International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 01 | Jan -2017 www.irjet.net p-ISSN: 2395-0072

Review of Vapour Absorption System and Vapour Compression System.

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Abstract - *This review deals with vapour absorption and vapour compression refrigeration system.The schematic diagram of both system is elaborated.The history of carbondioxide as a refrigerant is also discussed.Uses of referigerant in various systems is also analysed. Latest literature surveys were carried out to improve the systems. The basic principle of operation of both system is systematically viewed in this paper and its future scope.*

Keywords – Refrigeration,vapour compression,vapour absorption,refrigerant,carbondioxide.

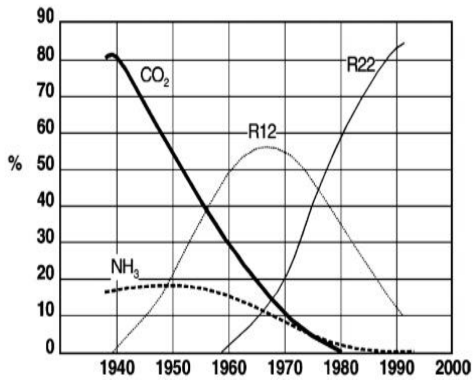
I. INTRODUCTION

A refrigeration system utilizes work supplied by an electric motor to transfer heat from a space to be cooled to a high temperature sink (place to be heated). Low temperature boiling fluids called refrigerants absorb thermal energy to get vaporized in the evaporator causing a cooling effect in the region being cooled. While comparing the advantages and disadvantages of various cooling systems, two most important parameters i.e. the operating temperature and the coefficient of performance are of vital importance in these systems. These systems can be evaluated using energy and energy analyses which are based on first and second law of thermodynamics, respectively and have been described .

Carbon dioxide is very old 'working fluid' in refrigeration system and needs to understand its history and why it was discontinued after the Second World War. Carbon dioxide has been known to mankind since first century AD. The Romans were aware of the effects of lethal gas coming out of volcano on blood circulations. They had also knowledge of suffocation due to displacement ventilation and called carbon dioxide – 'Spiritus Letalis', which killed without leaving any traces! In 1756, Joseph Black proved that carbon dioxide, which he called 'fixed air' present in the atmosphere and combines with other elements to form compounds.

Carbon dioxide has been used in refrigeration and cooling in solid and liquid form because it sublimates to gas at very low temperature of -78.5oC giving total loss of refrigerant. It is widely used in brewing of soft drinks, beers,other alcoholic drinks. Recently, it is being used in softening water to avoid corrosion problems in long water distribution lines and also in producing potable drinking water. The use of carbon dioxide as fire extinguisher is known from century. It also finds application in petroleum industry to bubble out crude oil, sand blasting and hardening

An extensive review of the literature has been done on different refrigeration and heat pump systems in present chapter. The main idea was to have possible future direction of research. The literature review has been



classified as under:of metal castings.it is shown in figure 1.

Fig 1. Use of primary refrigerants over last century.

a. Vapour Absorption Refrigeration System.
b. Vapour Compression Refrigeration System.

1.1. Vapour Absorption System

Vapour Absorption system is an attractive method for utilizing low grade energy directly for cooling. This is an important advantage as against the conventional vapour251compression system which operates on high grade energy.

Another important feature of these systems is that it does not use any moving component except a very small
liquid pump. Vapor absorption system consists of four basic components viz. an evaporator, an absorber (located on low pressureside), a generator and a compressor (located on high pressure side). A refrigerant flows from the condenser to the evaporator, then via absorber to the generator and back to condenser, while the absorbent passes from absorber to the generator and back to absorber. For maximum efficiency, the pressure difference between the low pressure side and high pressure side is maintained as small as possible.

Although, the initial cost of these systems is at present higher but their operating expenses are often appreciably lower, which can further be reduced if efficient absorption and distillation can be achieved. Since, the efficiency of these processes is determined largely by thermodynamic properties of the refrigerant –absorbent combination, an extensive study of these properties is of utmost importance in the development of an efficient absorption refrigeration cycle.

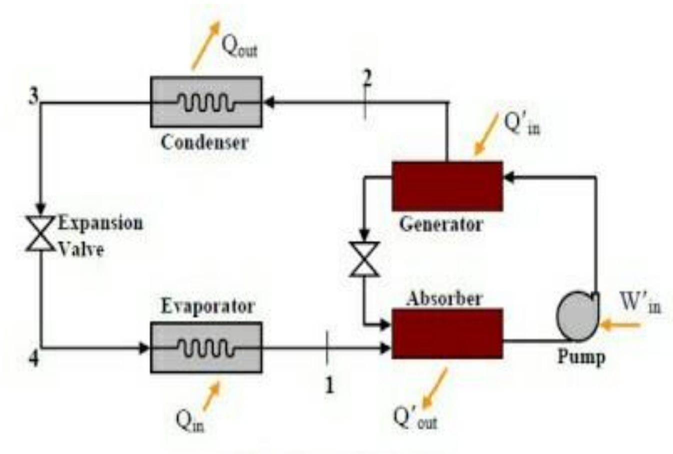


Fig. 1.1 Diagram Of Simple Vapour Absorption Refrigeration Cycle.

1.1.1 Practical Vapour Absorption Refrigeration System.

The working and the schematic diagram of practical vapour absorption refrigeration system is similar to that of theoretical vapour absorption refrigeration system.but there is some additional equipment associated in the practical system.the additional features are analyser and rectifier.it is illustrated in figure 1.1.1.

a) Analyser:

- When ammonia is vapourised in generator ,some water is also vapourised and will flow into the condenser along with ammonia vapour.
- If these unwanted water particles are not removed they will enter into expansion valve and evaporator where they freeze and choke the pipeline.
- In order to remove unwanted particles,analyser is used.

b) Rectifier:

- In case the water particles are not completely removed in analyser,a rectifier is used.its function is to cool ammonia vapour so,that water vapour are condensed.

1.1.2 Domestic Electrolux Refrigeration system.

- The main purpose of this system is to eliminate the pump ,so that in absence of moving part,machine becomes noiseless
- It is also known as three fluid refrigerator.

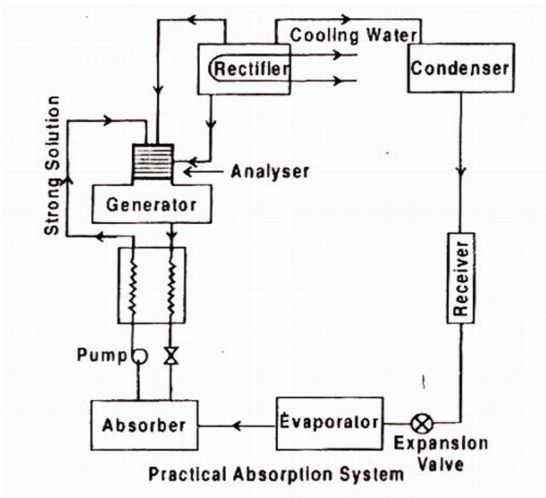


Fig 1.1.1 Practical Vapour Absorption Refrigeration System.

- The three fluids used in system are ammonia ,hydrogen and water),ammonia is used as refrigerant and hydrogen being the lightest gas is used to increase rate of evaporation of liquid ammonia passing through evaporator.

- It is clearly illustrated in below figure no 1.1.2.

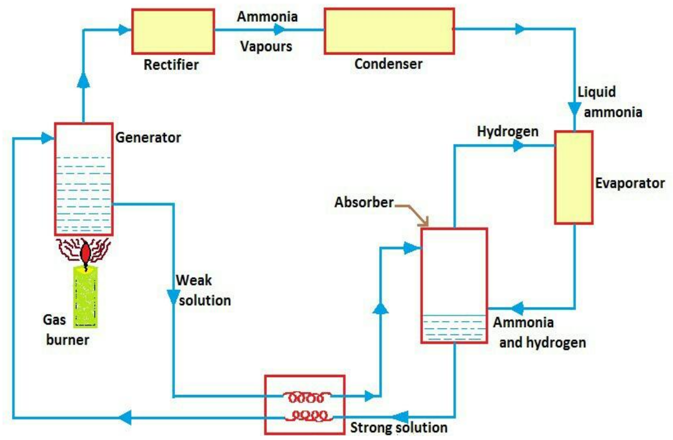


Fig 1.1.2 Domestic electrolux refrigeration system.

1.2 Vapour Compression System

In Vapour Compression System ,there are four major components. They are evaporator, compressor, condenser and expansion device. Power is supplied to the compressor and heat is added to the system in the evaporator, whereas in the condenser heat rejection occurs. Heat rejection and heat addition are dissimilar to different refrigerants.

A standard vapour compression cycle consists of four processes viz. a reversible adiabatic compression from the saturated vapour to the compressor pressure followed by a reversible heat rejection at constant pressure causing de-superheating and condensation.

This is further extended to an irreversible expansion at constant enthalpy from saturated liquid to evaporator pressure and there after a reversible heat addition at constant pressure causing evaporation to saturated vapour.

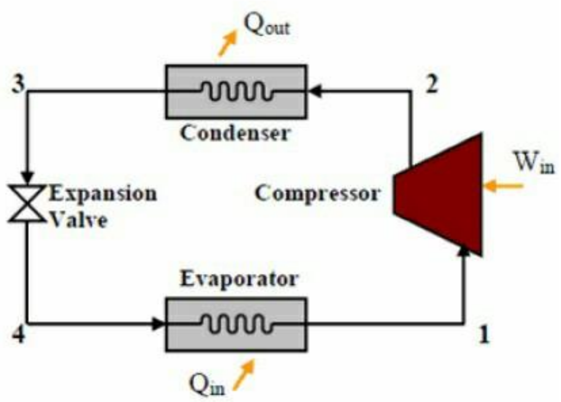


Fig. 1.2 Diagram Of Simple Vapour Compression Cycle.

II. LITERATURE SURVEY

2.1 Shu Haiwen et al. [1] (2010): The study of the energy saving judgment of electric driven sea water source heat pump district heating system over boiler house district heating system. They concluded that for renewable energy utilization system, the electricity driven heat pumps are gaining popularity, but the energy saving condition is still not clear.

In this study, an expression of the critical COP of the heat pump system for energy saving is derived through the comparison of the system and conventional boiler house district heating system in the energy consumption aspects. Also, the actual COP values of the heat pump unit are calculated by the experimental data regression model based on the details from the supplier of the heat pump. The comparison of the values of both COP's critical as well as actual brings out a judgment on the energy saving aspect of an electric driven sea water heat source pump for district heating. The results also indicate that both the heating radius and the natural conditions of sea water are the most important factors to determine the energy efficiency of the system.

The results indicate that selection of sea water area should be done in a way that it should have the largest sea water temperature difference that could be utilized thereby decreasing the water head of the sea water pump. The type of fuel used in the boiler greatly influences the critical COP value of the heat pump. [1]

2.2 Qureshi and Zubair [2] (2012): The Investigation is done on performance characteristics due to use of different refrigerant combinations in vapor compression cycles with dedicated mechanical sub-cooling.

For basic designs, R-134a used in both cycles produced the best results in terms of COP, COP gain and relative compressor sizing. In retrofit cases, considering the high sensitivity of COP to the relative size of heat exchangers in the sub-cooler cycle and the low gain in COP obtained due to installation of a dedicated sub-cooling cycle when R-717 is the main cycle refrigerant, it seems that dedicated mechanical sub-cooling may be more suited to cycles using R-134a as the main cycle refrigerant rather than R-717.

With R-134a as the main cycle refrigerant, no major difference was noted, by changing the sub-cooler cycle refrigerant, in the degradation of the performance parameters such as COP and cooling capacity, due to equal fouling of the heat exchangers. 253[2]

2.3 Arora et al [3] (2007): The parametric investigation of actual vapour compression refrigeration cycle in terms of COP, energy destruction and energy efficiency for R-22, R-407C and R-410A by developing a computational model. The results showed that COP and energy efficiency for R-22 are higher in comparison to R-407C and R-410A.

It was concluded that R-410A is better alternate as compared to R-407C with high coefficient of performance and low energy destruction ratio when considering for refrigeration applications. For air conditioning application R-407A is better alternative than R-410A. 254[3]

2.4 Gomri (4)(2009) : The comparative study is carried out between single effect and double effect absorption refrigeration systems. They developed the computer program based on energy balances, thermodynamic properties to carry out thermodynamic analysis. They concluded that for each condenser and evaporator temperature, there is an optimum generator temperature where change in energy of single effect and double effect absorption refrigeration system is minimum.

Their study showed that the COP of double effect system is approximately twice the COP of single effect system but there is marginal difference between the energetic efficiency of the system. 254[4]

2.5 Kilic and Kaynakli (5)(2007): There has been the use of first and second law of thermodynamics to analyze the performance of a single stage water lithium bromide absorption refrigeration system by varying some working parameters. They introduced a mathematical model based on energy method. They found that the performance of the ARS increases with increasing generator and evaporator temperatures but decreases with increasing condenser and absorber temperatures. They concluded that the highest energy loss occurs in generator regardless of operating conditions and therefore it is most important component of the system. 254[5]

2.6 Kaushik and Arora (6)(2009): The energy and energy analysis of single effect and series flow double effect water–lithium bromide absorption system. They developed the computational model for parametric investigation. Their analysis involves the effect of generator, absorber and evaporator temperatures on the energetic and energetic performance. They concluded that the irreversibility is highest in the absorber in both systems as compared to other systems.254[6]

2.7 Garousi Farshi et al (7)(2011): The computational model to study and compare the effects of operating parameters on crystallization phenomena in three classes of double effect lithium bromide–water absorption refrigeration systems (series, parallel and reverse parallel) with identical refrigeration capacities.They concluded that the range of operating conditions without crystallization risks in the parallel and the reverse parallel configurations is wider than those of the series flow system. 254[7]

2.8 Behrooz and Ziapour (8)(2011): The thermodynamic analysis of a diffusion absorption refrigeration heat pipe (DARHP) cycle. A computer code was developed for an ammonia–water DARHP cycle with helium as the auxiliary inert gas using EES software.The second law efficiency was examined parametrically by the computer simulation. They validated the model by comparison with previously published experimental data for DARHP system. The cycle performance results under different conditions indicated that the best performance was obtained for the concentration rich solution of 0.35 ammonia mass fraction and the concentration of weak solution about 0.1. They concluded that the energy losses in the evaporator, condenser and dephlegmator were small. Also the second law efficiency increases with increasing evaporator temperature; and decreases with increasing thermosyphon temperature. 254[8]

III. FUTURE SCOPE

Scope for future work as suggested in above review is to include analyzer, rectifier and working fluid hydrogen to convert the strong solution into weak solution and to facilitate the faster rate of evaporation in the evaporator in vapour absorption system.

To modify the size of compressor so as to get proper compression ratio of vapours leaving the compressor.The future design of the compressor should be well insulated so as to reduce heat leakages during the operatio.The refrigerant entering the evaporator has to be fully converted into liquid so as to improve the efficiency of the vapour compression system.

IV. CONCLUSION

A comprehensive review of the literature on vapour absorption systems, compression-absorption system and vapour compression system has been carried out on various aspects of energy analysis, the type of cycles analyzed, working pairs used and energy analysis.

With regards to vapour absorption cycles, it is found that mostly the studies are carried out on large capacity systems and the investigation had been carried out with in a limited range of system design parameters. The literature on small vapour absorption systems is scant and very few studies have been done on smaller systems. The above studies are simulation studies. Regarding compression-absorption systems studies have been carried out by many researchers mostly analytically and experimentally.

The investigations have been done on wet compression cycles which eliminated the need of solution pump. The literature provides details with regard to the applications of this cycle. However the literature on energy analysis of such systems is scant. In CA systems, refrigerant –absorbent mixtures are used as working fluids which provide temperature gradient profiles in the absorber and desorber. Literature reveals that NH3-H2O is the most suitable working fluid due to its high latent heat and excellent heat and mass transfer properties.

V. REFERENCES

[1] Hiwen, Shu., Lin, Duanmu., Xiangli, Li., Yingxin, Zhu., Energy–saving judgment of electric- driven sea water source heat pump district heating system over boiler house district heating system, Energy and buildings, Vol. 42, (2010), pp. (889-895).

[2] Qureshi, B.A., Zubair, S.M., The effect of refrigerant combinations on performance of a vapor compression refrigeration system with dedicated mechanical sub-cooling, International Journal of Refrigeration, Vol. 35(1), (2012), pp. (47-57255).

[3] Arora, A., Arora, B.B., Pathak, B.D. and Sachdev, H.L., Exergy analysis of a vapour compression refrigeration system with R22, R407C and R410A, International Journal of Exergy, Vol. 4(4), (2007), pp. (441-454).

[4] Gomri, R., Second law comparison of single effect and double effect vapour absorption refrigeration systems, Energy Conversion and Management, Vol. 50, (2009), pp. (1279-1287).

[5] Kilic, M. and Kaynakli, O., Theoretical study on the effect of operating conditions on performance of absorption refrigeration system, Energy Conversion and Management, Vol. 48, (2007), pp.(599-607).

[6] Kaushik, S.C., Arora, A., Energy and Exergy analysis of single effect and series flow double effect water-lithium bromide absorption refrigeration systems, International Journal of Refrigeration, Vol. 32, (2009), pp. (1247-1258) .

[7] GarousiFarshi, L., Mahmoudi, S.M.S., Rosen, M.A., Analysis of crystallization risk in double effect absorption refrigeration systems, Applied Thermal Engineering, Vol. 31(10), (2011), pp.(1712-1717).

[8] Behrooz, M., Ziapour, M.T., Performance study on a diffusion absorption refrigeration heat pipe cycle, International Journal of Thermal Sciences, Vol.50(4),(2011), pp.(592-598).