reason that absorption refrigeration technologies have the advantage of removing the bulk of harmful effects of ancient refrigeration machines which the peaks of necessities in cold coincide most of the time with the provision of the waste heat, the event of absorption refrigeration technologies became the worldwide center of attention for concern once more. Waste heat will be reworked either to electricity or to heat to power a refrigeration cycle.

1.2 DIESEL ENGINE

Diesel is an interior combustion engine that operates victimization the diesel cycle. Diesel engines have the best thermal potency of any internal or external combustion engine, thanks to their compression magnitude relation. The diesel combustion engine differs from the fuel powered Otto cycle by employing a higher compression of the air to ignite the fuel instead of employing a sparking plug, for this reason, it's referred to as compression ignition and also the gasoline engine is referred as spark ignition engine. Within the diesel, solely air is introduced into the combustion chamber.

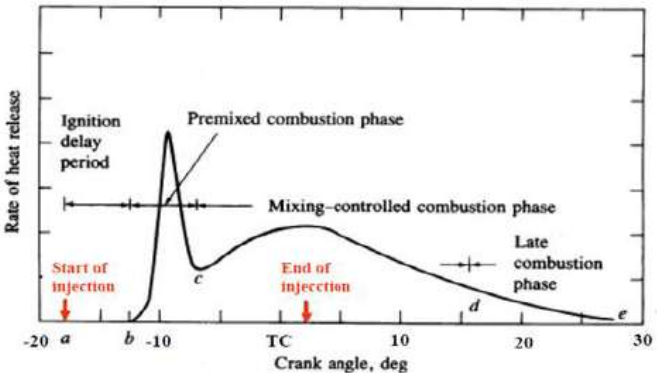

Fig - 1: Rate of Heat Release curve

The air is then compressed with a compression magnitude relation usually between 15 and 22 ensuing into a 40 bar pressure compared to fourteen bar within the ICE. This high compression heats the air to 450 °C. At concerning this moment, fuel is injected directly into the compressed gas within the combustion chamber.

The potency of such associate degree IC engine is 35–40%, that means that solely concerning common fraction of the energy within the fuel used is regenerate to helpful work. This suggests that the remaining 60-65% of the first energy is rejected to the atmosphere by cooling water/lubricant losses of roughly 28-30%, exhaust gas losses of roughly 30–32%, and also the remainder by radiation, etc. identical is true for the significantly additional powerful main propulsion engines of the road vehicle.

2. LITERATURE REVIEW

N. Hossain And S Bari[3], The exhaust gas of diesel engines is a very important heat supply to supply supplementary power and advances overall potency of engine. Geometric variables together with baffle, variety of tubes, length style and square measure all examine one by one. When examine however these parameters manipulate device effectiveness, tube device is planned.

Abdullah, M.O., & Hien, T.C. [4] They used 2 forms of sources of energy to search out transient temperature performance of 3 fluid (H2O–NH3–H2) absorption system's components. The 2 sources of energy square measure liquid crude oil gas and electrical energy from grid. They additional third supply of energy i.e. alternative energy for economical study. The analysis indicates the electrical energy from grid is best one for brief term purpose.

T. Endo, S. Kawajiri, Y. Kojima, K. Takahashi, T. Baba, S. Ibaraki, T. Takahashi [5], They researched the utilization of waste heat for vehicle engine that applied temperature unit cycle from the angle of obtainable energy. The temperature unit cycle system was put in in a very hybrid motorcar and to vary steam temperature and pressure in line with the load variation the automated system was made this is often done to verify the system

Atishey Mittal, Devesh Shukla, Karan Chauhan[6], They tried to put in a refrigeration unit within a vehicle that relies on vapour absorption refrigeration surpass exhaust gases from engine. They used ammonia rather than chloro-fluero for the sake of setting safety, as a result of ammonia may be a gas and isn't liable for inexperienced house impact. Object of this paper is to developed a setting friendly automobile air-con system surpass exhaust waste heat of diesel.

Chandel, Vaibhav Singh , Sohail Bux, and Aseem C. Tiwari.[7] They have done the analysis of various review & research papers & carried out an test on three fluid vapor absorption refrigeration cycle on a standard test rig. They have observed the of ranging from 0.64 – 1.34 under various loading condition also they have plotted the various graphs according to the load conditions.

Christy V Vazhappilly [8], He tried to exchange heating coil generator system of absorption cooling system by plate

frame kind device, and pass by exhaust gases of the IC engine. Moreover, the given heat within the exhaust gases must be calculable supported real I.C-Engine cycles. The work cycle must be simulated, and a full model of the condenser and absorbent must be developed and established.

Aman, J., Ting, D.S.K., & Henshaw [9], Their work is targeted on to capitalize the potency of associate degree absorption excitement employed in residential cooling application with the employment of alternative energy that may be a driving supply of cold. In results, the COP of the system raises with increase in temperature of warmth supply and also the temperature of evaporator however once the absorbent material and condenser temperatures increase COP decreases

P. Sathiamurthi[10], He tried to seek out the likelihood to style a refrigeration unit within associate degree automobile victimization the waste heat from the engine exhaust of the vehicle supported Vapour Absorption cooling is realistic. For Environmental safety purpose of read he created this technique is Eco-friendly because it involves the employment of Ammonia as a refrigerant and isn't accountable for inexperienced House result and depletion of layer.

3. STUDY OF HEAT EXTRACTION FROM EXHAUST GAS

Khaled S. AlQdah [11] in this paper, the system mistreatment the exhaust waste heat of an indoor combustion diesel motor as energy supply. The energy accessibility that may be utilized in the generator and therefore the impact of the system on engine performance, exhaust emissions, car air-con performance and fuel economy are evaluated. as a result of automotive air-con is one the foremost instrumentation that heavily uses greenhouse gas compounds and the escape of CFCs from such air conditioners impact on the atmosphere. The most purpose of this investigation to explore the feasibleness of mistreatment waste energy to style the absorber and generation since these parts are the foremost important parts of absorption and that they are directly influence the performance of the full system. It's been found that the blueness -ammonia concentration impact the cooling capacity. The calculable cooling load for the auto found to be inside acceptable ranges that are concerning one.37-ton refrigeration. The obtained results show that the constant of performance values directly proportional with increasing generator and evaporator temperatures however decrease with increasing condenser and absorbent temperatures. Measured values for generator, absorber, and evaporator and condenser temperature were recorded and therefore the coefficient of performance of the system varied between zero.85 and 1.04. The aqua-ammonia vapour absorption automobile air conditioner is Associate in Nursing economically engaging conception for utilizing exhaust waste heat as a result of most of the energy input comes from the warmth offered within the exhaust gases, with solely tiny electric power accustomed operate the pump. The engine exhaust gas was confirmed as a possible power supply for absorption automobile air conditioning system. In alternative words, the absorption cooling could also be ready to profit of the exhaust gas power accessibility and supply the cooling capacity needed for automotive air-con. Overall, carbon monoxide gas emission was shriveled when the absorption cooling was put in within the exhaust gas. So, changes in exhaust parts concentration were a consequence of the main modifications within the exhaust system. The absorption cycle has the economic advantage of having few high exactness parts, so reducing manufacturing prices. The low potency, however, is a negative economic issue. Ammonia Absorption cycle, should be thought-about as a viable various to mechanical vapor compression cycle. Considerable cooling load reduction is realized by modification on the auto body and therefore the door and windows style. With flexibility operative, absence of mechanical device noise, terribly low maintenance and high responsibleness. The waste heat energy offered in exhaust gas is directly proportional to the engine speed and exhaust gas flow rates.

Jianbo Li, et al [12] during this paper, through quantitatively analyzing the waste heat from a vehicle engine below completely different running conditions and conniving the warmth load of devices in the absorption compression hybrid refrigeration cycle, the heat transfer space and structure of the most unit are determined. The research results show that the absorption refrigeration sub cycle can fully meet the area cooling demand (30 kW) for the coach once it runs over one hundred km/h. The compression refrigeration sub-cycle absolutely provides the cooling load for the coach once speed is under forty km/h. each the sub-cycles work along to produce the area cooling for the coach once speed is between 40 km/h - 100 km/h

Conclusions

1) The exhausted waste heat from the running coach engine is well-established by simulation calculation. The scheming results have fine coincidence with the tested knowledge.
2) On the idea of the quantitative chemical analysis of the exhausted gas parameters, the most devices are determined within the absorption compression hybrid cycle driven severally by the waste heat of exhaust gases and power from the coach engine. One dimensional steady distribution parameter model within the generator and lumped parameters model within the alternative heat exchangers are established, for coupling heat transfer within the unit
3) The ARSC will fully meet the demand of coach space cooling, once the running speed (u) is larger than 100 km/h; the ARSC at the side of the CRSC provides the cooling capacity for the coach, once u is between forty and one

hundred km/h; When u is under forty km/h, the ARSC has no cooling effect, and therefore the cooling demand for the coach is absolutely equipped by the CRSC. The characteristics of the ARSC are analyzed under completely different close temperatures. The performance of the ARSC drops with the increase in close temperature.

4) The ACHRC have benefits of meeting coach cooling demands by convalescent the waste heat from engine and consuming less fuel. The compact and light-weight weight structures are thought-about to use into the key devices within the ACHRC.

4. WORKING OF THREE FLUID VAPOUR ABSORPTION REFRIGERATION SYSTEM

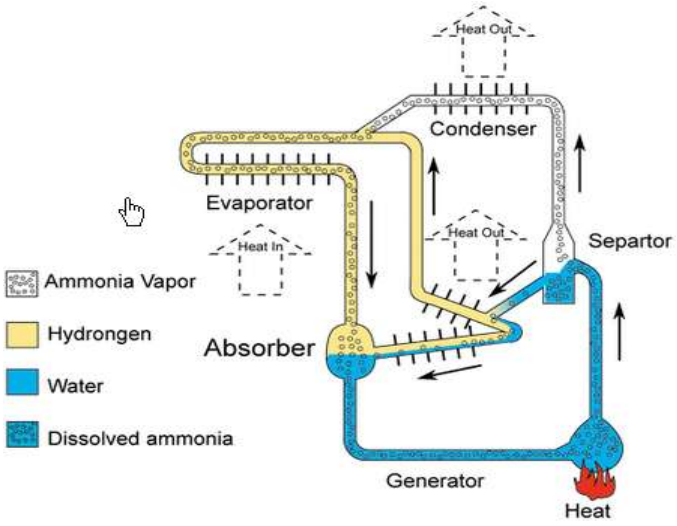

Fig-2: Three fluids (Ammonia-Water-Hydrogen) vapour absorption refrigeration system

This type of refrigeration is typically used for domestic functions solely because it is advanced within the construction and dealing. This kind of icebox was referred to as 3 fluid cooling. The elimination of the pump from the absorption system with the whole absence of moving components and work input. The most purpose of removing the pump was to form the machine quiet. It uses refrigerants as solvent associate degreed a body of water gas for the body of water of the system. The element is sustained to the lower facet of the system solely by its system. It's doable to keep up the uniform pressure throughout the system and once typically allowing the refrigerant to evaporate at coldness similar to its partial pressure. Within the air mass facet system, there exists solely the refrigerant that is subjected to total pressure of the system in order that it's condensed by victimization traditional cooling water because it exhausted alternative system. In lower facet of the system, the overall pressure is add of the partial pressure of the gas that is employed as an associate degree element. The liquid ammonia that comes into the evaporator because the partial pressure of ammonia is low. The sturdy turquoise ammonia answer is heated in the generator by the appliance of external heat supply. The vapor carried with ammonia vapour is removed in separate kind as shown in the figure. Then the dry ammonia vapour is passed into the condenser and it condensed by victimization external cooling supply. The liquid ammonia flows underneath gravity within the evaporator and it evaporates. The mixture of gas and ammonia vapour is passed into the absorbent material and therefore the weak answer from turquoise ammonia from the setup is allowed to follow into the absorbent material, through receptacle this weak turquoise ammonia answer comes into contact with gas separated. This sturdy answer is more passed to the generator and it completes the cycle. There's no pump to make the pressure differential between condenser associate degreed evaporator or not an enlargement valve. The gas returns to the evaporator having no affinity for the absorbent. The gas is control during this condition by the v tube thanks to little pressure distinction within the system. The solution is circulated through absorbent material and generated by thermal action alone. The ways square measure thus organized that the liquid refrigerant flows through evaporator by gravity, solely care is to be taken to stay gas isolated within the correct a part of the system otherwise pressure are unbalanced and therefore the machine can stop.

5. CONCLUSIONS

- The COP of the system is increasing with increase of generator temperature and condenser temperature, and trend is reverse with increase of absorber temperature and evaporator temperature.
- By using waste heat input in the form of heat at the generator pipe the maximum COP of the system is obtained as 1.04 [11]
- The analysis of both cycles proves that the performance of the proposed system is higher than existing system
- Since in ammonia, there is no chlorine atom which is responsible for ozone layer depletion so it is eco-friendly in nature
- Utilizing ammonia as refrigerant because it is easily available and it is also cheap.
- Since one-third of energy of fuel is utilised by three fluid vapour absorption refrigerator which was wasted through exhaust gas shows that it is good to install absorption refrigerator
- A maximum power consumption of 42.38% is saved using proposed system compared to existing system.[13]

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