REVIEW ON ADSORPTION ICE-MAKER FOR FISHERY BOAT DRIVEN BY WASTE HEAT OF DIESEL ENGINE EXHAUST

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Abstract— Due to ecological problem and energy crisis in word, the development of sustainable energy utilization system has attracted more attention. An adsorption ice-maker may be used storing fish and other food in fishery boat. Design of efficient heat exchanger use of topping cycle with different adsorbent/adsorbate pair to maximize the performance of the ice maker. Silica-gel/water, zeolite/water and Ac/Methanol pair has been used in adsorption ice-maker. It has been powered by waste heat from water coolant in engine. Due to its relatively low working temperature. Result show that this technology help increase COP of system.

Keywords—Adsorption Ice-maker, Waste Heat, Diesel Engine Exhaust

I. INTRODUCTION

Refrigeration is a process of removing heat from a low-temperature reservoir and transferring it to a high-temperature reservoir. The work of heat transfer is traditionally driven by mechanical means, but can also be driven by heat, magnetism, electricity, laser, or other means. Refrigeration has many applications, including: household refrigerators, industrial freezers and air-conditioning. Mechanical refrigeration technology has rapidly evolved in the last century, from ice harvesting to temperature-controlled rail cars.

1.1 Basic adsorption refrigeration system

1.1.1 Heating and Pressurization

During this period, the adsorber receives heat while being closed. The adsorbent temperature increases, which induces a pressure increase, from the evaporation pressure up to the condensation pressure. This period is equivalent to the "compression" in compression cycles.

1.1.2 Heating and Desorption + Condensation

During this period, the adsorber continues receiving heat while being connected to the condenser, which now superimposes its pressure. The adsorbent temperature continues increasing, which induces desorption of vapor. This desorbed vapor is liquefied in the condenser. The condensation heat is released to the second heat sink at intermediate temperature. This period is equivalent to the "condensation" in compression cycles

1.1.3 Cooling and Depressurization

During this period, the adsorber releases heat while being closed. The adsorbent temperature decreases, which induces the pressure decrease from the condensation pressure down to the evaporation pressure. This period is equivalent to the "expansion" in compression cycles.

1.1.4 Cooling and Adsorption + Evaporation

During this period, the adsorber continues releasing heat while being connected to the evaporator, which now superimposes its pressure. The adsorbent temperature continues decreasing, which induces adsorption of vapor. This adsorbed vapor is vaporized in the evaporator. The evaporation heat is supplied by the heat source at low temperature. This period is equivalent to the "evaporation" in compression cycle.

II. LITERATURE SURVEY

Due to ecological problem and energy crisis in word, the development of sustainable energy utilization system has attracted more attention. Waste-heat driven refrigeration technology represents a promising alternative for food preservation on-board, that could help reducing pollutant emissions. This system also reduce exhaust gas so that it is also useful for environment. Electrical demand also reduce with help of this system.

1. **Various refrigeration cycle**

Author name	Title	Result	Conclusion
S.G. Wang, R.Z. Wang	Recent developments of refrigeration technology in fishing vessels	The initial test results show that a COP of 0.18 has been achieved to produce 18–20 kg/h of flake ice at temperature -7°C around.	A wide variety of the modern large and fast fishing vessels include mechanical refrigeration today, Along with a consideration for energy efficiency, increasing attention is being given also to the use of waste heat.
Maciej Chorowski, Piotr Pyrka	Modelling and experimental investigation of an adsorption chiller using low-temperature heat from cogeneration	Greatest COP was 0.642 achieved for parameters: greatest summary cooling capacity was 90.5 kW for parameters:	It was shown that three-bed adsorption chiller can achieve above 0.6 COP when driven by heating water with temperature lower than 60°C.

2. Various refrigeration cycle

Author name	Title	Result	Conclusion
Ramesh P. Sah, Biplab Choudhury, Ranadip K. Das	A review on low grade heat powered adsorption cooling systems for ice production	With comparison of result of different pairs, ACF/Methanol pair has better performance. • Cop = 0.56 (ACF/Methanol) • Cop = 0.12 (Ac/Methanol)	These adsorption ice makers are powered by solar heat and waste heat of diesel engines. Waste heat driven adsorption ice makers can be used on fishing boats to preserve fish.
Gequn Shu, Youcai Liang, Haiqiao Wei , Hua Tian, Jian Zhao, Lina Liu	A review of waste heat recovery on two-stroke IC engine aboard ships	Efficiency of engine without EGR- 49.3% and efficiency of engine with EGR- 54.9%. 1.Ac/methanol Temp.= 100°C, Cop = 0.13 2.Zeolite/water Temp.= 450°C, Cop = 0.25	A detailed literature survey of WHR technologies based on waste heat aboard ships was performed, Refrigeration cycle using WHR technologies is more efficient.
L.W. Wang , R.Z. Wang, Z.S. Lu, C.J. Chen	The performance of two adsorption ice making test units using activated carbon and a carbon composite as adsorbents	Result obtain by physical adsorption working pair: 1.Ac/methanol Scp=32.6 w/kg Cop = 0.12 Result obtain by composite adsorption working pair: 2.CaCl2-Ac/ NH3 is: Scp=536.2 w/kg Cop=0.28	Considering physical adsorption working pairs, the highest adsorption quantity of activated carbon–methanol is 59% larger than that of activated carbon–ammonia. Composite adsorbents CaCl2 and activated carbon show best result
Mohamed Hamdy, Ahmed A. Askalany, K. Harby, NaderKora	An overview on adsorption cooling systems powered by waste heat from internal combustion engine	1. The most commonly working pairs are zeolite–water and silica gel–water. 2. The intermittent of ICE adsorption cooling system has been commonly studied theoretically and experimentally due to its simplicity and low operation costs.	Environmental benefits of applying adsorption cooling technology in automobile and its independence on conventional energy sources makes it highly attractive for further developments and a potential alternative to conventional systems in the future.
Mohamed M. Younes, Ibrahim I. El-Sharkawy,	A review on adsorbent-adsorbate	1. AC (adsorbent) and methanol (refrigerant) – 16 w/kg (SCP) and 0.125 (COP)	Various types of adsorbent-adsorbate

Abd elnaby Kabeel,	pairs for cooling applications	2.Monolithic carbon (adsorbent) and ammonia(refrigerant) – 60 w/kg (SCP) and 0.12 (COP) 3.AC (adsorbent) and ammonia(refrigerant) – 104 w/kg (SCP) and 0.43 (COP) 4.Silica gel (adsorbent) and water (refrigerant) – 198.4 w/kg (SCP) and 0.30 (COP) 5.zeolite (adsorbent) and water (refrigerant) – 7 w/kg (SCP) and 0.25(COP)	(refrigerant) pairs have been reviewed and Adsorption characteristics of the reviewed pairs have been summarized.
Qun Cui, Gang Tao, Haijun Chen, Xinyue Guo,	Environmental benign working pairs for adsorption refrigeration	The maximum adsorption capacity of water on proposed NA reaches 0.7 kg/kg, which is 2.3 times that of water on 13x. The maximum adsorption capacity of ethanol on NB is 0.68 kg/kg, which is three times that of ethanol on activated carbon.	From the view point of adsorption refrigeration cycle time, proposed NA is superior to silica gel but molecular sieve is the best, from the point of utilizing high-temperature waste heat, the NA is a promising adsorbent to substitute molecular sieve
Q.W. Pan, R.Z. Wang, Z.S. Lu, L.W. Wang	Experimental investigation of an adsorption refrigeration prototype with the working pair of composite adsorbent-ammonia	1. A 4-valve adsorption refrigeration prototype is developed and tested. 2. Reliability is improved by the design of adsorber and heating/cooling circuit. 3. The optimal cycle time and mass recovery time are 50 min and 120s, respectively. 4. COP and SCP of typical conditions are 0.197 and 205.2 W/ kg, respectively.	A 4-valve adsorption refrigeration prototype using the composite adsorbent of calcium chloride/activated carbon is designed and manufactured

3. Method for improving efficiency

Author name	Title	Result	Conclusion
S.W. Hong, O.K. Kwon, J.D. Chung,	Application of embossed plate heat exchanger to adsorption chiller	Result are as follow: 1. COP decreases and SCP increases with increasing embossing height. 2. COP increases and SCP decreases with increasing embossing pitch. 3. COP increases and SCP decreases with increasing bed height.	Embossed plate heat exchanger (Plate HX) type adsorption chiller with SWS-1L and water pair, using a numerical method. The plate HX has a relatively high heat transfer capacity and compact size, and this study is a first attempt to apply the plate HX as a new type of adsorption chiller
Zhaohong He, Yu Bai, Hongyu Huang, Jun Li, Huhetaoli, Noriyuki Kobayashi,	Study on the performance of compact adsorption chiller with vapor valves	The maximum output of 1500 W prototype is observed at a driving heat source temperature of 368K	The compact adsorption chiller containing vapor valves has a good working performance.

- **Adsorption ice-maker driven by waste heat of diesel engine**

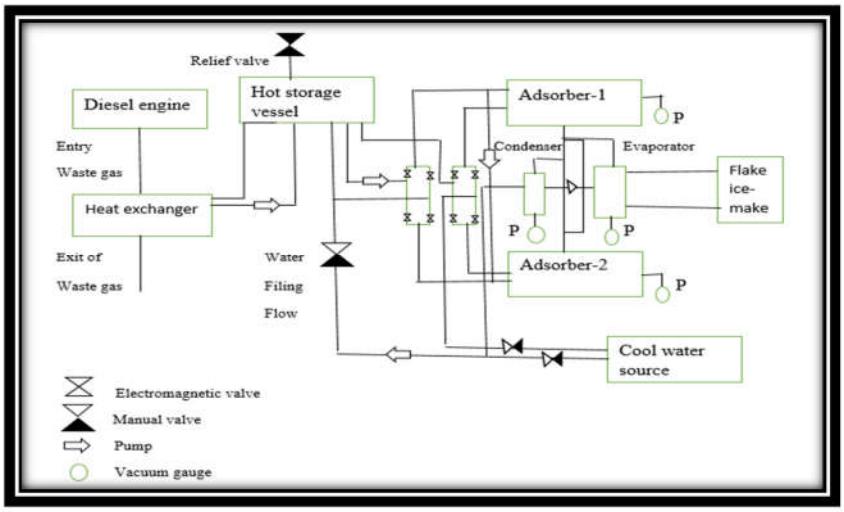

Figure 2.1 schematic diagram of adsorption ice-maker

III. future work

For experimental analysis, will do an experiment on adsorption refrigeration with changing of adsorption pair and measure COP, SCP and cooling temperature and also measure above quantity with change of temperature of waste heat.

IV. CONCLUSIONS

Through the study of all the research papers we conclude that due to the ecological problems and energy crisis in the world, the development of sustainable energy utilization systems has attracted more attention. An adsorption ice maker may be used for storing perishable foodstuffs, fruits, medicines, etc. These adsorption ice makers are powered by low grade heat sources like solar heat, automobile/industrial waste heat etc. Waste-heat driven refrigeration technology represents a promising alternative for food preservation on-board, that could help reducing pollutant emissions. Reduce exhaust gases, So that adsorption system also have environmental benefit. Adsorption system can reduce electricity demand. Three type of adsorbents use in adsorption refrigeration system. Among them physical refrigeration show the advantage of reliable safety. Zeolite-water, silica gel-water, activated carbon-methanol is use as working pair in refrigerator. Among them activated carbon- methanol has more advantage. Heat pipes could be used as heat exchangers for adsorber, evaporators or condensers. It helps to reduce cost and solve the problem of corrosion. Embossed plate heat exchanger use for increase capacity of adsorption refrigeration system. Cop increase with the increase of embossing pitch and bed height.

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