

# Review of effect of magnetic field on diffusion absorption refrigeration cycle

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**Abstract** - Refrigeration system is one of important system in industry. In rural areas where there is no electricity, so conventional refrigeration systems are useless. With the help of magnetic enhancement of COP of diffusion absorption systems can be increased and these systems can be utilized everywhere. Absorption refrigeration system is emerging as important technology for utilization of thermal energy such as waste heat energy and solar energy. Particularly system based on ammonia water diffusion absorption refrigeration systems are very useful for developing countries due to low capital cost, low maintenance cost and unique design requirement which do not need electrical pump. Objective of this paper is to identify, summarize and review papers with enhancement of absorption process by means of magnetic field.

**Key Words**- refrigeration systems, energy, magnetic field, COP enhancement, diffusion absorption refrigeration system.

## I. INTRODUCTION

Effect of magnetic field on ammonia-water is been controversial topic but in past 2-3 decades lot of research paper proving positive effects of magnetic field on water are published. Many authors [1-7] published papers on magnetic effect on water. Initially magnetic field is used to remove scale formed in boiler and other installation where higher temperature is required but after sometime scientist observed elevation in physiochemical properties of ammonia-water.

Natural resources are depleting by extreme consumption of energy. Increase in energy is caused due to globalization. Developed and Developing countries have an opportunity to work towards achieving the goal for CO<sub>2</sub> emission limits for 2030. More than half of energy consumption in building is due for air-conditioning.

Nowadays everywhere vapour compression refrigeration are used but there are some drawbacks of vapour compression refrigeration. Some of the drawbacks are as follows:

1. Refrigerant used in these cycle have adverse effect on environment
2. It requires compressor which need large power for its operation
3. Lower COP than carnot cycle.

Due to this reason engineers are trying to find alternative technologies. Magnetic refrigeration is one of the best alternatives for this.

Air-conditioning equipments using VCC require very high electrical input as well as need of appropriate refrigerants. Both of these factors have adverse effects on environment so there is need of finding eco-friendly techniques that replace old techniques. Diffusion absorption refrigeration (DAR) has advantages in air conditioning and other places that need refrigeration. It can be driven by low grade heat resources, such as waste heat and solar energy, which is beneficial to energy saving. The working fluids in ammonia-water absorption refrigerator are not ozone-depleting substances zero ODP and very low GWP, which is helpful to the environmental conservation. Low temperature below 0°C can be attained in the diffusion absorption refrigeration system because NH<sub>3</sub> is used as refrigerant, which can satisfy varies application conditions. However, the relatively low COP has restricted more widely application of such energy saving and environmental friendly refrigeration operation.

Purpose of this paper is to review latest research paper for magnetic field on ammonia-water solution and study experiment, result and mechanisms for heat transfer enhancement

## II. EFFECT OF MAGNETIC FIELD ON AMMONIA WATER SOLUTION

In experiment [1] is which he tested the theoretical and experimental values of heat input requirement for diffusion Absorption cycle it showed that heater require nearly 5000 sec to attend the temp required for diffusion Absorption cycle. As there need so reduce temperature requirements so that temperature can be achieved, easily.

In diffusion absorption refrigeration system heat is required to separate ammonia and water solution. Due to higher heat input requirement coefficient of performance of diffusion absorption refrigeration system is less. To use diffusion absorption refrigeration cycle for industrial application and various applications it should have less heat input requirement.

In research [2] found effect of magnetic field on kinematic viscosity as well as conductivity of ammonia-water. They used magnetizer in which ammonia water solution which is placed in space where there is no magnetization so that it can be magnetized with different intensities.

Results obtained by them are as follows:

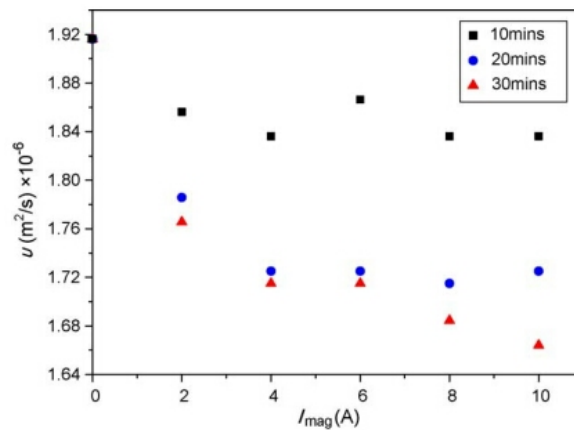


Fig A : Kinematic viscosities of the magnetized ammonia – water.

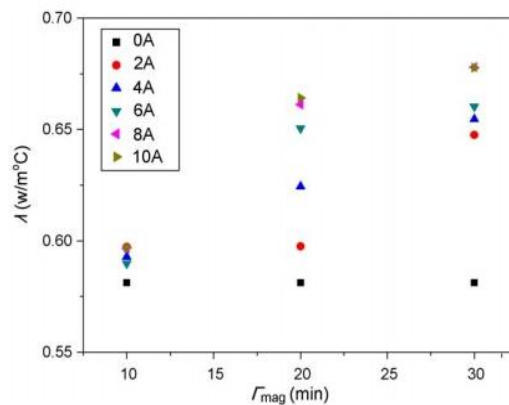


Fig. B: Variations in heat conductivity with the increase in magnetization time.

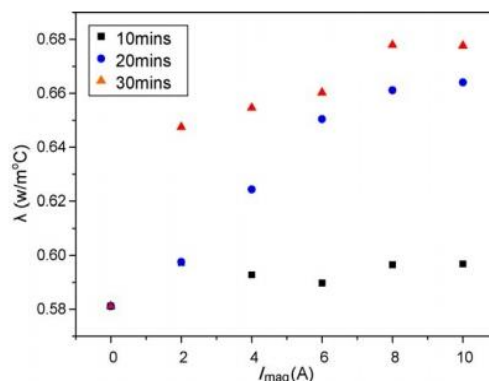


Fig. C: Variations in heat conductivity with the increase in magnetization current.

It can be seen from fig.A: [5] kinematic viscosity of magnetized water is less than that of un-magnetized water. But decrement is not uniform with increasing in magnetization of solution.

Fig. B: [5] shows increase in thermal conductivity w.r.t. Magnetization time. It can be seen that conductivity vary fewer when time of magnetization is less. In case of higher magnetization time conductivity for higher magnetization current.

Fig. C: [5] shows increase in thermal conductivity w.r.t. Magnetization current. Even for lower magnetization current and high magnetization time thermal conductivity has improved.

### III. ION MECHANISM

Magnetic effect can also be explained in terms of hydration of ions. [3] in some papers it is explained that the bond between ammonia and water is hydrogen bond. It is dynamic bond which repeatedly breaks and form it is balance reaction. Even if energy of magnetic field is not enough to break hydrogen bond between ammonia and water it is helpful dynamic action of breaking of hydrogen bond. Due to magnetic field this dynamic reaction of forming bond and breaking of bond becomes unbalanced. Power of molecules becomes less and this result into increasing mean free path of molecules So thermal conductivity of molecules increase. Force of attraction between molecules is the reason for viscosity in refrigerant breaking hydrogen bond make easy to flow molecules which result in reduction of viscosity of magnetized ammonia-water.

## IV. EFFECT OF MAGNETIC FIELD ON WATER EVAPORATION

Several papers are published showing positive effect of magnetic field on aqueous solutions. They found increase in evaporation rate which was different for different setups.

[4] study shows that the rate of evaporation for high magnetic gradient using super conducting magnet. Amount of water evaporated was different for different locations. They concluded that rate of evaporation is dependent on surface area of gas water interface.

## V. REFRIGERATION SYSTEMS

## A. Basic theory about refrigeration system

Every refrigeration system works on 2 basic laws of thermodynamics:

1. First law of thermodynamics: it tells us about energy. Energy is the important parameter for thermodynamic analysis of system. So it is very important to understand about energy. It can be stored in various forms i.e. kinetic energy, potential energy as well as internal energy of system. Energy can't be created it can only be transferred from one form to another form. (one system to one system). It is never lost during transformation from one form to other. For closed system energy can be transferred by mass and heat transfer.
2. Second law of thermodynamics: this is basic law for working of refrigeration cycle. It tells us direction of heat transfer. It states that "heat transfer take place from higher temperature to lower temperature".

## B. Diffusion absorption refrigeration cycle

System description: Principal of operation of diffusion absorption refrigeration cycle is similar to conventional absorption system but the difference is no mechanical pump is included in it. Ammonia water solution is used as refrigerant for diffusion absorption refrigeration system.

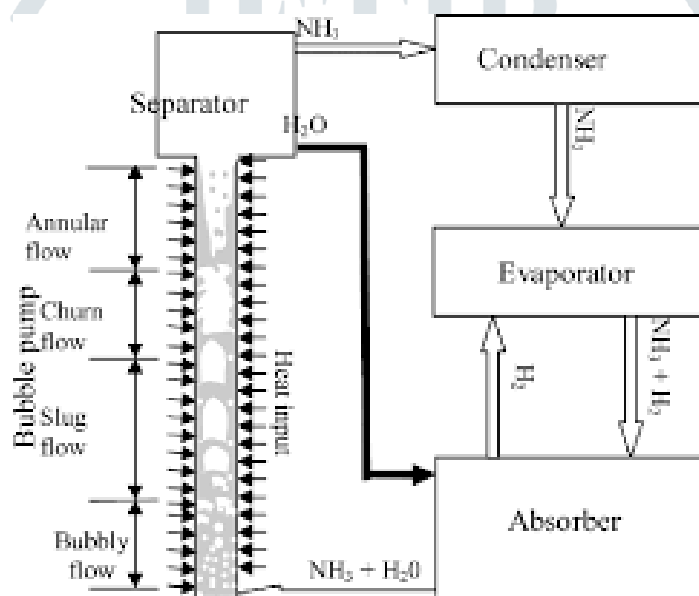


Fig. 1: Diffusion absorption refrigeration cycle

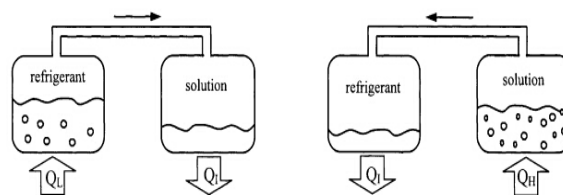


Fig.2: Absorption and cooling.andFig.3: Rrefrigerant separation

## C. Parts of diffusion absorption refrigeration cycle

1. Evaporator: In it refrigerant pure ammonia ( $\text{NH}_3$ ) in liquid state produces the cooling effect. It absorbs the heat from the substance which has to be cooled and gets evaporated. From this stage, the ammonia passes to the absorber in the gaseous state.
2. Absorber: In it the weak solution of ammonia-water is already there. The water is the absorbent in the solution. As the ammonia from evaporator enters the absorber, it is ready to by water and the strong solution of ammonia-water is formed. Absorption capacity of water to absorb ammonia is function of temperature. The process of absorption heat is liberated which can reduce the ammonia absorption capacity of water; hence the absorber is need to be cooled by cooling water. Due to absorption of ammonia in weak solution of water and ammonia strong solution of ammonia - water is formed.

3. Pump: it is used to generate high pressure solution which is further supplied to generator.
4. Generator: strong solution of ammonia and water is heated with help of source of heat. These source of heat can be waste exhaust heat, natural gas or electrical heater. After reaching some specific temperature ammonia and water solution is separated but water has strong affinity for ammonia so some water particle get carried away with ammonia so it is necessary so pass it through analyser
5. Condenser: high pressured ammonia when passes through condenser loose its heat to cooling water. Refrigerant change its phase to liquid phase.

Expansion valve: In expansion valve pressure as well as temperature of refrigerant drops. Ammonia refrigerant is finally passed on to evaporator where it will give refrigeration effect.

## VI. COMBINED EFFECT OF MAGNETIC FIELD AND DIFFUSION ABSORPTION REFRIGERATION SYSTEM

[6]The waste heat can be used in many ways and one of the best practices is to use it for vapour absorption refrigeration system. To ensure effective working of absorption cycle and making use of optimum heat, energy is the best tool for analysis for any system.

We use  $\text{NH}_3$  as refrigerant and water as absorbent is DAR cycle. This refrigerant and absorbent are stable over wide range of temperature. High amount of latent heat available for  $\text{NH}_3$  which is used to get refrigeration effect. But this system has low COP.

COP of this system can be increased by decreasing heat input requirement for this system.[7] aim of the generator is to deliver the refrigerant vapour to the rest of the system. It is done by separating refrigerant from the solution. In then generator, the solution vertically falls in horizontal tubes with high temperature source typically steam or hot water flowing through the tubes. The solution absorbs heat from the steam or water, causing the refrigerant to boil and separate from the absorbent solution. As the refrigerant is boiled away, the absorbent solution becomes more concentrated. The concentrated absorbent solution returns to the absorber and the refrigerant vapour migrates to the condenser.

If magnetic field is used in Vapour absorption cycle with other modifications like heat exchanger, analyser, rectifier etc it will give better COP. Magnetic field can be installed in generator which will reduce the heat requirement for the generator. It might also increase its thermal conductivity which will be useful in evaporator.

## VII. ADVANTAGES OVER OTHER SYSTEMS

1. Eco-friendly technique: most important advantage of diffusion absorption refrigeration system with magnetic field is that it get rids of harmful refrigerant that are used in VCC namely CFC and hydroflorocarbon. Ammonia has zero ODP and GWP.
2. High thermodynamic efficiency: it is observed that using magnetic field heat input requirement of diffusion absorption refrigeration system can be reduced which effectively increase the coefficient of performance of system
3. Silent, vibration free design: conventional VCC system has compressor which brings noise and vibration. But in DAR cycle instead of compressor there is heating unit so there is no noise or vibration.
4. Cost saving: heat input used is low grade energy such as solar energy or waste heat so its is cost saving unlike systems working on electricity.

## VIII. CONCLUSION

Review dealing with magnetic field mainly used in aspect to reduce boiling point but there is still lack of complete understanding of mechanism. But there are some papers in last few decades paper are published clearly putting forward our understanding of Field action is based on change in hydrogen bonding in cluster.

It should be noted the role of Lorentz force when field is perpendicular to ammonia-water solution due to potential gradient. Lorentz force enhances the rate of evaporation it is believed this this new results can be applied to diffusion absorption cycle. So get high COP by decreasing the heat input requirement for it. Even if temperature requirement is reduced by 50-60°C time required for heating will be less.

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