A Review on Solar Powered Air Compression Refrigeration System for Rural Application

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Abstract:
Air compression/ pressure refrigeration system is a thermally determined innovation which uses cheap level thermal power for the operation. Air compression refrigeration system when liquid is associated to a target utilizing of an air pressurized spray gun. The air gun has a nozzle, liquid bowl and air compressor. When the trigger is pressed the liquid blends with the compressed air stream and discharged in a fine spray. In this study we reviewed status of work carried out on an air compression refrigeration system for rural application with different refrigerants and same air as a working fluid. The system works on waste air provided by the waste exhausted air from the industry and the used of this system are water chilling and conditioning air system where as the temperature of cooling isn’t low.

Keywords: Air compressor, Nozzle, Solar energy, Refrigeration system, Refrigerants.

I. INTRODUCTION

Air compressor is generally used where less air utilization and pressure is required. Refrigeration is a process of attaining and maintaining a temperature at a lower that of the environment, the purpose being to cool some item or space to the required temperatures. A conventional spray gun utilizing a compressor to supply the air, however the spray gun itself involves a lower pressure (LP). A higher volume (HV) of air is utilized to convert into a fine spray and move the liquid at lower air pressure. The outcome is a higher magnitude of liquid achieving the objective surface with decreased overspray, materials utilization, and air pollution. Now a day, the most widely utilized refrigeration systems for air-conditioning in the domestic sector and buildings are vapor compression refrigeration system. This system basically requires electrical power to create the helpful refrigeration. This is because such system must be driven by method of a mechanical compressor. Conventional VCRS system utilize electricity for there working time & use up a lot of electricity. Due to the increases of atmospheric pollutions, the thermal energy appliances are decreases and the energy charge is large, the usage in little proportion sources of energy for example, wastage air, sun oriented energy as well as geo-thermal energy in a refrigeration system. Such types of energy should be utilized to deliver the refrigerate impact in an air compression refrigeration systems. Further, the advantage of air compression refrigeration system is low working, installation as well as maintenance cost. But, the coefficient of performance of an air compression refrigeration cycle is decrease than the vapor compression refrigeration cycle. To decrease the demand of electrical energy for refrigeration application, the alternative refrigeration systems that can work by utilizing thermal energy. The Evaporator is filling up with refrigerant up to the predetermined level. Air compressor is a machine to press the air and to increase its pressure. Air compressor sucks the air from surrounding, packed it and after delivered some under the high pressure. To run the air compressor, a large number of electrical energy is needed depending upon the output pressure of air. The non-renewable resources to create electricity have become a limited, driving high energy cost. In that circumstance, the renewable sources like solar power are extremely useful and use of this technology to run air compressor is called as solar power air compressor. The high pressure refrigerant goes through the nozzle of compressor. The primary stream quickens and expands to the convergent divergent nozzle to delivered supersonic flow which makes the low pressure and increase the velocity. This fractional vacuum is made by the supersonic primary flow entrains refrigerant liquid in an evaporator. The pressure of evaporator decreases and refrigerant in an evaporator happens at the lower temperatures & at a little beat pressure. The use of air compression refrigeration system is to power the air conditioning system providing cooling in a disaster areas and Run off the waste air from the compressor to cool food and medicine. An air compression refrigeration system is a part of ejector refrigeration systems. Ejector is made up of three main components, a convergent-divergent supersonic nozzle, mixing chamber and diffuser. But I am use only one component i.e. convergent-divergent supersonic nozzle instead of ejector. Boiler is replaced by air compressor. There is a no need of condenser.

II. LITERATURE REVIEW

Aphornratana S et al. [1] have conduct an experimentally investigation of a jet refrigeration system utilizing the ejector along with a primary-nozzles are movable. There outcomes indicates the utilization of such types of a nozzle gives greater supple performance than an absolutely the geometry of ejector is fixed and raises coefficient of performance of systems.

Nalldi E et al. [2] concentrated tentatively the exhibition of super-sonic ejector with refrigerant R11 besides a great scope in blending chamber in to area of throat nozzle proportion & communicated there outcomes allow optimal outline of system. At a point when the heat source temperatures are to be known.
Sun DW et al. [3] is experimentally performed in the exhibition qualities of ejector refrigeration system. In this literature the author says that when the ejector is performed secondary flow from evaporator in choking phenomenon occurred. The choking phenomenon is a significant role in performance of ejector and the obtained guide performance of systems.

Addy AL et al. [4] advanced a single dimensionally system for the area of ejector is constant on the outside of diffuser and the author shows that theoretical outcomes achieved by utilizing these system in great retirement along with experimentally outcomes.

Table 1: This table shows performance parameter of steam jet refrigeration system.

<table>
<thead>
<tr>
<th>Name</th>
<th>Work reported</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eames and Aphornratana</td>
<td>Ejector refrigeration system utilizing an ejector with a primary nozzle is movable.</td>
<td>COP increases</td>
</tr>
<tr>
<td>Huang and Jiang</td>
<td>Secondary stream from evaporator choking phenomenon occurred.</td>
<td>COP varied between 0.59 to 0.67</td>
</tr>
</tbody>
</table>

In this table utilization of nozzle gives a more flexible operation and operation at accurate condition; however in which the jet refrigeration systems can be work, proved to be identical.

Sankarlal T [5] built up a simple ejector steam refrigeration systems works on the ammonia as a refrigerant and has examined the factor influencing the working temperatures on performance of system. According there theoretically & experimentally outcomes, great achievement on each other. The boiler temperature & evaporator temperature are increase with the coefficient of performance of system also rises as well as decrement along with the raising temperature of condenser.

Mani A et al. [6] the consequence of an analysis performed over jet system with alkali, and concluded that the entrainment ratio and coefficient of performance raise with raise expanding ratio as well as area proportion in ejector with lower the compressor ratio.

S.B. Riffat et al. [7] has introduced the effect of an examination and experimental examination of a system along with methanol. They acquired trial estimate of performance coefficient of between 0.2 and 0.4 at working conditions achievable utilizing low-grade heat such as waste heat and solar energy.

D.W. Sun et al. [8] understood a hypothetical review constructing the COP of a jet refrigeration system utilizing working liquids, for example, R123, R152a, R113, R134a, R142b, R12 and R11. The result indicates that steam jet systems have low COP values. The system utilizing R152a as a working liquid has better performance.

Roman R [9] investigation of the jet refrigeration cycle is performance with R134a operating fluid. The COP is increasing together along with the raise of the generating temperature values, the best Coefficient of Performance value being 0.178.

<table>
<thead>
<tr>
<th>Work Fluid</th>
<th>Generator Temp[°C]</th>
<th>Condenser Temp[°C]</th>
<th>Evaporator Temp[°C]</th>
<th>COP</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2O</td>
<td>95-130</td>
<td>5-15</td>
<td>25-45</td>
<td>0.05</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>CH3OH</td>
<td>80-100</td>
<td>-2-14</td>
<td>16-28</td>
<td>0.20</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>R134a</td>
<td>65-90</td>
<td>2-13</td>
<td>26-38</td>
<td>0.03</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td>R113</td>
<td>65-80</td>
<td>7-12</td>
<td>28-45</td>
<td>0.16</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>R245fa</td>
<td>90-100</td>
<td>8</td>
<td>29-38</td>
<td>0.27</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>R123</td>
<td>80-105</td>
<td>9-15</td>
<td>32-37</td>
<td>0.22</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>H2O</td>
<td>120-140</td>
<td>5-15</td>
<td>22-36</td>
<td>0.28</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.48</td>
<td></td>
</tr>
</tbody>
</table>

These table special considerations are given on the performance, working condition & working fluid. The exhibition of jet refrigeration systems efficiently dependant on the working fluids & each and every refrigerant there are suitable working times.

Huang BJ et al. [10] have built up an great performance of solar powered steam refrigeration systems utilizing single working fluid refrigerant 141b and presented single ejector refrigeration systems they got high coefficient of performance of 0.6 experimentally.

Sun, DW et al. [11] the numerical representation of atmospheric friendly in a solar energy systems. The separate sub-cycle of a compression & an ejector utilizing the two different refrigerant i.e. R134a & steam as a refrigerant. The affected outcomes indicated the improvement in coefficient of performance up to the 60% comparing the conventional VCRS systems.

Nguyen VM et al. [12] have built up refrigeration systems that system is almost powered by solar energy totally. Rather than the feeding pump in systems, to exchange the liquid from condenser to generator by utilizing heat gravity. The author resultant the created cooling systems have insignificant requirement of maintenance & this system possible for the very moderate rate of break-down as well as long life period.

Zeren, F et al. [13] considered the commercially capability of a solar powered jet refrigeration system along with the
refrigerant use of this system are R12. They decided the efficiency from a systems dependant predominantly on a beneficially of solar heating source.

**Table 3:** This table shows working conditions and performance of solar powered jet refrigeration with various temperatures & working fluids.

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Tg [°C]</th>
<th>Tc [°C]</th>
<th>Te [°C]</th>
<th>COP</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>R11,R12</td>
<td>65-100</td>
<td>15-20</td>
<td>45-50</td>
<td>0.43</td>
<td>25</td>
</tr>
<tr>
<td>H2O</td>
<td>85-95</td>
<td>5-15</td>
<td>20-40</td>
<td>0.18-0.32</td>
<td>26</td>
</tr>
<tr>
<td>R600a</td>
<td>50-65</td>
<td>5-8</td>
<td>25-35</td>
<td>0.16-0.20</td>
<td>27</td>
</tr>
<tr>
<td>R245fa</td>
<td>90-100</td>
<td>11-25</td>
<td>36-40</td>
<td>0.2-0.5</td>
<td>28</td>
</tr>
<tr>
<td>R134a</td>
<td>82-92</td>
<td>-10-0</td>
<td>32-40</td>
<td>0.035-0.20</td>
<td>29</td>
</tr>
</tbody>
</table>

Solar ejector refrigeration system are interesting systems appropriate to their naturalness, utilize of a solar power & combination of the ejector refrigeration system technologies. Disadvantages that restrict the performance of system containing the solar flat plate collector technique & the interrupt character along with solar energy. In a Solar ejector system, the COP of the ejector cycle lies between 0.1 and 0.55, where the generator temperature and COP are furthermore dependent on the collector utilized.

Gil B et al. [14] Performance & Development of an advanced steam jet ejector cooling systems for a supportable built environment. R600a was chosen as working fluid. Experimental Coefficient of Performance varied from 0.4 to 0.8 depends on working conditions. The cooling cycle is being coordinated into a solar driven.

K. Chunnanond et al.[15] Learned about components affecting the performance of ejector. Additionally the impact on one of the geometrical parameter was inspected. In the work, three geometrical components – the area proportion in between the nozzle and the constant area segment, the nozzle outlet position and constant area segment length were viewed. The hypothetical investigation was completed by a CFD model of a steam jet ejector utilizing FLUENT. The outcomes demonstrated the presence of optimal area proportion, hanging on working conditions.

T. Sankarlal et al. [16] a numerical model is produced for the jet refrigeration systems utilizing one-dimensional stream and a grading model. The created model is utilized as a part of reproducing the ejector jet cooling system for R152a and R134a to decide the enhanced performance, refrigerant and ejector geometries for the system. Properties of liquid during the stream at the segments of ejector were obtained. P. Chaiwongsa et al. [17] tentatively review the like hood of energy efficiency are improving the VCRS where a two-stage ejector replaces the extension valve. A test seat utilizing refrigerant R134a was outlined and constructed which works in both the ejector mode and in conventional mode. In jet refrigeration the primary nozzle was outfitted along with two throats, having a movable area for primary throat and a completely fix area for second throat. Test comes about demonstrated a change of 11% in the COP in ejector mode as contrasted and conventional mode.

**III. CONCLUSION**

*From the review, it is found that:*

- At any given generator, condenser and evaporator temperatures, just a single unique geometry will outcome in the largest entrainment proportion and COP of the ejector.

- Dry liquid refrigerants, for example butane,R113, iso-butane and R114, produce better performance and need less extreme energy for the superheating than isentropic liquids and wet liquids at same working temperatures.

- Jet refrigeration system is mechanically straightforward and investment costs are low. But, such refrigeration has generally low COP than the other conventional refrigeration technology.

- The area proportion between primary nozzles is a critical non-dimensional variable that influences ejector performance. The optimum area proportion relies on the refrigerant type and working conditions. The primary nozzle diameter reduces for optimum value with raising generator temperature.

**IV. REFERENCES**


[17]. P. Chaiwongsa and S. Wongwises, Experimental study on R-134a refrigeration system using a two-phase ejector as an expansion device, Applied Thermal Engineering, Vol. 28, No. 5 2008 pp. 467-477


