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Green Approach for Comfort Cooling In Domestic Application

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Abstract

In the present era of sustainable energy 'Green' has evolved as the buzzword, which dominates every new research and developmental work. It has compelled us to review the potential of an equally dynamic and sustainable form of comfort conditioning technology. This paper reviews the potential of vapour absorption comfort cooling method for domestic application. It thrives on the probability of using solar thermal energy as the source of power to run the VARS cycle. On the whole this paper will try to provide us with a general platform to understand the importance of cooling in present world and to appreciate the innovative efforts of scientific community towards the global concern for clean, green and sustainable technology.

Keywords: comfort, cooling, air-conditioning, absorption, solar.

Introduction

Refrigeration process can be broadly classified into *Natural Refrigeration & Artificial Refrigeration. Natural Refrigeration* is that where low temperature is achieved by using some natural medium, like natural snow. *Artificial Refrigeration, on the other hand,* was discovered only few centuries back when human civilization evolved into a more scientific and modern society. And this art of natural refrigeration turned into a comprehensive *science* of low temperatures. [2][3][12]

Modern day refrigeration technology developed on the fundamental principal of '*heat transfer through phase change or evaporation of liquids at low pressure*', enunciated by *Darwin*. The conventional method of artificial cooling used today are as follows: [2][3][12]

1. The 'vapour compression system', which transfers heat from through alternate cycle of compression and expansion. (Figure 1)

2. The 'vapour absorption system', which produces cooling effect through a thermodynamic process of phase change without using compression. (Figure 2)

Both the above mentioned systems produces cooling effect through evaporation of refrigerant at a lower pressure, but on the one hand the vapour compression system first compresses and then expands (suddenly) the refrigerant before causing evaporation, while in case of absorption system compression process is replaced by absorption-generation unit, wherein direct heat energy is utilized for producing lower temperatures, through a sequential thermodynamic phase change process

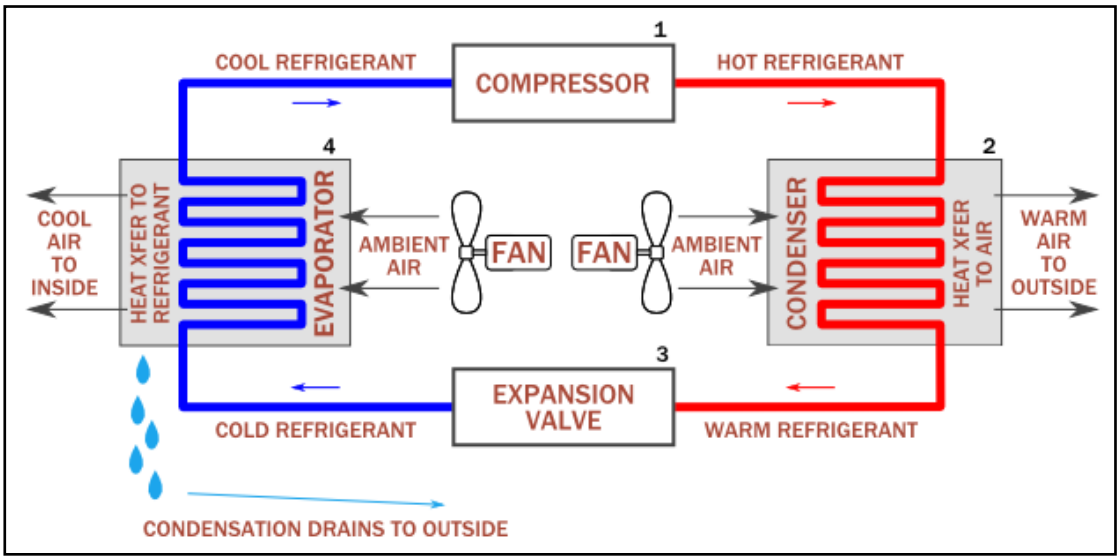

Figure 1: Line diagram of a simple conventional vapour compression refrigeration cycle. [4]

Energy concerns are rising in the developing countries like India and the scientific community is constantly looking for various avenues and alternative resources of energy or at least alternative methods of saving the energy. The run for this energy efficient system has raised many questions on wasting a large chunk of conventional sources of energy on the leisure applications like comfort conditioning systems. Therefore it's a high time to think and execute our energy conservation regime into the niche sector of comfort condition systems. Now since the comfort cooling requirement increases with the rise in atmospheric temperature, therefore this corresponding availability of increased solar insolation makes the solar powered cooling systems a potential solution for a sustainable technology. [10]

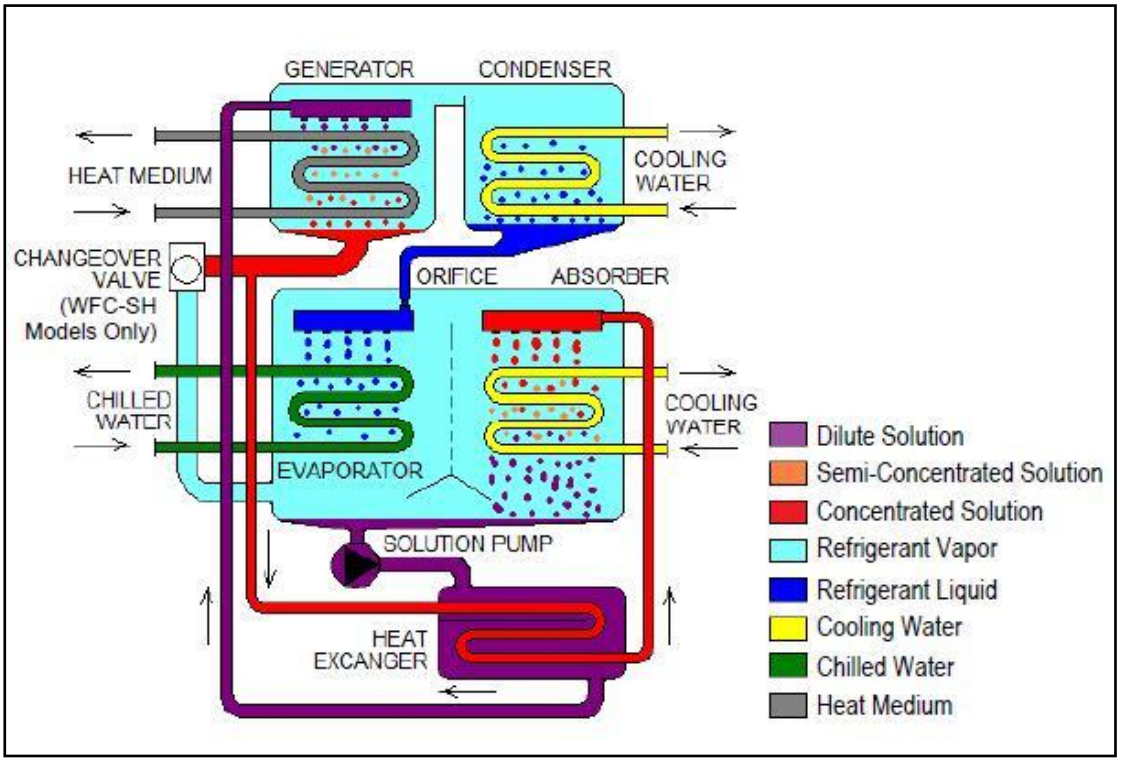

Figure 2 : Diagram of vapour absorption refrigeration system. [5]

Green cooling system

Conceptually, an absorption-refrigeration machine (Figure 2) corresponds to the vapour-compression refrigerator in which the compressor is substituted by four elements: a vapour absorber, a Pump (replacing a compressor), a generator or boiler, and a valve to recycle the absorbent liquid. Its great advantage is that this cycle requires very less work to operate the pump as compared to the energy required to run the compressor.

But the major drawback of this technology is that it requires high grade of energy (i.e. electricity) to produce and supply a low grade energy (i.e. Heat) for the Generator unit , to produce cooling effect, therefore it is suitable or commercially feasible for large commercial installations only and not for the small or domestic comfort cooling applications. [7]

This limitation of the VARS system can be targeted and efficiently met by utilizing the solar thermal energy to provide this Heat energy to the Generator unit instead of using the conventional electricity to run the system. *Solar assisted vapour absorption air-conditioning system* works on the principal of conversion of thermal energy from the sun into useful work. This is done by collecting solar radiations/thermal potential, through solar collectors and transferring it to the generator unit. The vapour absorption air-conditioning system acts as an intermediate agent, which transforms the heat energy from solar circuit into the desired refrigerating effect for the air-conditioned space. [8][9]

A workable Green comfort cooling system may consist of the following elements: (Figure 3)

1. Solar collector loop
2. Vapour absorption system ($LiBr_2 + H_2O$)
3. Air-conditioning loop

In solar collector loop, solar energy is utilized to generate very high temperature in order to heat up the working fluid (in this case, water). Solar collectors are used to collect the incident radiations of sun, and the heat is transferred to the working fluid, which is made to flow through the solar collector.

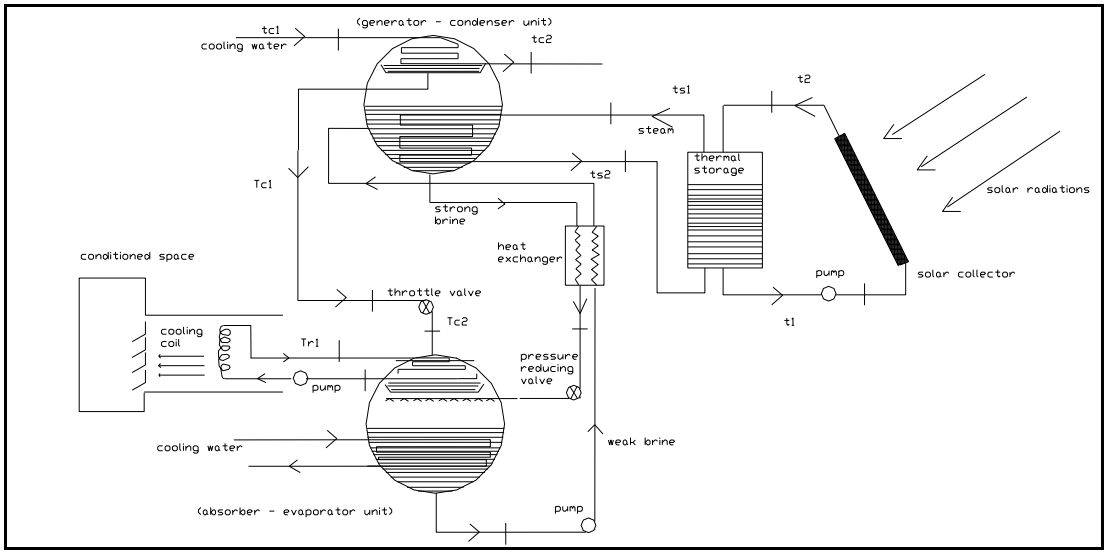

Figure 3: Schematic Diagram of a Solar Powered VARS for Domestic Comfort Cooling Application.[10]

Now the steam generated by the solar collector loop is passed through the generator unit of V.A.R.S., where the $LiBr_2 + H_2O$ solution is heated by this steam, and h_2o (refrigerant) is vaporised and reaches condenser, whereas, the remaining $libr_2$ solution is sent back to the absorber through pressure reducing valve by the use of gravity forces. The refrigerant vapours in the condenser are cooled at constant pressure to become saturated liquid (because heat carrying capacity of liquid is more than that of a gas). Now, this saturated solution of refrigerant is passed through expansion valve, where it goes through isenthalpic expansion, and its temperature is reduced to very low degree. [4][7]

Then, this low temperature liquid is passed through the evaporator (or to the air conditioner) where it absorbs heat and becomes saturated vapour. This vapour is absorbed by $libr_2$ solution due to its high affinity towards it, and again forming a $libr_2 + h_2o$ solution, which is pumped to the generator for the next cycle. In the air-conditioning loop the chilled refrigerant is used to chill the air blowing in to the room

to be air-conditioned, and this chilled air rejects its heat to the refrigerant and absorbs heat from the room. [4][7]

Conclusion

On the whole we can assume that the future of refrigeration science is safe and secured in the hands of our scientists, engineers and researchers who are continuously working towards sustainable cooling technology. The new methods of cooling like thermo-electric effect and solar assisted refrigeration system have the potential to become basis of future technology. We expect that this brief review about the potential of solar assisted vapour absorption air conditioning system will act as a guiding beam of light for the young researchers and scholars who wish to work on the promising technology for a sustainable future.

Moreover so because the cooling requirement is directly proportional to the rise in ambient temperature, which in turn is directly proportional to the solar heat gain by the solar power circuit. Therefore we are of the firm opinion that the application of solar thermal energy is most feasible, Potential and viable in the field of refrigeration and air conditioning.

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