Adsorption Air-Conditioning Of Automobile Using Waste Exhaust Gases

Ganesh Chavan[1], Nitesh Agwane[2], Kamlesh Singh[3], Vinayak Shinde[4], Ashish Bandewar[5]
[1]Student, Department of Mechanical Engineering, SCOE Kharghar, ganeshchavan020@gmail.com
[2]Student, Department of Mechanical Engineering, SCOE Kharghar, niteshagwane58@gmail.com
[3]Student, Department of Mechanical Engineering, SCOE Kharghar, singh.kamlesh33@gmail.com
[4]Student, Department of Mechanical Engineering, SCOE Kharghar, vinayakshinde5716@gmail.com
[5]Assistant Professor, Department of Mechanical Engineering, SCOE Kharghar, ashishmech89@gmail.com

ABSTRACT:
The sun is an outstanding energy source for mankind. It is clean and comes to the earth for free. In recent years, increasing attention is being given to the use of waste heat and solar energy in energizing refrigerating systems. Solar powered refrigeration and air-conditioning have been very attractive during the last twenty years, since the availability of sunshine and the need for refrigeration both reach maximum levels in the same season. Conventional cooling technologies are generally based on the electrically driven refrigeration system. These systems have several disadvantages: they require high levels of primary energy consumption, causing electricity peak loads and employ refrigerants with negative environmental impacts. Solar adsorption refrigeration is an option to overtake the drawbacks of the conventional cooling system. The adsorption refrigeration is based on the evaporation and condensation of a refrigerant combined with adsorption. This project will describes the design and fabrication of the experimental chamber, the experimental procedure and its feasibility towards development of an alternative eco-friendly refrigeration cycle for replacement of chlorofluorocarbons. The objective of this project is to establish an alternative eco-friendly refrigeration cycle for producing a temperature usually encountered in a conventional refrigerator. By manufacturing such type of refrigerator adds new dimension to the world of refrigeration. This refrigerator gives some amount of relief to the refrigeration world by making it independent of electric power supply and zero running cost.

Key words: Adsorbent; Refrigerant; waste exhaust gas; Adsorption; air-conditioning.

1. INTRODUCTION:

Air conditioning of automobile is a new concept in India and has not been addressed. But in summer the temperature in some parts of India is very high and results in unbearable automobile temperatures. In such conditions an air cooled for automobile is a necessity. The present work is focused towards the design and development of an air cooling system for the automobile using waste heat from exhaust. It is observed that much work has not been done in the field of cabin cooling of transport truck. The available options in heat generated cooling have been critically reviewed. The vapour absorption refrigeration cycle is found to be suitable for automobile air cooling. The heat potential in the exhaust has been analyzed and found to be sufficient enough for powering the proposed Air conditioning system. Preliminary design of system and components are carried out. The work is in developing stage sufficient literature and theoretical background is available which will lead towards the development of an air cooling system for automobile.

In India road transport is a major mode of transport for goods over large distances. The atmospheric temperature in some parts of India touches 45^{o}C.In such condition studies shows that the temperature inside the cabin of a transport truck even exceeds

55^{o}C (Alam, 2006). So some measures must have to be taken to reduce the temperature inside the cabin of the truck. To provide air cooling for the driver of a truck is never given importance in India, the basic reason is the use of available methods of air cooling affects the fuel consumption and the initial cost of the truck. For automobile air conditioning normally vapour compression refrigeration cycle is used. The cycle run on engine power and consumes around 10% of the total power produced by the engine and thereby increases the fuel consumption (Lambert and Jones, 2006).

2. LITERATURE SURVEY:

(Alam S (2006)) , studied on a topic of A "Proposed model for Utilizing Exhaust Heat to run Automobile Air-conditioner". And he concluded that This regulation concern about the climate change in an attempt to face out (CFC's) followed by (HCFC's) and the mounting to tetraflorocarbon.

(Atan R (2004)), "Heat Recovery Equipment (Generator) in an Automobile for an Absorption Air-Conditioning System". Simulation model has been developed on the basis of the building energy simulation program (Energy Plus). An hourly simulation has been performed for an entire year and the proposed retrofit air conditioning system was found to be more energy efficient.

(Bell I. A, Daini A. J, Ali H. Abdel-Gayed R. G and Duckers L (1996)), The Design of an Evaporator/Absorber and Thermodynamic analysis of a Vapour Absorption Chillier Driven by Solar EnergyIn this article, they present a two stage indirect exhaust heat recovery system of automotive engine employing an effective lumped parameter model to simulate the dynamic behaviours of an adsorption chiller that ranges from the transient to the cyclic steady states. The thermodynamic framework of adsorption chiller is developed from the rigor of mass and energy balances of each component of the system and experimentally confirmed isotherms and kinetics data of various adsorbent-adsorbate pairs.

(Dossat R. J (2001)), "Principles of Refrigeration in automobile" This article investigates low-energy consumption silica gel circulating fluidized beds for the dehumidifi- cation of air conditioning systems

(Hilali I. and Soylemez M. S (2007)), "On the Optimum sizing of exhaust gas-driven automotive absorption cooling systems". In this work, a new all-in-one compact solar air conditioner concept is presented. The system is mainly based on a new DEC process which utilises fixed and cooled adsorption beds operating in a batch process and two wet heat exchangers.

(Iyer R. C, Gohil P, Nagarsheth H. J. and Channiwala S. A (2005)), Development of Vapour Compression Air Conditioning System Utilizing the Heat Potential of Exhaust Gases in Automobiles. This paper presents a novel adsorption air-conditioning system used in internal combustion engine locomotive driver cabin. This system employs the zeolite-water as working pairs and is driven by the waste heat from exhaust gas of internal combustion engine.

(Jakob. U, Eicker. U, Schneider. D and Teuber (2007)), Experimental Investigation of Bubble Pump and System Performance for a Solar Driven 2.5 KW Diffusion Absorption Cooling Machine. This new type of system employs zeolite–water as the working pair and is powered by waste heat from the exhaust gas of the internal combustion engine. Operating experiments of a prototype machine showed that this system has a lot of unique advantages compared to a traditional air conditioning system.

(Johnson V. H (2002)), "Heat-Generated Cooling Opportunities in Vehicles". In this paper, one novel heat pipe solar adsorption chiller with mass-heat recovery was designed. 65 kg of micro-porous silica gel was used as adsorbent in each adsorbent bed. The influence of operating conditions on the chiller was investigated

(Kim B and Park J (2007)), "Dynamic Simulation of a Single-effect ammonia-water absorption chiller". The processes of mass recovery and heat recovery in one micro-porous silica gelewater solar adsorption air conditioner were investigated. The

influences to MH recovery (masseheat recovery) performances under different working conditions were studied.

(Koehler. J, Tegethoff. W. J, Westphalen. D and Sonnekalb. M (1997)), Absorption Refrigeration System for Mobile applications utilizing Exhaust Gases. In this study, for the first time we propose that air bubbles originally existing in solution or being formed during shaking play an important role in the adsorption of PFOS on the aminated polyacrylonitrile fibers (APANFs).

(Lambert M. A. and Jones B. J (2006)), Automotive adsorption air conditioner powered by exhaust heat. , This paper investigates the feasibility of a commercially available MOF, CPO-27(Ni), for automotive adsorption air conditioning through dynamic modelling and experimental testing

(Manrique J. A (1991)), Thermal Performance of an Ammonia – Water Refrigeration System. In the present study, water vapor adsorption onto silica-gel, activated carbon powder (ACP) and activated carbon fiber (ACF) has been experimentally measured at 20°C, 30°C and 50°C. The adsorption data is fitted with Guggenheim–Anderson–De Boer and Dubinin–Astakhov adsorption models for silica-gel and ACP/ACF, respectively

(Martinez P. J, Garcia A and Pinazo J. M (2003)), Performance analysis of an air conditioning system driven by natural gas, In the present study, water vapor adsorption onto silica-gel, activated carbon powder (ACP) and activated carbon fiber (ACF) has been experimentally measured at 20, 30 and 50 C using a volumetric method based adsorption measurement apparatus for greenhouse air-conditioning (AC).

(Mostafavi M and Agnew B (1997)), Thermodynamic Analysis of Combined Diesel Engine and Absorption Refrigeration Unit – Naturally Aspired Engine with Precooling. This paper is focused on the description of a mobile adsorption chiller for cooling in a truck cabin and its experimental performance. The prototype, designed and built at CNR e ITAE, consists of a double-bed adsorber connected with an evaporator and a condenser and driven by the low grade thermal energy coming from the engine coolant loop

(Riffat S. B. and Shankland N (1993)). Integration of Absorption and Vapor-Compression System. In this first part, theoretical and experimental investigations were performed on a two bed, silica gel adsorption chiller for automotive applications.

(Salim M (2001)), Technical Potential for Thermally Driven Mobile A/C Systems, A two bed, continuous adsorption refrigeration cycle with heat recovery and mass recovery is adopted. Micropore spherical silica gel and water are selected as the working pair.

(Sumathy. K, Huang. Z. C and Li. Z. F (2002)), Solar Absorption Cooling with Low Grade Heat source – A Strategy of Development in South China. Solar Absorption Cooling with Low Grade Heat source – A Strategy of Development in South China.

(Venkatesan. J, Praveen. V. M, Bhargav. V. K and Moorthy. B. B (2005)), "Performance Improvement in Automotive Engines using Vapour Absorption Refrigeration System for Air Conditioning" Highly concentrated photovoltaic (HCPV) module exhaust heat recycle system incorporated with adsorption air-conditioning (AAC) module and PCM, along with providing domestic hot water was designed and discussed.

(Wicks F (1989)), Design and Benefits of a Non-Electric Air Conditioner that Combines Compression and Absorption Cycle. The paper describes the design and fabrication of the experimental chamber, the experimental procedure and its feasibility towards development of an alternative eco friendly refrigeration cycle for replacement of chlorofluorocarbons.

(Zoontjens L, Howard C, Zander A and Cazzolato B (2005)), Study of an Automotive Thermo acoustics Refrigerator. The present work is focused towards the development of prototype of vapour adsorption refrigeration system and design of innovative vapour absorption system using aqua ammonia which is based on working cycle of adsorption system and a prototype of 1 KW capacity has been designed, developed and tested in laboratory for vapour adsorption system

CONCLUSION:

Recent research has shown that new evolvement in adsorption technology has a promising potential to

be adopted in automobile air-conditioning purpose. The technology is expected to be practical when further improvements are done to overcome some of the limitations mentioned above. Using clean refrigerants in adsorption air-conditioning systems will reduces the production of unwanted ozone depleting substances, such as CFCs and HCFCs. As such, adsorption air-conditioning system for automobile should be seriously looked into. Besides it being environmentally friendly, low maintenance cost could be expected. By implementing the adsorption air-conditioning system powered by waste heat may provide a comfort for the driver and/or passengers by lowering the air temperature level and also for air ventilation during driving or parking.

ACKNOWLEDGEMENT:

We wish to express our gratitude to **Dr. ManjushaDeshmukh (Principal)**, Saraswati College of engineering for providing an opportunity and necessary facilities to carry out this project.

We also wish to convey our sincere thanks to **Dr. FauziaSiddhiqui (Head of the Department)**, Mechanical Engineering for his encouragement and support towards this project. We owe our deep sense of gratitude to our **Project Coordinator,** having extended his fullest support in completing the project work.

We would like to thank our guide **Assistant Professor Mr. Ashish Bandewar**, Department of Mechanical Engineering for providing the technical support and guidance during various stages of project experimentation.

We also like to express our thanks to all teaching and non-teaching staff members in the Department of Mechanical Engineering.

The acknowledgement would be incomplete if we do not mention the emotional support and blessings provided by our friends and family and also our thanks to the entire Mechanical department faculty and supporting staff for their good support for completing my project in successful manner. We had a pleasant enjoyable and fruitful company with them. Last but not the least we would like to thank all the people who directly or indirectly helped us.

REFERENCES:

1. Alam S, 2006, “A Proposed model for Utilizing Exhaust Heat to run Automobile Air-conditioner”, The 2nd Joint International Conference on Sustainable Energy and Environment 21-23 November 2006, Bangkok, Thailand.

2. Atan R., “Heat Recovery Equipment (Generator) in an Automobile for an Absorption Air-Conditioning System” SAE technical paper, no. 980062.

3. Bell I. A, Daini A. J, Ali H. Abdel-Gayed R. G and Duckers L, 1996, “The Design of an Evaporator/Absorber and Thermodynamic analysis of a Vapour Absorption Chiller Driven by Solar Energy” WREC - 1996.

4. Dossat R. J, 2001, “Principles of Refrigeration”, Fourth edition, Addison Wesley Longman (Singapore) Pvt Ltd, Delhi.

5. Hilali I. and Soylemez M. S, 2007, “On the Optimum sizing of exhaust gas-driven automotive absorption cooling systems”, International journal of Energy research DOI: 10.1002/er.1383

6. Iyer R. C, Gohil P, Nagarsheth H. J. and Channiwala S. A, 2005,“Development of Vapour Compression Air Conditioning System Utilizing the Heat Potential of Exhaust Gases in Automobiles”SAE technical paper, no. 2005 01 3475.

7. Jakob. U, Eicker. U, Schneider. D and Teuber. A, 2007,“Experimental Investigation of Bubble Pump and System Performance for a Solar Driven 2.5 KW Diffusion Absorption Cooling Machine”Heat Set 2007, Heat transfer in components and systems for energy technologies Chambery, France.

8. Johnson V. H., 2002, “Heat-Generated Cooling Opportunities in Vehicles”, SAE technical paper, no. 2002 – 01 - 1669.

9. Kim B and Park J, 2007, “Dynamic Simulation of a Single-effect ammonia-water absorption chiller”, International Journal of Refrigeration Vol. - 30, 535-545. 27

10. Koehler. J, Tegethoff. W. J, Westphalen. D and Sonnekalb. M, 1997, "Absorption Refrigeration System for Mobile applications utilizing Exhaust Gases", Heat and Mass transfer 32(1997) 333-340.

11. Lambert M. A. and Jones B. J, 2006, "Automotive adsorption air conditioner powered by exhaust heat".Journal of Automobile Engineering. Vol.220.

12. Manrique J. A., 1991, "Thermal Performance of an Ammonia – Water Refrigeration System", International Comm. Heat Mass Transfer Vol. 18, pp. 779 – 789.

13. Martinez P. J, Garcia A and Pinazo J. M, 2003, "Performance analysis of an air conditioning system driven by natural gas", Science Direct Energy and Buildings 35 – Pages 669-674.

14. Mostafavi M and Agnew B, 1997, "Thermodynamic Analysis of Combined Diesel Engine and Absorption Refrigeration Unit – Naturally Aspired Engine with Precooling", Elsevier Science Applied Thermal Engineering Vol. 17. No 6. pp. 593-599.

15. Riffat S. B. and Shankland N, 1993, "Integration of Absorption and Vapor-Compression Systems", Elsevier, Applied Energy 46, 303-316.

16. Salim M, 2001, "Technical Potential for Thermally Driven Mobile A/C Systems", SAE technical paper, no. 2001 – 01- 0297.

17. Sumathy. K, Huang. Z. C and Li. Z. F, 2002, "Solar Absorption Cooling with Low Grade Heat source – A Strategy of Development in South China", Elsevier Science Solar Energy Vol. 72, No 2, pp 155 - 165

18. Venkatesan. J, Praveen. V. M, Bhargav. V. K and Moorthy. B. B, 2005, "Performance Improvement in Automotive Engines using Vapour Absorption Refrigeration System for Air Conditioning", SAE technical paper no. 2005-01-3466.

19. Wicks F, 1989, "Design and Benefits of a Non-Electric Air Conditioner that Combines Compression and Absorption Cycle", SAE technical paper no. 899180. 28

20. Zoontjens L, Howard C, Zander A and Cazzolato B, 2005, "Feasibility Study of an Automotive Thermo acoustics Refrigerator", Proceedings of Acoustics, 2005.