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Steady-State Research of the Solar-Driven Ejector Refrigeration Technique

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Abstract – The Pulse Refrigeration System, or PRS, is a heat transfer and cooling system that may be powered by solar or waste heat. The building model embodies a stack of steady volume boilers, a counter-flow shell and tube heat exchanger, an ejector and information procurement equipment and programming. The ejector trades a compressor that is typically needed in the cooling part of the cycle, diminishing energy utilization. It is a mechanically basic mechanism that empowers the blending of two streams, where the intention flow entrains and packs the lower pressure optional stream. The essential gulf to the ejector is supplied with shaky pressure beats from the boilers and the coming about flow is anticipated utilizing an expository semi enduring model actualized in MATLAB, joining genuine vapour information sub-schedules. The ejector modes of operation are researched throughout the transient highlighting the prerequisite of system valve timing so as to maximise performance.

In this research paper, the solar cooling is finished with the assistance of an ejector refrigeration system. There are two investigation in this system first one is relentless state dissection in which the performance of the system has been dissected throughout the enduring state. Thus, by doing this investigation, the outcome has been indicated for the refrigerants under the enduring state conditions. Solar Ejector Refrigeration System, Steady State Analysis.

This research paper, the solar cooling is finished with the assistance of an ejector refrigeration system. The exergy examination is utilized to confirm the different misfortunes. This paper manages the exergy examination to recognize the misfortunes and best conditions for driving such a refrigeration system. This paper likewise manages the effect of misfortunes on the performance of the system. To realize this investigation for energy and exergy is completed. The exergy investigation of a cycle distinguishes the performance of every part of the cycle.

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INTRODUCTION

Renewable energy sources give a maintainable elective to lessen carbon discharges and our reliance on fossil energizes. Different heat transfer and cooling systems that might be powered by waste heat or solar thermal energy have been created and are generally suited for regions encountering high separation levels or are off the electricity network. Compressor based refrigeration systems could be powered by solar created electricity, however the by and large efficiency is lessened because of the unnecessary energy transformation from solar, to electric, to mechanical energy. Solar cooling systems powered principally by immediate solar thermal energy is subsequently an alluring choice and enhanced performance could be realized with an increment in accessible solar radiation (Khattab and Barakat, 2002).

Various thermally driven ejector cooling systems have been examined where an ejector packs the refrigerant to the condenser pressure instead of a mechanical compressor (Meyer et al., 2009, Abdulateef et al., 2008, Eames et al., 1995), however all require a flow, or encourage pump to work. The Pulse Refrigeration System (Prs) portrayed here does not oblige an encourage pump. Rather it makes utilization of a stack of consistent volume boilers that beat refrigerant around a circle, like the Pulse Thermal Loop, or PTL (Weislogel, 2004).

The Prs configuration is at present restricted by the performance of the ejector (du Clou, 2010). Optional flow is entrained by the low pressure, high Mach number district that is framed at the outlet of the essential focalizing veering nozzle, in the suction chamber. The nozzle pressure degree (Pr), suction chamber pressure over heater pressure, expands throughout a beat because of the exhausting evaporator that sustains it, diminishing the speed profile at the nozzle passageway, restricting the entrainment. A variable geometry nozzle at the bay to the ejector might take care of this issue however the small scale and quick response time obliged is unfeasible. An improved comprehension of the transient fluid flow is needed with a specific end goal to define a suitable settled geometry ejector that will empower entrainment over a reach of driving pressures. This work presents a systematic model, actualized in Matlab, to anticipate the performance of the ejector throughout transient operation and highlights the diverse ejector working modes.

The models of the different parts of the solar-driven ejector refrigeration system, which are utilized for simulation as a part of this paper, are portrayed in this. The schematic of the system is demonstrated in Figure 1. A solar thermal collector is utilized to supply heat to the generator as a major energy source for the ejector refrigeration subsystem, by means of a thermal storage and an assistant heater. An evaporator gives cooling to the conditioned space. Hence, the cooling load is thought to be the recently presented small 150 m3 office building. Parts of every subsystem are depicted in the following segment, beginning with the model of the solar collector subsystem, followed by the ejector refrigeration subsystem, and the cooling load.

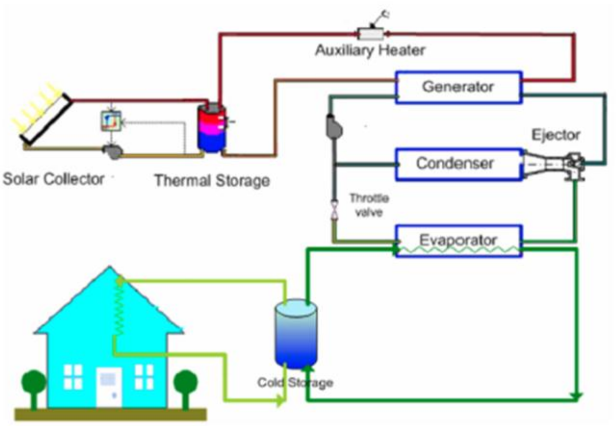

Figure 1 : A Solar Driven Ejector Refrigeration System

In this study, TRNSYS and EES simulation devices are utilized to model and investigate the performance of a solar-driven ejector refrigeration system using purported co-fathoming. TRNSYS is a transient systems simulation program with a measured structure. It is broadly utilized for the dissection of time ward systems, for example, solar systems and HVAC systems. The entire system is displayed in the TRNSYS studio and it is partitioned into 3 fundamental subsystems: solar collector subsystem, refrigeration subsystem and cooling load (building). The model of the ejector refrigeration subsystem is produced in Engineering Equations Solver, Ees (Klein, 2004), since it is suitable for cycle counts obliging great access to thermo physical lands of the working fluid.

The principal steam ejector refrigeration system was created by Maurice Leblanc in 1910 and picked up in fame for air conditioning requisitions until the development of chlorofluorocarbon refrigerants in the 1930's and their utilize 111 the vapour squeezing cycle which was a great deal more effective than elective thermally driven cycles. Research and development proceeded however and the ejector technology discovered requisitions in numerous building fields especially in the chemical and process businesses, Systems have been produced with cooling limits going from a couple of Kw to 60,000 k\v yet regardless of noteworthy development exertion the Cop of the system, which might be characterized as the proportion of the refrigeration impact to the heat enter to the evaporator, if one ignores the pump work which is generally small, is still moderately low. not exactly 0.2. Ejector refrigeration systems are most certainly not in the blink of an eye economically accessible off the rack yet various organizations spend significant time in the plan and requisition of bespoke steam ejector systems that utilize water as a refrigerant for cooling requisitions above 0 C.

To enhance the efficiency of the straightforward ejector cycle more unpredictable cycles have been examined and the incorporation of ejectors with vapour pressure and absorption systems. A sample of this is the Denso transport refrigeration system. Huge exertion has likewise been dedicated to the development of solar driven ejector refrigeration systems.

EJECTOR DESIGN

The ejector is a mechanically straightforward blending apparatus which may be dissected utilizing compressible flow hypothesis. The ejector delineated in Figure 2 is embodied the focalizing veering (CD) nozzle at the essential delta, the suction chamber lodging the optional gulf, the steady range blending chamber and the recuperation diffuser. Following compressible gas hypothesis, the flow extends isentropically and quickens through the CD nozzle to arrive at supersonic speed (process 0-e) bringing about the low pressure district in the suction chamber. The auxiliary flow is entrained (process e-1) and experiences Fabri chocking (Munday and Bagster, 1977) because of the theoretical meeting conduit framed between the essential flow stream and the ejector divider. The essential and optional flows blend throughout the consistent pressure (process 1-m). A stun wave structures in the consistent zone chamber if the ejector is working under gagged conditions (basic operation). The coming about stream recaptures pressure in the diffuser (process 2-c).

An ejector is characterized utilizing geometric proportions, pressure degrees and the entrainment degree. The entrainment proportion (ω) is the degree of the entrained optional flow rate to the essential flow rate. The ejector clamping degree (ψ) is the proportion of the packed downstream pressure to the entrained auxiliary pressure and is conversely corresponding to the entrainment degree. The entrainment degree for an ejector in the PRS is expected to be extremely low because of the clamping proportion which approaches solidarity.

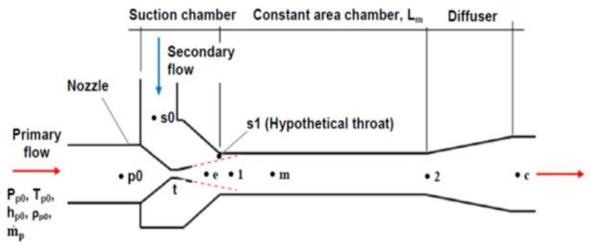

Figure 2. Ejector design schematic

EJECTOR DESIGN MODEL

The ejector plan model improved in MATLAB produces the ideal geometry for relentless state operation (steady flow rate). The model rationale is delineated in Figure 3. The code has the capacity to record for two stage flow and the fluid thermodynamic lands are referenced utilizing NIST Refprop (Ver. 7.0) subroutines. Routine requisition of the legislating mathematical statements understands the flow at every focus along the ejector pivot yielding the key extents. The non-isentropic typical stun wave is modeled by iteratively expanding the pressure over the stun wave, and uncovering the neighborhood fluid lands utilizing protection of mass and force for the control volume encompassing the stun, until the computed thickness after the stun is equivalent to or more terrific than the reference density.

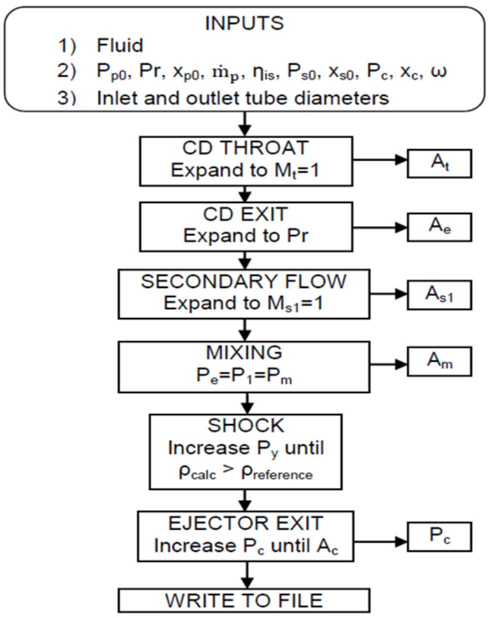

Figure 3. Design model logic diagram

EJECTOR TRANSIENT MODEL

The transient performance show unravels for the working parameters of a settled geometry ejector that is sustained by a depressurizing evaporator at first holding an altered mass. The precarious flow is thought to be semi unfaltering with the prompt flow lands being a capacity of time. At every incremental time step, an altered mass of refrigerant leaves the evaporator bringing about a decline in sustain pressure, temperature and thickness. In spite of the fact that the kettle hinder in a PRS might work at a consistent temperature, the quick blow-down lessens the pressure of the refrigerant inside the vessel speedier than thermal conduction and convection from the square to the refrigerant can happen. In this manner the border for the control volume of the fluid in the heater is recognized to be adiabatic, and it depressurizes isentropic ally.

Since the under-stretched free development wave and the over-developed stun prepare downstream of the CD nozzle can't be caught utilizing one-dimensional hypothesis, just the CD nozzle at the gulf of the ejector is modeled for the transient administration. When the flow through the nozzle is completely characterized, whatever is left of the ejector could be modeled utilizing the outline code. For an ejector to give entrainment, the CD nozzle should completely stretch the flow and keep away from diagonal and ordinary stun waves that generate entropy.

RESEARCH AND DEVELOPMENT NEEDS

To increase the attractiveness and application of ejector refrigeration systems research and development is required to:

- Increase the efficiency of steady flow ejectors particularly at operation away from the design point.
- Develop alternative ejector types, such as rot dynamic ejectors that offer potential for higher efficiencies.
- Develop ejectors that can operate with other natural refrigerants apart from water, such as CO_2 and hydrocarbons, to extend the range of applications to below 0°C.
- Research into the optimization of cycles and the integration of ejectors with conventional vapour compression and absorption systems.

CONCLUSION

Successful demonstration of the Pulse Refrigeration System relies on upon the performance of the ejector. An improved comprehension of the ejector and how it reacts to transient inputs is needed so that it will be intended to capacity optimally throughout blow down operation.

The outline and performance of an ejector for utilization under transient flow conditions is nitty gritty utilizing a two part, explanatory, two-stage model. The configuration demonstrate exactly depicts the geometry needed for unfaltering flow conditions. Distinctive enduring working parameters are encroached to attain particular ejector geometries. A chose configuration is then further researched utilizing the performance demonstrate. For an expanding pressure proportion (because of the depressurizing sustain evaporator) the flow quickly gets subsonic and brings about zero entrainment.

The performance model is additionally used to research the consequence of changing the CD nozzle geometry for a given blow down condition. A smaller CD nozzle veering passageway distance across effects in a more drawn out time of supersonic downstream flow and less stun waves. Planned effectively, an ejector that works in a transient system can give entrainment for a limited period.

The performance model was not enlarged to incorporate the blending of the transient essential and optional stream in light of the fact that the free extension wave and the sideways stun wave couldn't be modelled exactly utilizing one-dimensional hypothesis. The outcomes might be further enhanced by consolidating differed back pressure in the code as the blow down happens. The back pressure is expected to expand throughout the blow down which will bring about a diminished time of supersonic down stream flow.

With respect to all refrigeration systems, the ejector system is more proficient at high evaporating temperature; consequently a more stupendous part of solar energy might be used.

Enduring state research uncovers the aspects and performance of the generally speaking system. A couple of guidelines for picking craved working conditions can consequently be specified.

REFERENCES

ABDULATEEF, J. M., SOPIAN, K., ALGHOUL, M. A. & SULAIMAN, M. Y. (2008). Review on solar-driven ejector refrigeration technologies. Renewable and Sustainable Energy Reviews, 13, pp. 1338-1349.

K. Chunnanond, S. Aphornratana, (2004) Ejectors: applications in refrigeration technology, Renewable and Sustainable Energy Reviews 8, pp. 129– 155.

DU CLOU, S., BROOKS, M.J., BOGI, B., LEAR, W.E., SHERIF, S.A., AND KHALIL, E.E. 2010. Modeling of transient ejector performance with application to a pulse refrigeration system. International Energy Conversion Engineering Conference (IECEC). Nashville, TN: AIAA.

G. K. Alexis, (2005) Exergy analysis of ejector-refrigeration cycle using water as working fluid, Int. J. Energy Res.; 29: pp. 95–105.

EAMES, I. W., APHORNRATANA, S. & SUN, D.-W. (1995). The jet-pump cycle—A low cost refrigerator option powered by waste heat. Heat Recovery Systems and CHP, 15, pp. 711-721.

HUANG, B. J., CHANG, J. M., WANG, C. P. & PETRENKO, V. A. (1999). A 1-D analysis of ejector performance. International Journal of Refrigeration, 22, pp. 354-364.

W. Pridasawas, (2006). Solar-driven refrigeration systems with focus on the ejector cycle, PhD Thesis, Royal Institute of Technology, KTH, Sweden, ISBN 91-7178-449-7, 286 pgs.

KHATTAB, N. M. & BARAKAT, M. H. (2002). Modeling the design and performance characteristics of solar steam-jet cooling for comfort air conditioning. Solar Energy, 73, pp. 257-267.

MEYER, A. J., HARMS, T. M. & DOBSON, R. T. (2009). Steam jet ejector cooling powered by waste or solar heat. Renewable Energy, 34, pp. 297-306.

J. Yu, H. Chen, Y. Ren, Y. Li, (2006). A new ejector refrigeration system with an additional jet pump, Applied Thermal Engineering, 26, pp. 312–319.

MUNDAY, J. T. & BAGSTER, D. F. (1977). A new ejector theory applied to steam jet refrigeration. Ind. Engng Chem., Process Des. Dev., 16, pp. 442-449.

WEISLOGEL, M. M., AND BACICH, M.A. (2004). A High Performance Semi-Passive Cooling System: The Pulse Thermal Loop. In: ASME Conference Proceedings, 2004. pp. 145-154.

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