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NÜRNBERG MESSE

DAIKIN Presents GLOBAL STUDENT POSTER DESIGN COMPETITION 2018

REFCOLD INDIA
22 - 24 NOVEMBER, 2018
Mahatma Mandir Convention Cum Exhibition Centre, Gandhinagar, Gujarat

"Performance Comparison and Thermo-economic Analysis of Solar Powered NH_3-$LiNO_3$ and NH_3-H_2O Absorption Refrigeration System"

Nishant Modi[1*], Bhargav Pandya[2]

*Contact: nishant.mmtmc17@sot.pdpu.ac.in , +918460642014

[1, 2]Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, India

SOT SCHOOL OF TECHNOLOGY

Introduction

Now a days Vapour Absorption Refrigeration System is becoming more popular for refrigeration applications like cold storage, pharmaceutical clean room etc. as it is heat driven system instead of conventional compressing chillers which are work driven. Although it suffers from below issues:

$LiBr$-H_2O VAR system cannot operate below 4 °C and faces crystallization problem

NH_3-H_2O VAR system requires rectifier mechanism separately

COP is less than 1 for single effect VARS

Solution lies with the study of noncombustible and stable new alternative mixtures such as NH_3-$LiNO_3$ and NH_3-NaSCN for VAR system, as their toxicity is moderate and shows better thermal performance.

Aims & Objectives

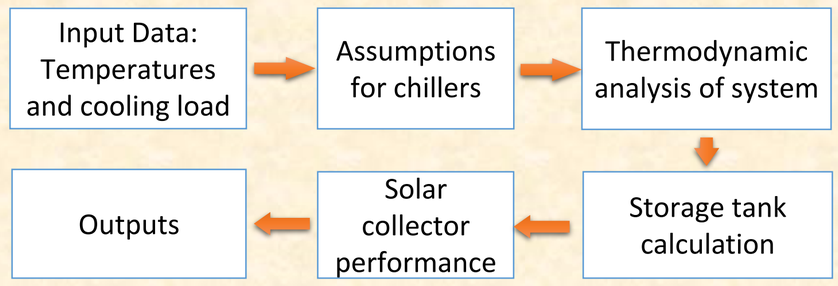
This study represents the comparison of thermodynamic performance and parametric optimization of *solar powered vapour absorption system* with working fluids as *NH_3-$LiNO_3$* and *NH_3-H_2O* for refrigeration purpose.

Evacuated tube collector (ETC) is integrated with a thermal storage tank that fuels the absorption chiller to produce *15 kW* refrigeration at *-5 °C* in evaporator.

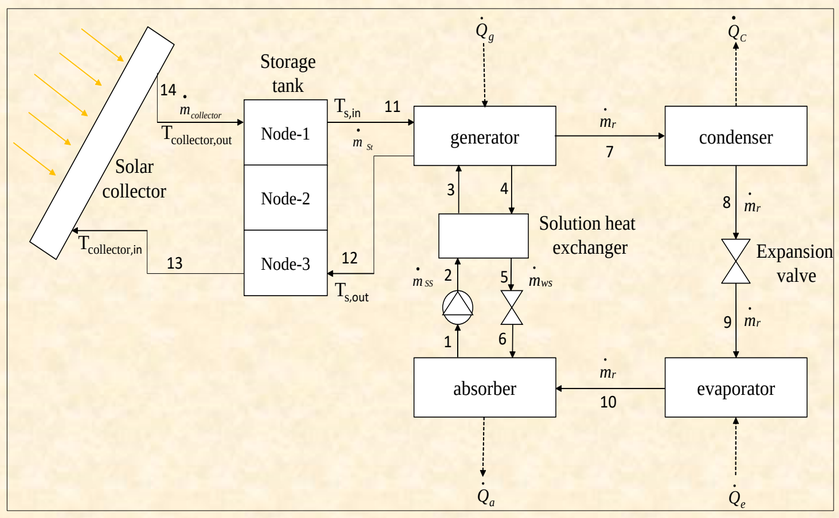
Thermodynamic performance parameters such as *Coefficient of Performance (COP), collector thermal efficiency* and *solar COP* are evaluated for both working fluid pairs.

Also, *Required solar collector area and cost* to operate the chillers are evaluated, which is the novelty of this present work.

Methodology



System Diagram



Results & Discussion

Performance Comparison of Solar Powered NH_3-$LiNO_3$ and NH_3- H_2O Absorption Refrigeration Systems

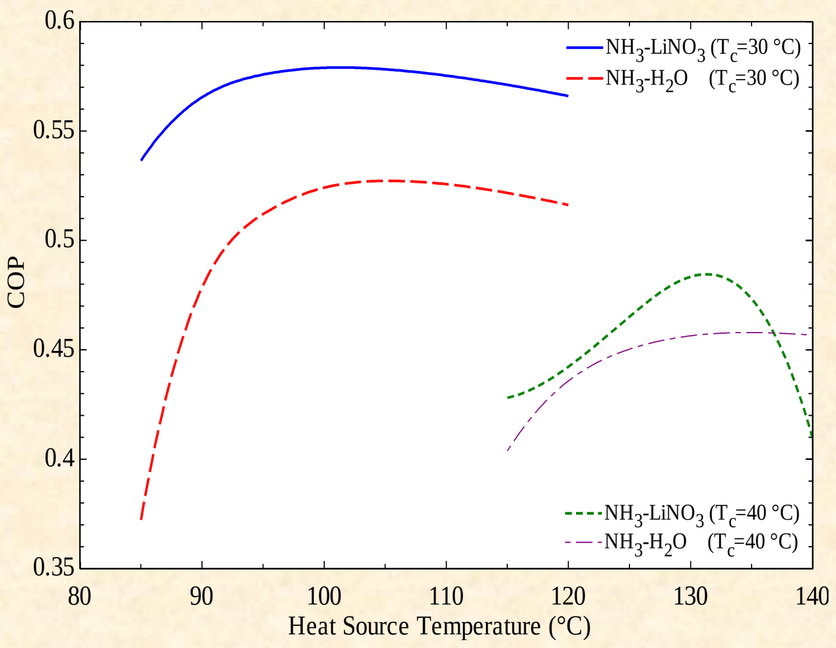


Fig. 1: Variation of COP with heat source temperature

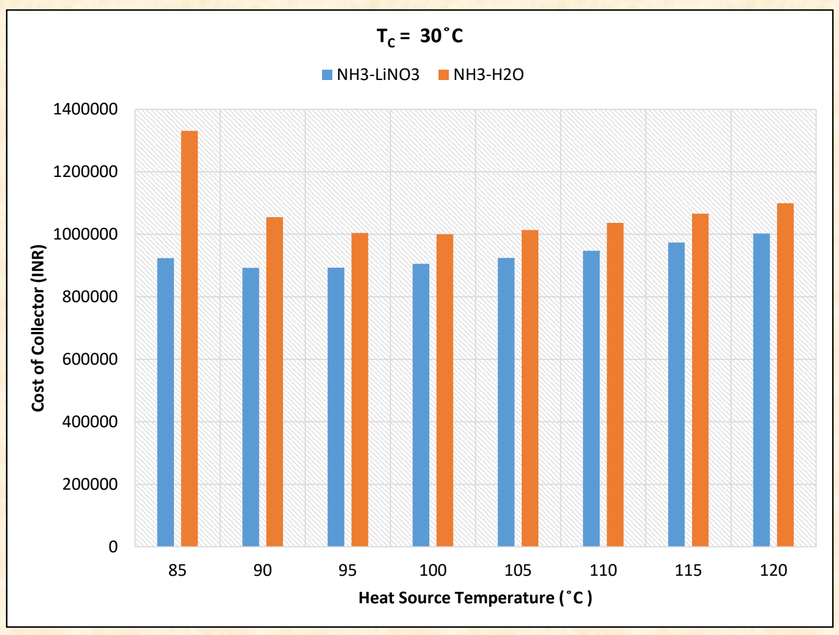


Fig. 3: Economic comparison between NH_3-$LiNO_3$ and NH_3- H_2O refrigeration system at 30˚C

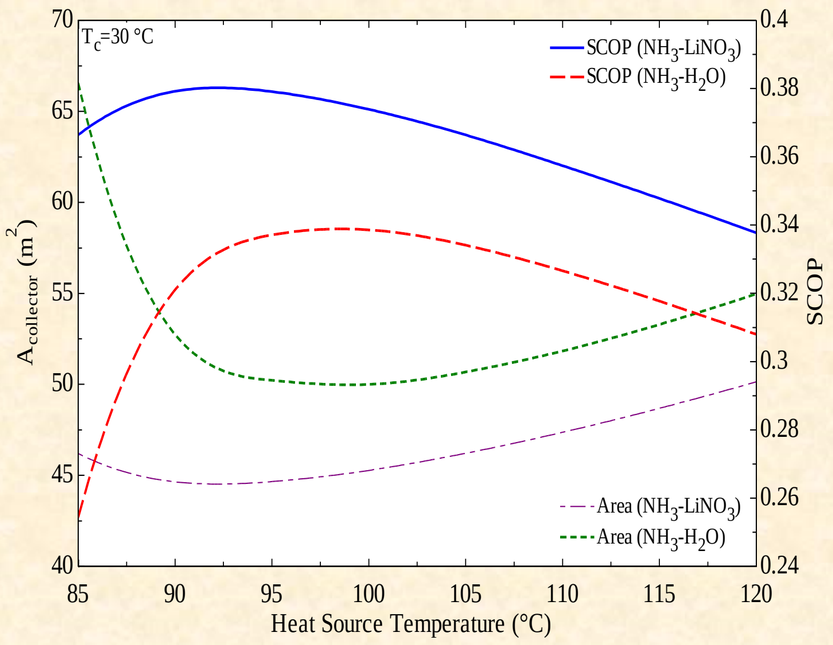


Fig. 2: Variation of Solar COP and required collector area with heat source temperature

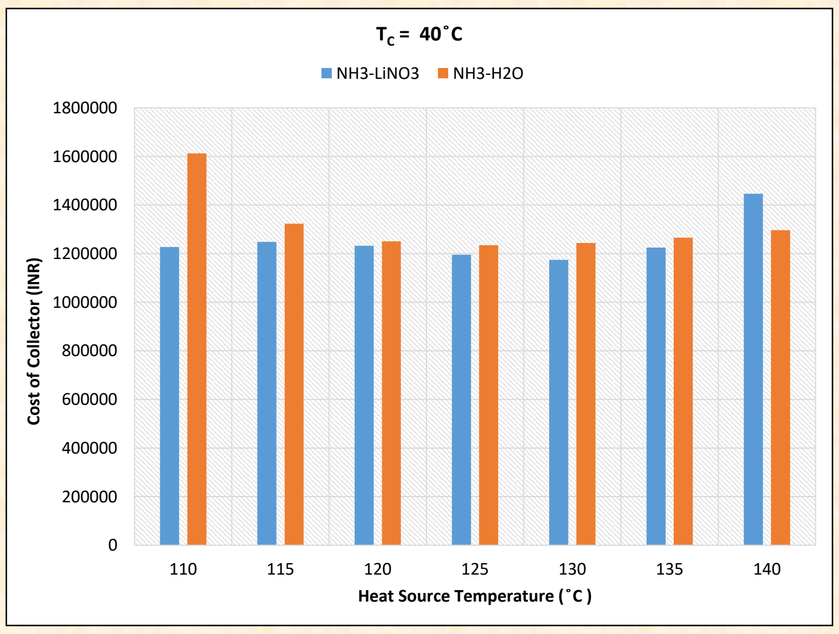


Fig. 4: Economic comparison between NH_3-$LiNO_3$ and NH_3- H_2O refrigeration system at 40˚C

References

[1]Pandya, B., Modi, N., Kumar, V., Upadhyai, R. R. and Patel, J., Performance comparison and optimal parameters evaluation of solar-NH_3–NaSCN and NH_3–$LiNO_3$ type absorption cooling system. *Journal of Thermal Analysis and Calorimetry*, pp.1-16.

[2]Pandya, B., Kumar, V., Matawala, V. and Patel, J., 2018. Thermal comparison and multi-objective optimization of single-stage aqua-ammonia absorption cooling system powered by different solar collectors. *Journal of Thermal Analysis and Calorimetry*, pp.1-14.

Conclusion

Higher COP, higher Solar COP and *lower collector area* have been obtained for *NH_3-$LiNO_3$* pair compared to NH_3-H_2O pair under identical ambient conditions.

Maximum solar COP of *NH_3-$LiNO_3$* is found *12 % higher* compared to NH_3- H_2O pair at *30˚C condenser temperature*.

Solar *collector cost* of *NH_3-$LiNO_3$* pair is found *24 % lower* in comparison with NH_3-H_2O pair, which illustrates that ***NH_3-$LiNO_3$*** pair system is more economical than traditional pair.

Acknowledgement

❖ Authors are grateful to **Dr. Jatin Patel**, Asst. Professor, Mechanical Engineering Department, PDPU, Gandhinagar for their valuable guidance.

Contact: Jatin.Patel@spt.pdpu.ac.in
+919428415422