

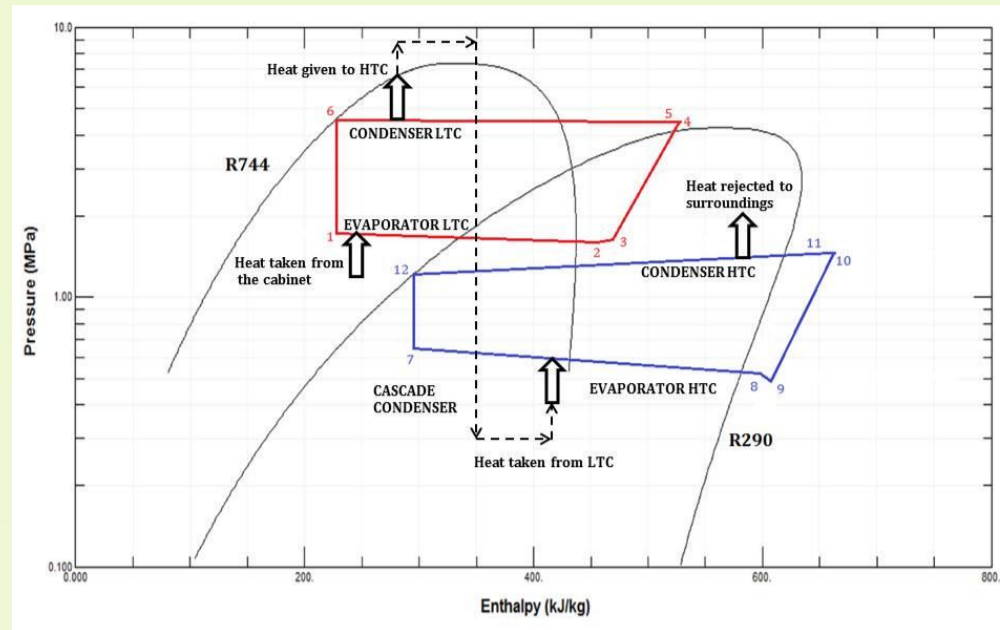
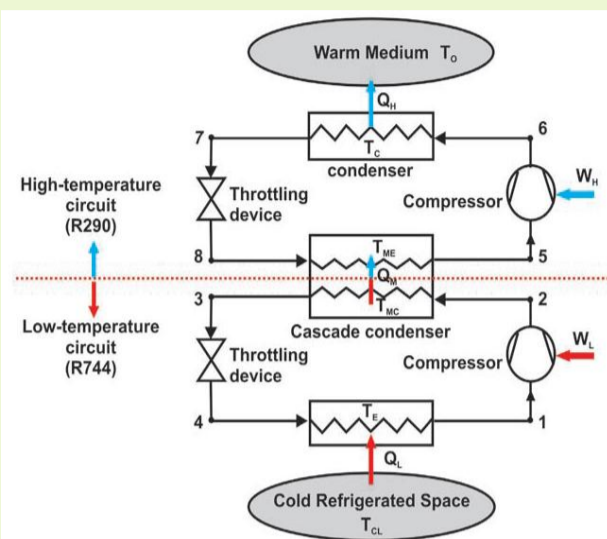
# Performance study of Cascade Refrigeration system using natural refrigerants (R290-R744)

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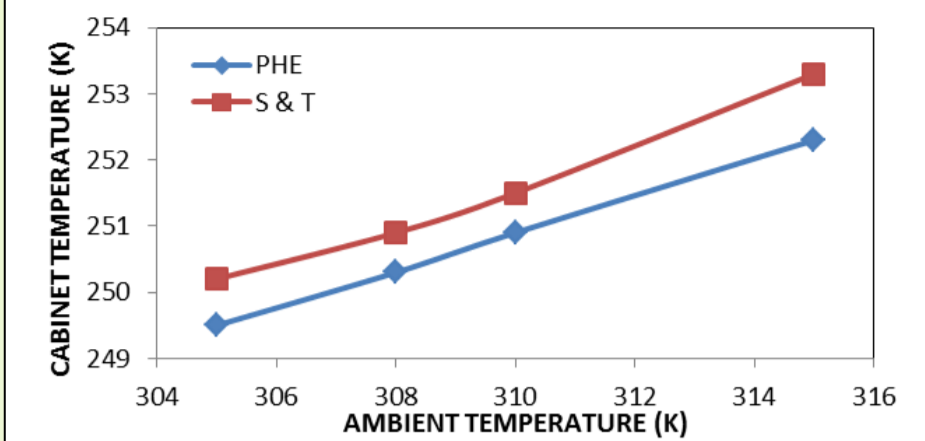
## Background

### Cascade Refrigeration

- Low temperature refrigeration in the range(-30°C to -100°C)
- Higher efficiency than single and multi-stage systems
- Employing optimal refrigerants for temperature ranges used

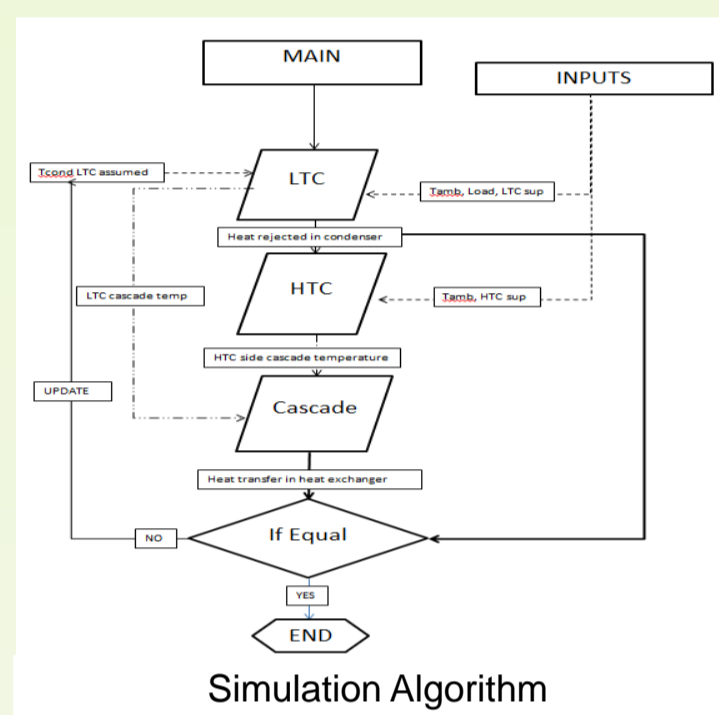


### Effect of change in ambient on cabinet temperature



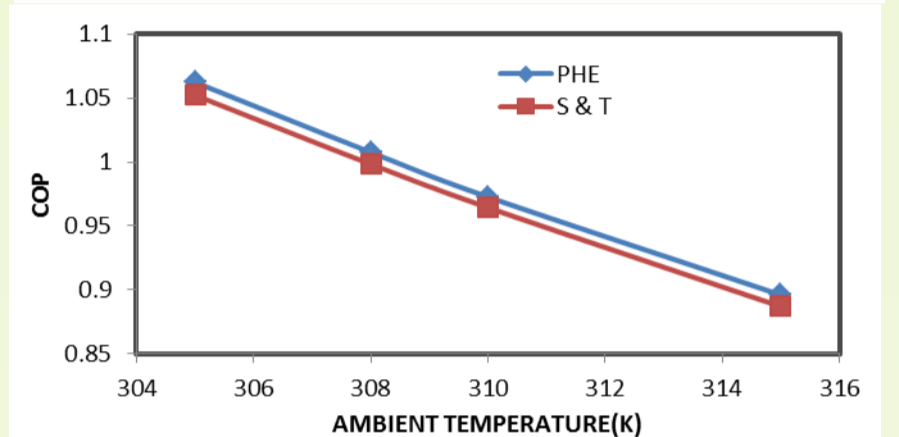
On higher ambient temperatures the separation between the two curves widens. The influence of ambient temperature in case of Shell-tube HE progressively gets more pronounced as compared to PHE suggesting an advantage of PHE.

## Simulation Algorithm



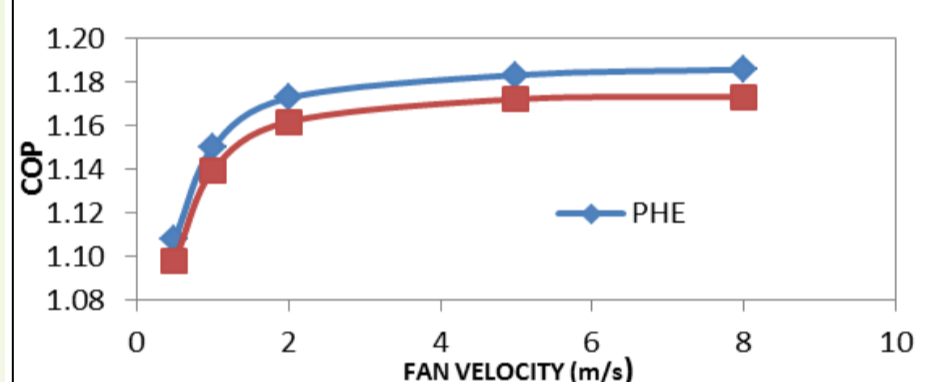
- Using MATLAB
- Use of minimum assumptions

### Effect of change in ambient temperature on COP



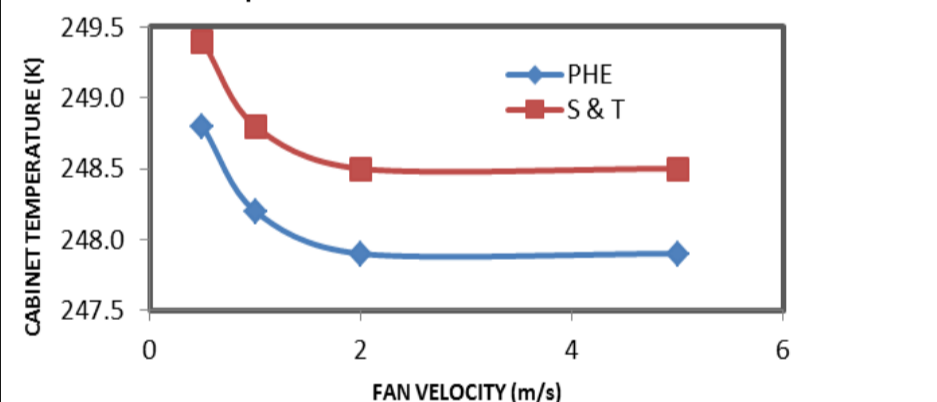
Similar behavior by both heat exchangers

### Effect of change in condenser fan velocity on COP

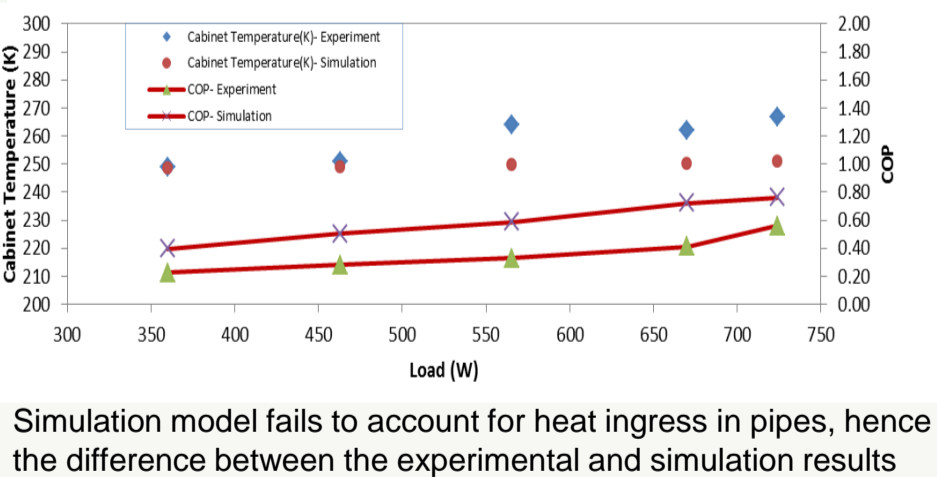


At higher velocities the outer surface temperature becomes ambient and hence no effect of further increase in velocity

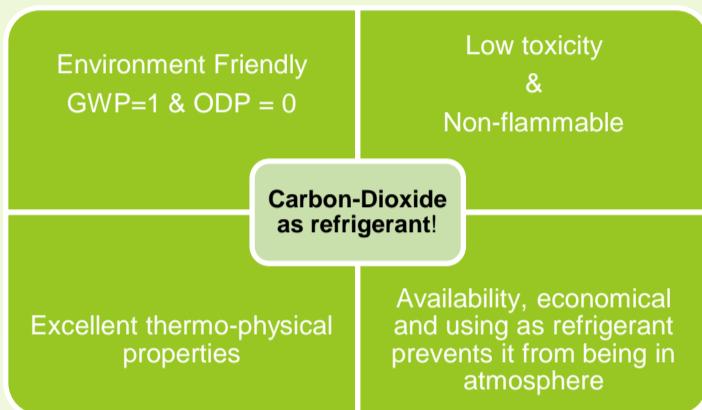
### Effect of change in condenser fan velocity on Cabinet Temperature



### Comparison of experimental and simulation results



Simulation model fails to account for heat ingress in pipes, hence the difference between the experimental and simulation results



## Objectives

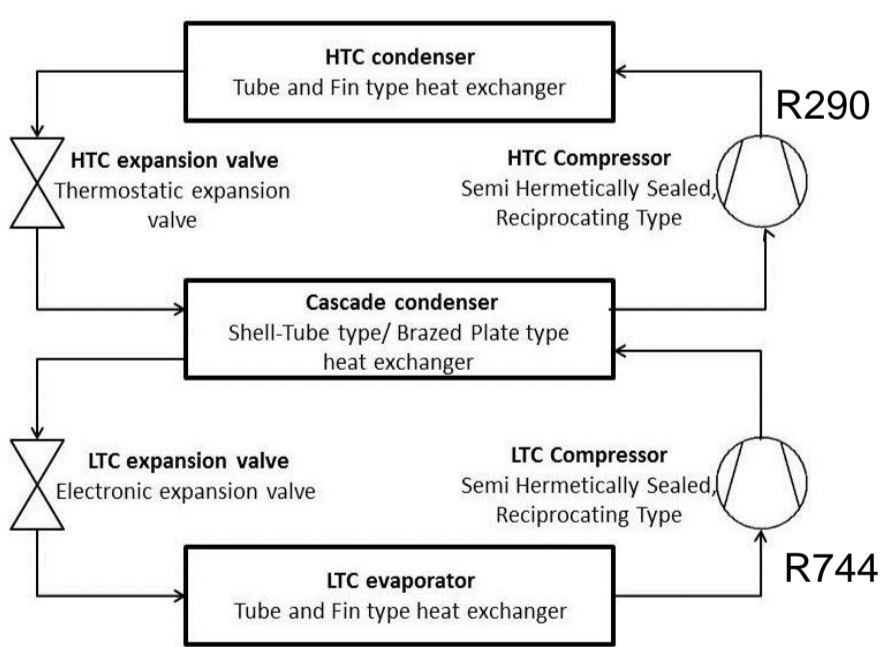
- Experimental Performance dependence of Cascade refrigeration system on following parameters
  - Ambient Temperature,
  - evaporator temperature, and
  - Cascade temperature
- Performance Simulation and comparison for 2 different types of heat exchangers



Shell-tube Heat exchanger

Brazed plate Heat exchanger

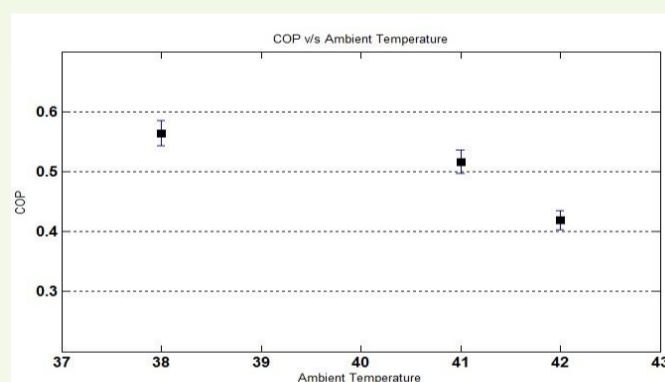
## Experimentation



Schematic of experimental setup

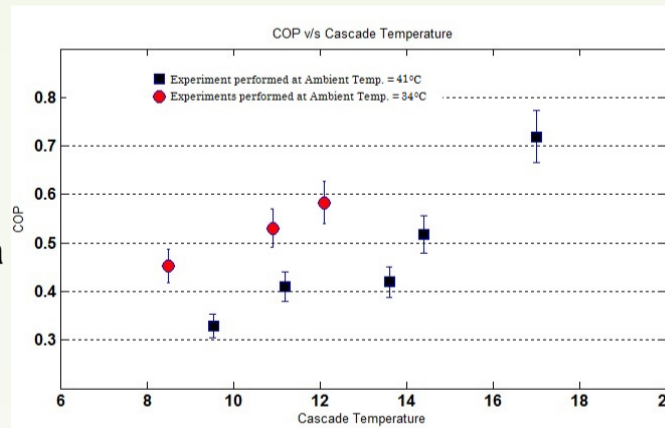
### Effect of Ambient temperature:

Experiments performed during summers when the ambient temperatures are high



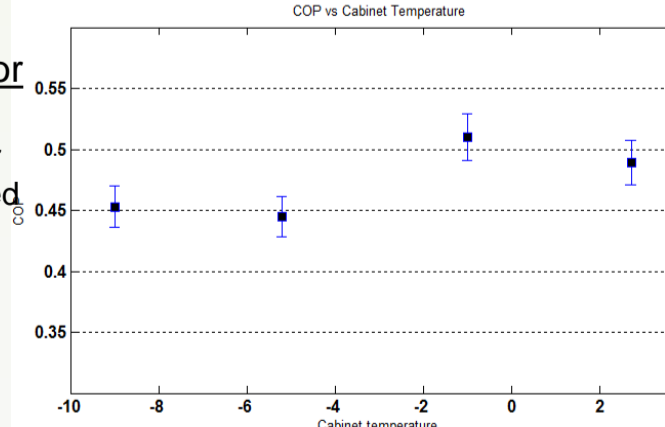
### Effect of Cascade temperature:

Change of cascade temperature has a significant effect on the COP of the system



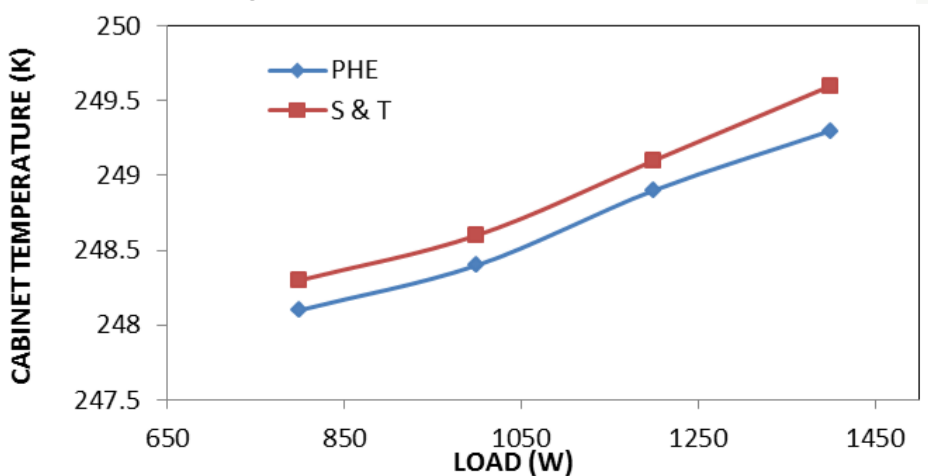
### Effect of Evaporator temperature:

Change in evaporator temperature is coupled with the effect of change in optimum cascade temperature oppositely



### SIMULATION RESULTS: comparison between Shell-tube and Brazed plate heat exchanger

#### Effect of change in load on cabinet temperature



Lower cabinet temperatures are observed for plate heat exchanger than shell-tube heat exchanger

## Conclusion

- Cascade temperature has a significant effect on the performance of system
- Experimental performance closely follows the simulation results.
- it is possible to achieve lower cabinet temperatures with Plate heat exchanger as compared Shell-Tube heat exchanger for the same heat transfer area for different load and ambient temperature conditions.

