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Research and Reviews on Refrigeration–A Summery

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Abstract—Refrigeration is used in many domestic, industrial, research and commercial applications. Food preservation is one of the major applications of refrigeration. Vapour compression and vapour absorption are two types of refrigeration cycles normally used. Vapour absorption system has advantages like no rotating part, no noise and wide choice of refrigerants. Freon 12, ammonia are commonly used refrigerants. The refrigeration systems are power consuming devices. It is therefore important to utilize the electricity efficiently. For this, the optimization of the refrigeration system is important aspect. The present review summarizes research and reviews carried out on refrigeration in order to analyze, optimize and modify the refrigeration system towards cost effectiveness and minimum energy requirement.

Keywords—coefficient of performance, compression, absorption, power consumption, temperature.

I. INTRODUCTION

Refrigeration is process of moving heat from one point to other point. Refrigeration finds wide application in industry, lifestyle, agriculture and settlement patterns. In hot climatic conditions it is very important to preserve the food items. Especially the seasonal crops and fruits needs to be preserved. In the cold drinks and beverage industry refrigeration is the most important operation. The refrigeration system works on vapour compression and vapour absorption systems. An absorption system finds use in recreational vehicles and industries. Compression cycles are used in preservation of food, air-conditioning and industrial processes. A gas refrigeration system finds application in passenger aircraft. The refrigeration systems can be made more efficient and economical. The minimum power consumption and maximum output are main objectives of research carried out on refrigeration systems. Various investigators have carried out research on refrigeration in order to optimize the system and obtain maximum output measured as coefficient of performance. The current review summarizes research and studies carried out on refrigeration.

II. RESEARCH AND REVIEWS ON REFRIGERATION – A SUMMERY

Sarkar investigated natural refrigerants based vortex tube expansion refrigeration cycles [1]. He compared ammonia, propane and isobutene based vapour compression refrigeration cycles. He presented effects of various operating and design parameters of the COP improvement using vortex tube instead of expansion valve. He observed that COP improvement using vortex tube depended on the refrigerant varieties, operating conditions as well as cycle configurations. He obtained maximum COP improvement of 12.2% using the vortex tube as an expansion device with isobutene. Srikhirin et.al. carried out a review on absorption refrigeration technologies [2].They described a number of research options of absorption refrigeration technology. According to their review, double-effect absorption systes using lithium bromide/water seem to be the only high performance system which is available commercially. A combined ejector-absorption system can also be considered as possible option. Vosough et.al. investigated optimization of the refrigeration cycles using genetic algorithm

[3]. They examined a refrigeration cycle with one and two intercoolers. They observed that the efficiency of the cycle decreases with the increase of the ambient temperature. They also observed that the highest percentage of irreversibility is related to the throttle valve(39.7%) and after that the compressors(29.23%).They concluded that the three stages cycle has higher performance than two stage cycle.

An adsorption-desorption refrigeration cycle was studied for cooling effect by Halder and Sarkar[4]. They used activated carbon granules as adsorbent indigenously developed from coconut shell and carbon dioxide gas as an adsorbate in a small experimental chamber. They found that adsorption followed by removal of heat of adsorption and subsequent desorption produces refrigeration. They observed that the temperature drop increases as the initial adsorption temperature of the adsorbent bed is decreased at a fixed pressure. Almeida and Barbosa studied theoretical analysis of a two-stage transcritical cooling cycle using R744 (carbon dioxide) as a refrigerant [5]. He subjected the effect of the intercooling process on performance in the two-stage transcritical system to varying pressures in a gas cooler. He observed that the coefficient of performance (COP) for the two-stage cycle is superior to the single stage cycle. It was also observed that the amount of heat rejected between compression stages depends primarily on the intermediate pressure adopted. Dong et.al. carried out studies on the thermo physical properties of the H_2O + 1,3-imethylimidazolium dimethylphosphate ([DMIM]DMP) system[6]. He adopted the boiling point to measure the vapor pressures of the system at mass fraction of ionic liquids (ILs) in the range from 0.10 to 0.90 as well as pressures range from 2 kPa to 101 kPa. It was observed that the coefficient of performance of H_2O + [DMIM]DMP system was close to that of conventional working pair H_2O + LiBr.

Sahni studied ejector expansion refrigeration system[7].This system was proposed in order to reduce the expansion process losses of the basic refrigeration cycle. He observed that the ejector expansion cycle improves the COP by more than 16% compared to the basic cycle for typical air conditioning application. Kaushik and Singh carried out research on an analytical study of absorption refrigeration technology[8].The objective of this work was to design a lithium bromide–water (LiBr-H_2O) absorption refrigerator with a nominal capacity of 5.25 kW. They found that the COP of the system for the different parameters was 0.881.According to them, a suitable working fluid is probably the single most important factor in any refrigeration system. Yang et.al. carried studies on exergy analysis of transcritical carbon dioxide refrigeration cycle with an expander[9]. Throttling valve and an expander were used for the transcritical carbon dioxide refrigeration cycles. A comparative study was performed based on the first and second laws of thermodynamics. They used exergy analysis in order to identify the amounts and locations of irreversibility within the two cycles. They found that the largest exergy loss occurred in the throttling valve was about 38% of the total cycle irreversibility. In expander cycle, the gas cooler and the compressor were sources of irreversibilities. The expander cycle exhibited about 30-33 percent higher performance. Patel and Chaudhary carried out investigation on comparison of ejector refrigeration cycle with throttled expansion cycle using R-170 as refrigerant[10]. It was observed that with ejector as an expansion device, R 170 yielded a maximum COP improvement of 24.12 percent. It was observed that, with increase in mixing temperature, coefficient of performance (COP) first increased as entrainment ratio increased, and after certain optimum value it decreased as entrainment ratio decreased. They concluded that the ejector expansion refrigeration cycle provided increased coefficient of performance, decreased compressor displacement, decreased compression ratio, reduced evaporator size as compared with a standard vapor compression cycle.

Dubey and Rajput presented the first law analysis of a coupled power-refrigeration cycle[11].For a condenser temperature range of 40-42^{0}C, they obtained increase in COP by 65 percent. In the cycle with recuperator, reheater and economizer, it increased by 80%.They also

observed that increasing the temperature of the refrigerant vapours at the inlet of the turbine at the same pressure can compensate for the decrease in COP and increase in mass flow rate in power cycle at elevated temperatures. Dhokane et.al. carried out studies on intermittent solid adsorption refrigeration system[12]. Their studies were focused on the design and development of the system working on solar system. In their paper they described the design and fabrication of the experimental chamber, the experimental procedure and its feasibility towards development of an alternative ecofriendly refrigeration cycle for replacement of chlorofluorocarbons. They concluded that more attention must be given to the design influence on the performance of the system. Raghuvanshi and Maheshwari analyzed ammonia –water (NH_3-H_2O) vapor absorption refrigeration system based on first law of thermodynamics[13].Their study was focused on empirical relations for evaluating the characteristics and performance of a single stage Ammonia water (NH_3-H_2O) vapour absorption system. They observed that as the generator temperature increases, coefficient of performance of the system decreases. According to them, the main advantage of this system was that, it can be operated with a relative low generator temperature to reach low evaporator temperature with an acceptable system COP. Also it was observed that coefficient of performance of the system increases as absorber temperature decreases. Alsaqoor and AlQdah studied performance of a refrigeration absorption cycle[14]. They used different types of power sources such as electric, conventional fuel and renewable energy sources. They measured temperature at the points like generator, absorber, evaporator and condenser. According to them use of solar energy for driving the refrigeration can be big advantage. They observed that when the plant driven by the solar thermal energy, the coefficient of performance reached to 0.801 under the generator temperature of 91˚C.

Kotb and Saad carried out studies on the magnetic-caloric effect for the refrigeration cycle performance[15].They observed that, applying magnetic field at the condensate line or suction line improves the performance of the vapor compression cycle. It was also observed by them that magnetic field at condensation line increases COP more than at suction line. Naser and AL-Ajmi carried out research aimed at studying COP of refrigeration cycles[16].They presented an experimental investigation of the performance of the refrigeration cycles. They carried out studies by using different condenser designs and under varying evaporator loads. They used regular condensers (I), condenser with copper plain tubes (II) and condenser with copper tubes welded with stainless steel flat plate(III). They observed that the average COP of cond.II and cond.III increased up to 20 % and 14% respectively. They also observed that, with working time, the values of the heat rejected from the condenser and COP of the refrigeration cycle increased gradually.

III. CONCLUSIONS

Various investigators have carried out investigation on refrigeration. Based on these investigations following conclusions can be drawn

- The coefficient of performance (COP) for the two-stage cycle is superior to the single stage cycle.
- The ejector expansion cycle improves the COP.
- Coefficient of performance of the system increases as absorber temperature decreases.
- Applying magnetic field at the condensate line or suction line improves the performance of the vapor compression cycle with working time.
- The values of the heat rejected from the condenser and COP of the refrigeration cycle increases gradually.
- With increase in mixing temperature, coefficient of performance (COP) first increases as entrainment ratio increases, and after certain optimum value it decreases.
- The temperature drop increases as the initial adsorption temperature of the adsorbent bed is decreases.

REFERENCES

[1] Jahar Sarkar,"Performance Analysis of Natural-Refrigerants-Based Vortex Tube Expansion Refrigeration Cycles", Int. J. of Thermal & Environmental Engineering , vol 6, no. 2, pp.61-68,2013.

[2] Pongsid Srikhirin, Satha Aphornratana, Supachart Chungpaibulpatana, "A review of absorption refrigeration technologies", Renewable and Sustainable Energy Reviews, vol.5, pp.343-372, 2001 .

[3] Amir Vosough, Shahab Shahidi, Ashcan Marahel, Fatemeh Hesami, "Optimization the refrigeration cycles using genetic algorithm", International Journal of Applied Research, vol.1,no.1,pp.9-12, 2014.

[4] G Halder, S C Sarkar, "The cooling effect by an adsorption-desorption refrigeration cycle", Journal of Energy in Southern Africa, vol.18, no.2., pp.26-30,May 2007.

[5] Igor Marcel Gomes Almeida, Cleiton Rubens Formiga Barbosa, "Performance Analysis Of Two-Stage Transcritical Refrigeration Cycle Operating With R744", 21st Brazilian Congress of Mechanical Engineering, October 24-28, 2011, Natal, RN, Brazil,pp.1-10.

[6] Li Dong, Danxing Zheng , Nan Nie, Yun Li, "Performance prediction of absorption refrigeration cycle based on the measurements of vapor pressure and heat capacity of H2O + [DMIM]DMP system", Applied Energy,vol. 98 ,pp.326-332,2012.

[7] Rounak Sahni, " Ejector Expansion Refrigeration Systems", Research Inventy: International Journal Of Engineering And Science, vol.5, no. 2,pp.25-29,February 2015.

[8] Sachin Kaushik, Dr. S. Singh, "Thermodynamic Analysis of Vapor Absorption Refrigeration System and Calculation of COP", International Journal For Research In Applied Science and Engineering Technology, vol. 2, no.2,pp.73-80, February 2014.

[9] Jun Lan Yang, Yi Tai Ma, Min Xia Li, Hai Qing Guan,"Exergy analysis of transcritical carbon dioxide refrigeration cycle with an expander", Energy, vol. 30,pp. 1162-1175,2005.

[10] Gourav Patel, Dr. Sharad Chaudhary, " Performance Comparison of Ejector Expansion Refrigeration Cycle with Throttled Expansion Cycle", International Journal of Scientific and Research Publications, vol. 4,no. 7, pp.1-5, july2014.

[11] Maneesh Dubey And S.P.S. Rajput, "First Law Analysis Of An Organic Rankine Cycle Powered Compression Refrigeration Cycle", Journal of Environmental Research And Development, vol. 4, no. 3, pp.822-833, January-March 2010.

[12] Nilesh T. Dhokane, Savita U. Shinde, Dr. S. B. Barve, "Design and Development of Intermittent Solid Adsorption Refrigeration System Running On Solar Energy", International Journal of Innovative Research in Science, Engineering and Technology, vol. 3, special Issue 4, pp. 98-104, April 2014.

[13] Satish Raghuvanshi, Govind Maheshwari, "Analysis of Ammonia –Water (NH_3-H_2O) Vapor Absorption Refrigeration System based on First Law of Thermodynamics", International Journal of Scientific & Engineering Research, vol. 2, no. 8, pp.1-7, August-2011.

[14] Sameh Alsaqoor, Khaled S. AlQdah, "Performance of a Refrigeration Absorption Cycle Driven by Different Power Sources", Smart Grid and Renewable Energy, vol.5, pp.161-169, 2014.

[15] A Kotb, H. E. Saad, "Experimental Investigation for the Magnetic-Caloric Effect on the Refrigeration Cycle Performance", Sch. J. Eng. Tech., vol. 2,no.3A,pp.339-347,2014.

[16] Eng. Naser R. M. AL-Ajmi, " Coefficient of Performance Enhancement of Refrigeration Cycles", Int. Journal of Engineering Research and Applications, vol. 5, no. 3, (Part -3),pp.117-125,March 2015.

