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VAPOUR ABSORPTION REFRIGERATION SYSTEM

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Abstract: Our primary focus of this project would be utilizing design and study environmentally friendly vapor absorption refrigeration systems. The vapor absorption system is a fluid system comprising ammonia and water and it has three phases: Evaporation, Absorption, and Regeneration. Here in this Refrigeration system when low boiling point refrigerant evaporates, it takes some heat away with it providing the cooling effect and changing gas back into liquid. In this system, the compressor is replaced by a generator and Absorber.

I. INTRODUCTION

Vapour Absorption Refrigeration Systems (VARS) belong to the class of vapour cycles similar to vapour compression refrigeration systems. However, unlike vapour compression refrigeration systems, the required input to absorption systems is in the form of heat. Hence these systems are also called as heat operated or thermal energy driven systems. Similar to vapour compression refrigeration systems, vapour absorption refrigeration systems have also been commercialized and are widely used in various refrigeration and air conditioning applications. Since conventional absorption systems use natural refrigerants such as water or ammonia they are environment friendly.

The function of compressor in the vapor compression system is to continuously withdraw the refrigerant vapor from the evaporator and to raise its pressure and hence temperature, so that the heat absorbed in the evaporator, along with the work of compression, may be rejected in the condenser to the surroundings In vapor – absorption system, the function of the compressor is accomplished in a three – step process by the use of the absorber, pump and generator. As Absorption unit become more popular not only in industry but also on a domestic level, their simulations become more important. This enables better understanding of the complex thermodynamic behavior which such system exhibit and for that various mathematical model have been created in the past.

Nowadays, investigation of ammonia water (H2O-NH3) systems is becoming more important especially with the introduction of efficient generator-absorber heat exchanger (GAX) absorption units. Although the latter systems are in principle the same, they require additional devices which in themselves require thermodynamic modelling.

II. LITERATURE SURVEY

“Development of a Model for Design of Double - Effect Vapor Absorption Refrigeration Systems” M. A. AKINTUNDE, F. H. ADEDOYIN , K. A. ADETORO. Mathematical models and computer software for double-effect reverse parallel vapour absorption refrigeration system was developed and provides data for future system design. Available data was used to validate the model. The software application was evaluated for its performance and various design data could be generated using the software. The result from the software was comparable with the published data in Fundamentals Handbook (ASHRAE, 1997) and an average of 20% variation was observed. It was also noted that the COP increased with increase refrigeration effect. Though the COP gives initial fluctuation with increase in generator temperature, but at generator temperature of 183ºC and above the COP steadily increased with the temperature.

“Study of Ammonia Water Vapour Absorption Refrigeration Chiller Run by Solar Thermal Energy” Ezaz Ahmad Ansari, Sohail Bux. This paper presents an extensive review of several kinds of vapour absorption systems, their thermodynamic aspects and performance assessment. Specifically vapour absorption refrigeration by solar thermal heat is concentrated. Requirement for the working pairs have also been discussed, over the last few decades, a lot of research work still need to be done. Here feasibility of solar thermal chiller is studied with aspects of thermodynamics and economically along with eco friendly in nature.

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"Design of Solar Powered Vapour Absorption Refrigeration System" Rohan Chandra, Rahul, Rahul Kumar, Prof. J.P. Kesari. In light of the above results, the feasibility of the solar powered vapour refrigeration system has been reasonably proved. The COP values as calculated by us are on a little higher side than the actual COP's, but , because we have assumed ideal processes in heat exchanges etc, this obliquity can be understood. Hence, a solar water heating unit can be usefully incorporated for water cooling purposes. In the month of summers, when the solar potential is quite high, the unit can be used for refrigeration.

"development of vapour absorption refrigeration system in automotive trucks for cold storage" Y. Lethwala, J. Surti, V. Jagtap. Vapour Absorption Refrigeration system is more effective than Vapour Compression Refrigeration system because it decreases temperature till -11°C and also we eliminate use of Highway Cold Storage. Because of this we developed this System. The heat load on the generator can be met very easily by using the engine exhaust for both the systems as available energy rejected by cooling system of truck engine is more than sufficient. Even with a minimum assumed COP of 0.2, the required input to generator is 17.5 kW, while waste heat available is 34 kW. Hence from the discussion, ammonia/ water vapour absorption system is suggested for the application. Though the COP of the system is less but since waste heat is given as input, it is not a matter of concern.

"Design and Fabrication of Vapour Absorption Refrigeration System [Libr-H20]" Mohd Aziz Ur Rahaman, Md. Abdul Raheem Junaidi, Naveed Ahmed, Mohd. Rizwan. A simple vapor absorption system was designed and fabricated to analyze the performance of the system. The system is tested with heat input from an electric heating element of 500 watts capacity for a pressure of 32.5 mbar. The COP is found to be 0.698 and the increase from the designed value is because of higher generator temperature. A more efficient thermal system should have higher COP and lower total entropy generation. Comparison between actual and calculated values shows that heat loss from the generator greatly affects the system performance. The cooling capacity is limited because of limitations temperature and need of rectification which is absent in the current system.

Further analysis to this system should involve the entropy generation to identify and quantify performance degradation of the system. The COP can be increased further by using a heat exchanger between the absorber and generator as well as between the condenser and pressure reducing valve. The various components of 0.05TR H20-LiBr vapour absorption system were fabricated using mild steel due to the corrosive nature of water on copper, brass etc.

III. DESIGN

3.1 CAD:

Computer-aided design (CAD) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. The term CADD (for Computer Aided Design and Drafting) is also used.

Its use in designing electronic systems is known as electronic design automation (EDA). In mechanical design it is known as mechanical design automation (MDA) or computer-aided drafting (CAD), which includes the process of creating a technical drawing with the use of computer software.

CAD software for mechanical design uses either vector-based graphics to depict the objects of traditional drafting, or may also produce raster graphics showing the overall appearance of designed objects. However, it involves more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions.

CAD may be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) space.

The design of geometric models for object shapes, in particular, is occasionally called computer-aided geometric design (CAGD).

CAD is one part of the whole Digital Product Development (DPD) activity within the Product Lifecycle Management (PLM) processes, and as such is used together with other tools, which are either integrated modules or stand-alone products, such as:

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- Computer-aided engineering (CAE) and Finite element analysis (FEA)
- Computer-aided manufacturing (CAM) including instructions to Computer Numerical Control (CNC) machines
- Photorealistic rendering and Motion Simulation.
- Document management and revision control using Product Data Management (PDM).

CAD is also used for the accurate creation of photo simulations that are often required in the preparation of Environmental Impact Reports, in which computer-aided designs of intended buildings are superimposed into photographs of existing environments to represent what that locale will be like, where the proposed facilities are allowed to be built. Potential blockage of view corridors and shadow studies are also frequently analysed through the use of CAD.

CAD has been proven to be useful to engineers as well. Using four properties which are history, features, parameterization, and high-level constraints. The construction history can be used to look back into the model's personal features and work on the single area rather than the whole model. Parameters and constraints can be used to determine the size, shape, and other properties of the different modelling elements.

The features in the CAD system can be used for the variety of tools for measurement such as tensile strength, yield strength, electrical or electromagnetic properties. Also, its stress, strain, timing or how the element gets affected in certain temperatures, etc. There are several different types of CAD, each requiring the operator to think differently about how to use them and design their virtual components in a different manner for each. There are many producers of the lower-end 2D systems, including a number of free and open-source programs. These provide an approach to the drawing process without all the fuss over scale and placement on the drawing sheet that accompanied hand drafting since these can be adjusted as required during the creation of the final draft.

3D wireframe is basically an extension of 2D drafting (not often used today). Each line has to be manually inserted into the drawing. The final product has no mass properties associated with it and cannot have features directly added to it, such as holes. The operator approaches these in a similar fashion to the 2D systems, although many 3D systems allow using the wireframe model to make the final engineering drawing views.

3D "dumb" solids are created in a way analogous to manipulations of real-world objects (not often used today). Basic three-dimensional geometric forms (prisms, cylinders, spheres, and so on) have solid volumes added or subtracted from them as if assembling or cutting real-world objects. Two-dimensional projected views can easily be generated from the models. Basic 3D solids don't usually include tools to easily allow motion of components, set limits to their motion, or identify interference between components.

There are two types of 3D Solid Modelling:
Parametric modelling allows the operator to use what is referred to as "design intent". The objects and features created are modifiable. Any future modifications can be made by changing how the original part was created. If a feature was intended to be located from the centre of the part, the operator should locate it from the centre of the model.

The feature could be located using any geometric object already available in the part, but this random placement would defeat the design intent. If the operator designs the part as it functions the parametric modeler is able to make changes to the part while maintaining geometric and functional relationships.

3.2 PUMP

- A pump is a device that moves fluids (liquids), or sometimes slurries, by mechanical action.Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps.

- When the absorbent absorbs the refrigerant strong solution of refrigerant absorbent (ammonia water) is formed. This solution is pumped by the pump at high pressure to the generator. Thus pump increases the pressure of the solution.

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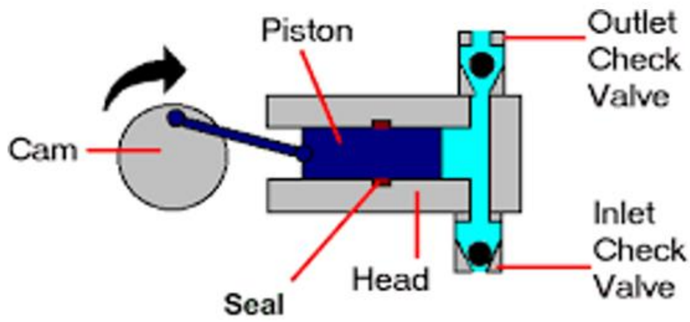
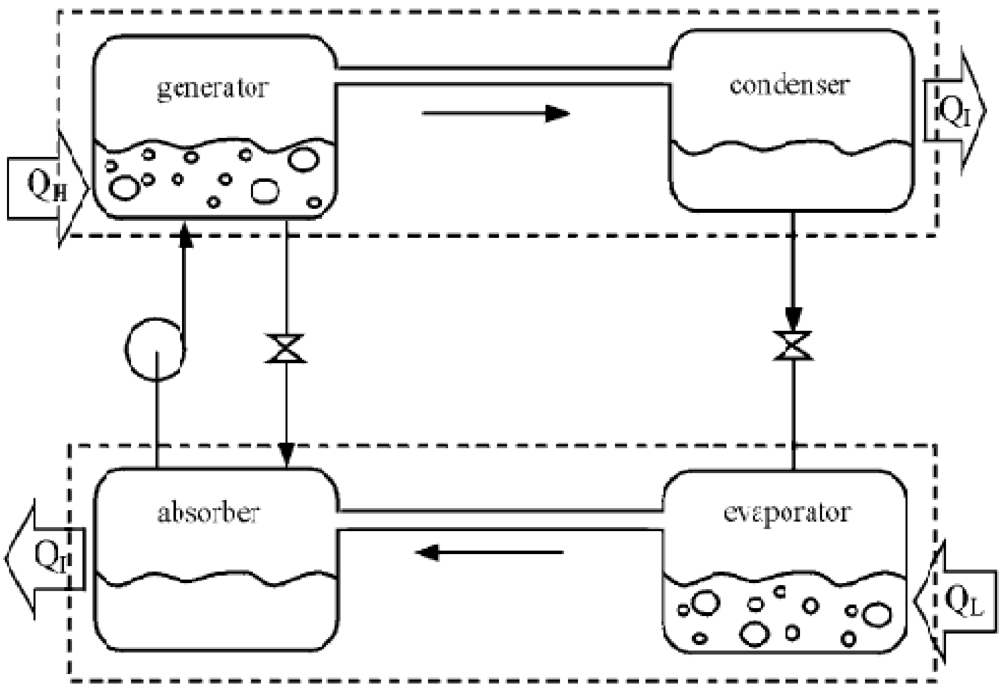


BASIC PRINCIPLE:
When a solute such as ammonia is dissolved in a solvent such as water, the boiling point of the solvent (water) is elevated. On the other hand, if the temperature of the solution (solvent + solute) is held constant, then the effect of dissolving the solute is to reduce the vapour pressure of the solvent below that of the saturation pressure of pure solvent at that temperature. If the solute itself has some vapour pressure (i.e., volatile solute) then the total pressure exerted over the solution is the sum total of the partial pressures of solute and solvent.

If the solute is non-volatile (e.g. ammonia) or if the boiling point difference between the solution and solvent is large (≥ 300 C), then the total pressure exerted over the solution will be almost equal to the vapor pressure of the solvent only.In the simplest absorption refrigeration system, refrigeration is obtained by connecting two vessels, with one vessel containing pure solvent and the other containing a solution. Since the pressure is almost equal in both the vessels at equilibrium, the temperature of the solution will be higher than that of the pure solvent. This means that if the solution is at ambient temperature, then the pure solvent will be at a temperature lower than the ambient. Hence refrigeration effect is produced at the vessel containing pure solvent due to this temperature difference.

The solvent evaporates due to heat transfer from the surroundings, flows to the vessel containing solution and is absorbed by the solution. This process is continued as long as the composition and temperature of the solution are maintained and liquid solvent is available in the container.



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Process Description:

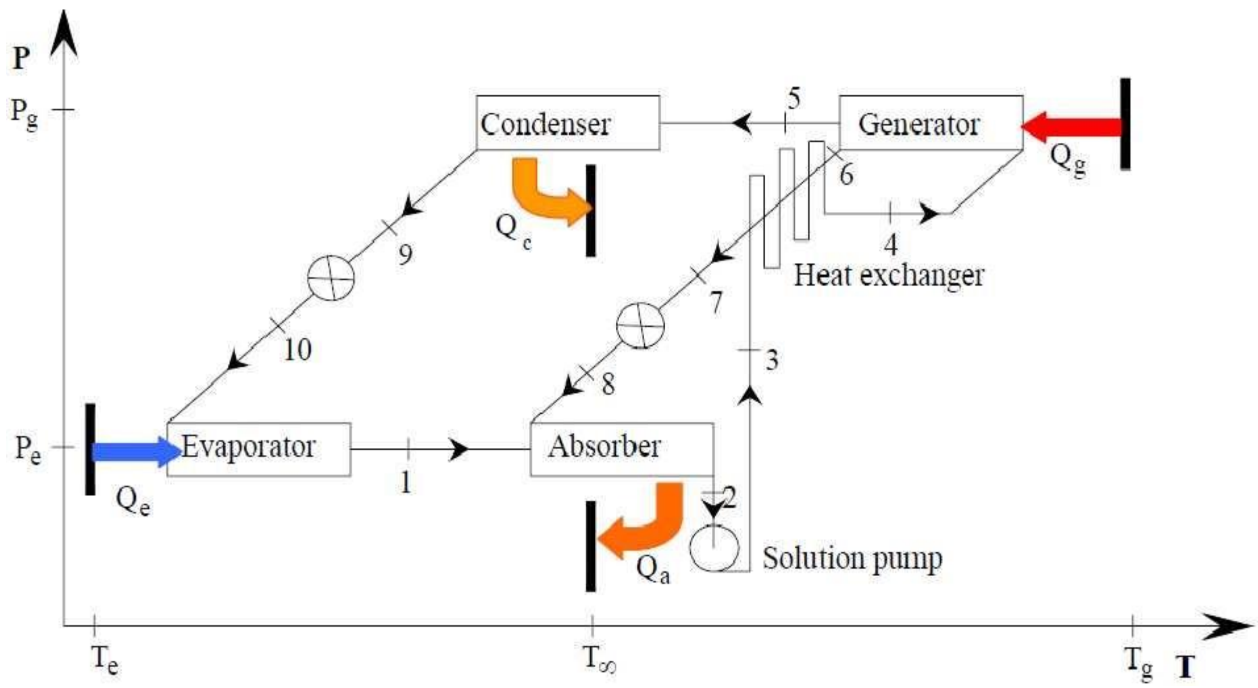

Figure shows a basic vapour absorption refrigeration system with a solution heat exchanger on a pressure Vs temperature diagram. As shown in the figure, low temperature and low pressure refrigerant vapour from evaporator at state 1 enters the absorber and is absorbed by solution weak in refrigerant (state 8). The heat of absorption (Qa) is rejected to an external heat sink at To.

The solution, rich in refrigerant (state 2) is pumped to the generator pressure (Pg) by the solution pump (state 3). The pressurized solution gets heated up sensibly as it flows through the solution heat exchanger by extracting heat from hot solution coming from generator (state 4).

Heat is supplied to this solution from an external heat source in the generator (Qg at Tg), as a result refrigerant vapour is generated (absorbent may also boil to give off vapour in case of ammonia-water systems) at state 5.

This high-pressure refrigerant vapour condenses in the condenser by rejecting heat of condensation to the external heat sink (Qc at To) and leaves the condenser as a high pressure liquid (state 9).

This high pressure refrigerant liquid is throttled in the expansion device to evaporator pressure P (state 10) from where it enters the evaporator, extracts heat from a low-temperature heat source (Q at T) and leaves the evaporator as vapor at state 1, completing a cycle.

IV. CONCLUSION

We created mathematical models and software for a double-effect reverse parallel vapour absorption refrigeration system, which may be used to build future systems. The model was validated based on available data. The program was examined for performance and ability to create design data.

The program produced equivalent results to published data in the Fundamentals Handbook (ASHRAE, 1997), with an average 20% fluctuation. Increased refrigeration resulted in higher COP. Although the COP fluctuates initially with increasing generator temperature, it gradually increases at temperatures over.

As the diluted concentration in the evaporator (x1) grew, the COP steadily climbed before decreasing as the concentration reached.

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REFERENCES

[1]. “Development of a Model for Design of Double - Effect Vapor Absorption Refrigeration Systems” m. A. Akintunde, f. H. Adedoyin , k. A. Adetoro
[2]. “Study of Ammonia Water Vapour Absorption Refrigeration Chiller Run by Thermal Energy” Ezaz Ahmad Ansari, Sohail Bux
[3]. “Design of Solar Powered Vapour Absorption Refrigeration System” Rohan Chandra, Rahul, Rahul Kumar, Prof. J.P. Kesari
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[5]. “Design and Fabrication of Vapour Absorption Refrigeration System [Libr-H20]” Mohd Aziz Ur Rahaman, Md. Abdul Raheem Junaidi, Naveed Ahmed, Mohd. Rizwan
[6]. “review paper on analysis of vapour absorption refrigeration system” Shubham Srivastava, Ravi Kumar Sen, Arpit Thakur, Manish Kumar Tated