An Experimental Comparison of the Refrigerant Flow along Adiabatic and Non-adiabatic Coiled Capillary Tubes

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Main topics of presentation

- Introduction
- Experimental setup
- Results and discussions
- Conclusion

Functions of expansion devices

- **Reduces down stream pressure of condenser to up stream pressure of evaporator**

- **Regulate mass flow rate of refrigerant**

Expansion device classification

(Refrigerant flow control devices)

- *Fixed Restriction Area*
- *Variable Restriction Area*

Expansion device classification

(Refrigerant flow control devices)

- *Variable Restriction Area*

- **Thermostatic Expansion Valve (TXV)**
- **Automatic Expansion Valve (AEV)**
- **Hand Expansion Valves**
- **Electronic Expansion Valve (EEV)**
- **…**

Expansion device classification

(Refrigerant flow control devices)

- *Fixed Restriction Area*

- **Long Capillary Tubes** | - Straight - Coiled **And** | - Adiabatic - Non-adiabatic

  → Adiabatic

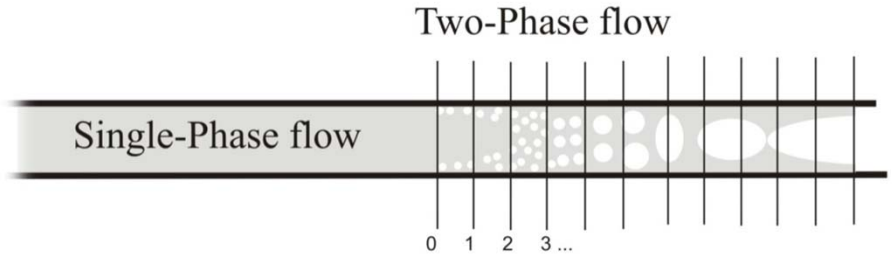
- **Short Orifices**

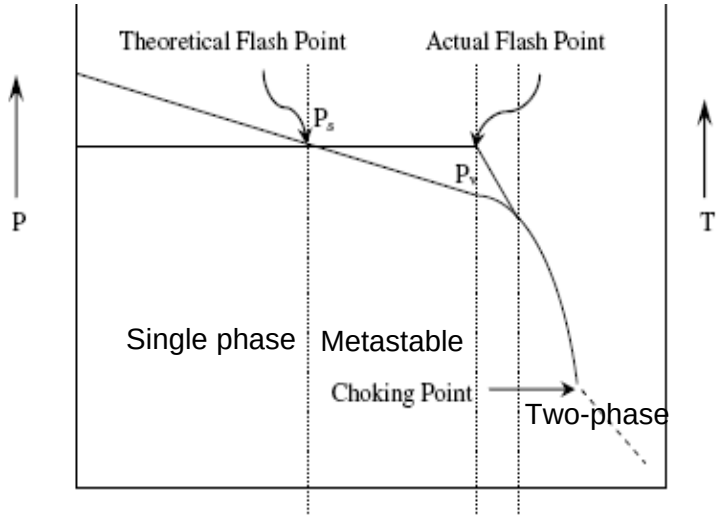
Comparison

- Expansion tubes: More durable and simpler

- Expansion Valves: Compatible with wide range of operating condition

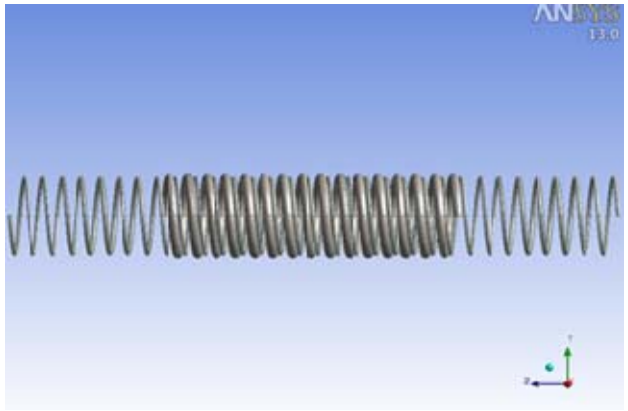
Flow Pattern Through Capillary Tube

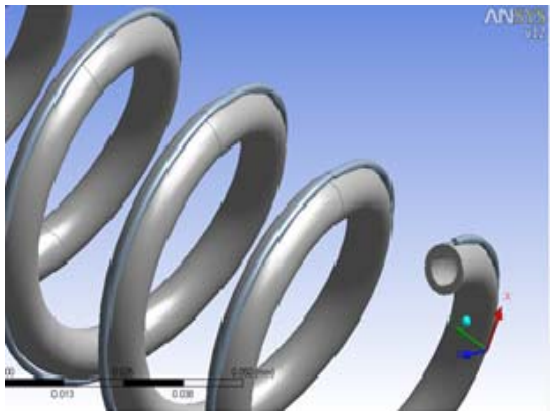




Objectives of Experiment

- Effect of heat transfer on length of metastable region by :
- Soldering a suction line with counter flow to the coiled capillary tube to cool the flow
- Using discharged vapor from evaporator



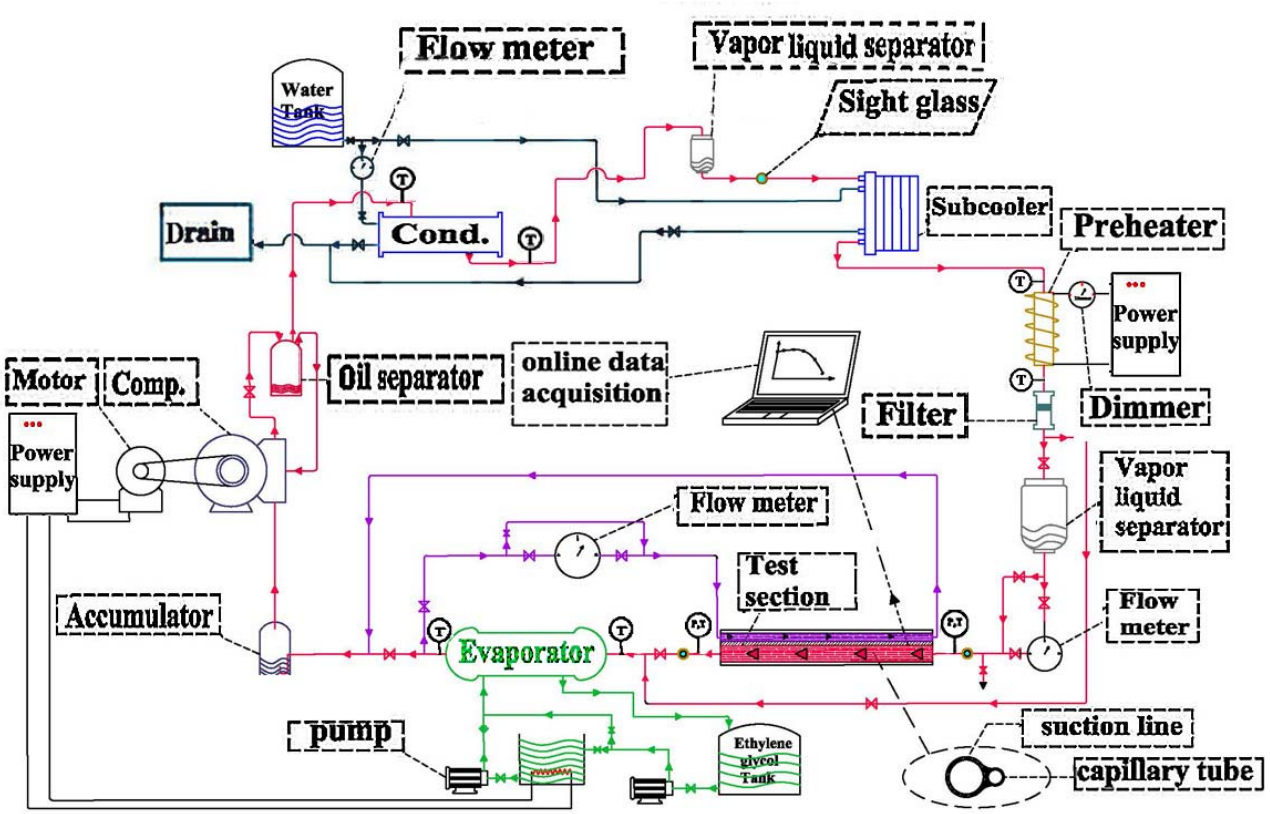


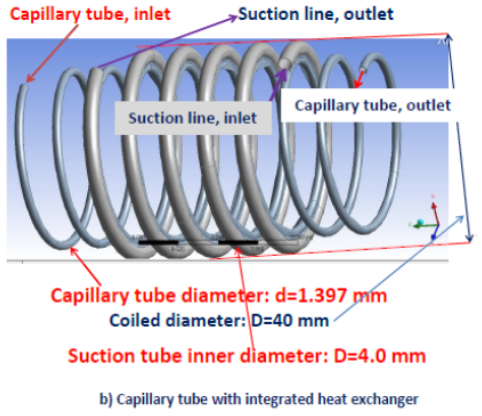
Objectives of Experiment

- Effect of mass flux ratio on length of meta-stable region and inception of flashing point through coiled tubes
- Mass flux ratio:

$$R = \frac{G_{capillary}}{G_{suction}}$$

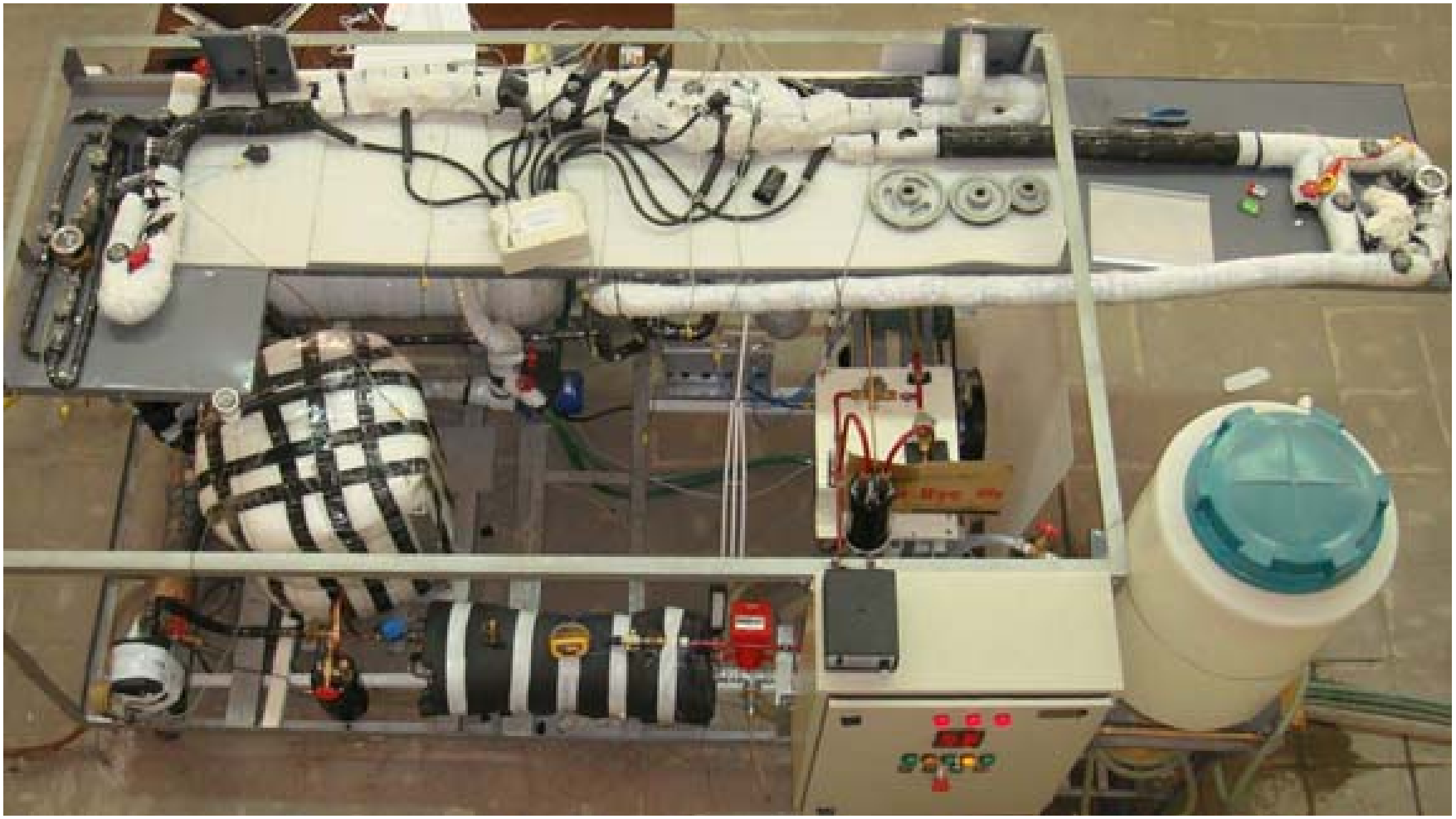
Experimental setup





b) Capillary tube with integrated heat exchanger

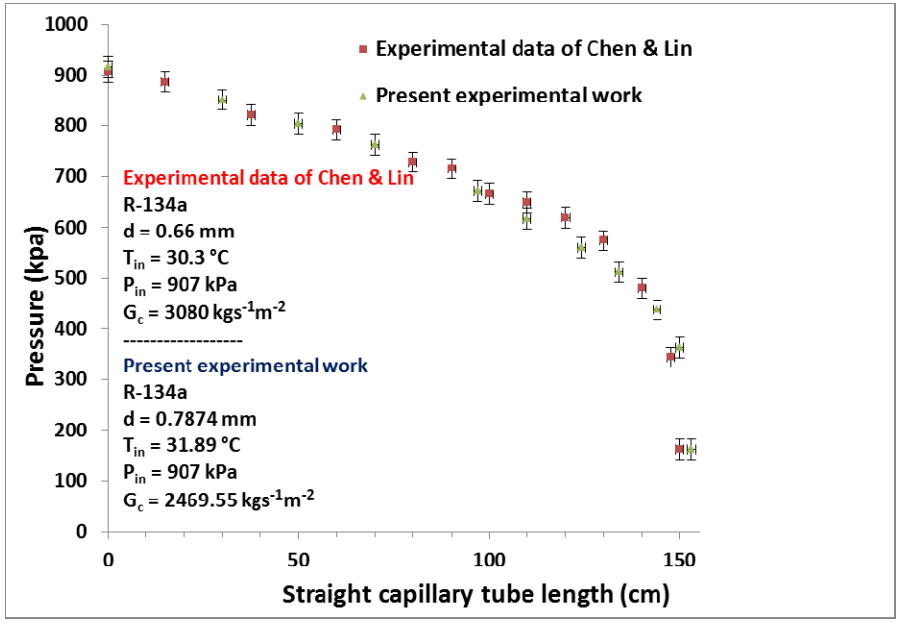
Experimental setup

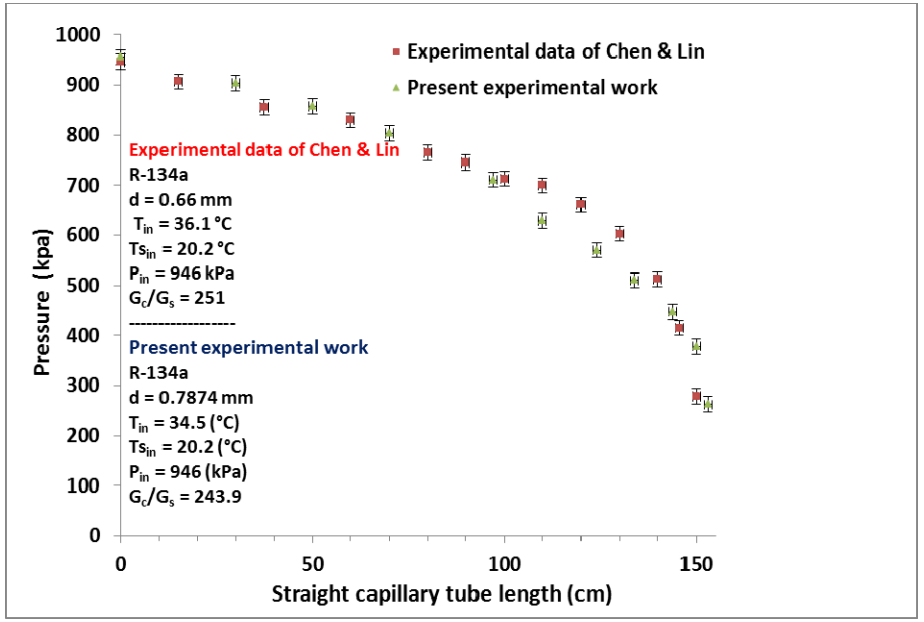


Results:

Validation with published data

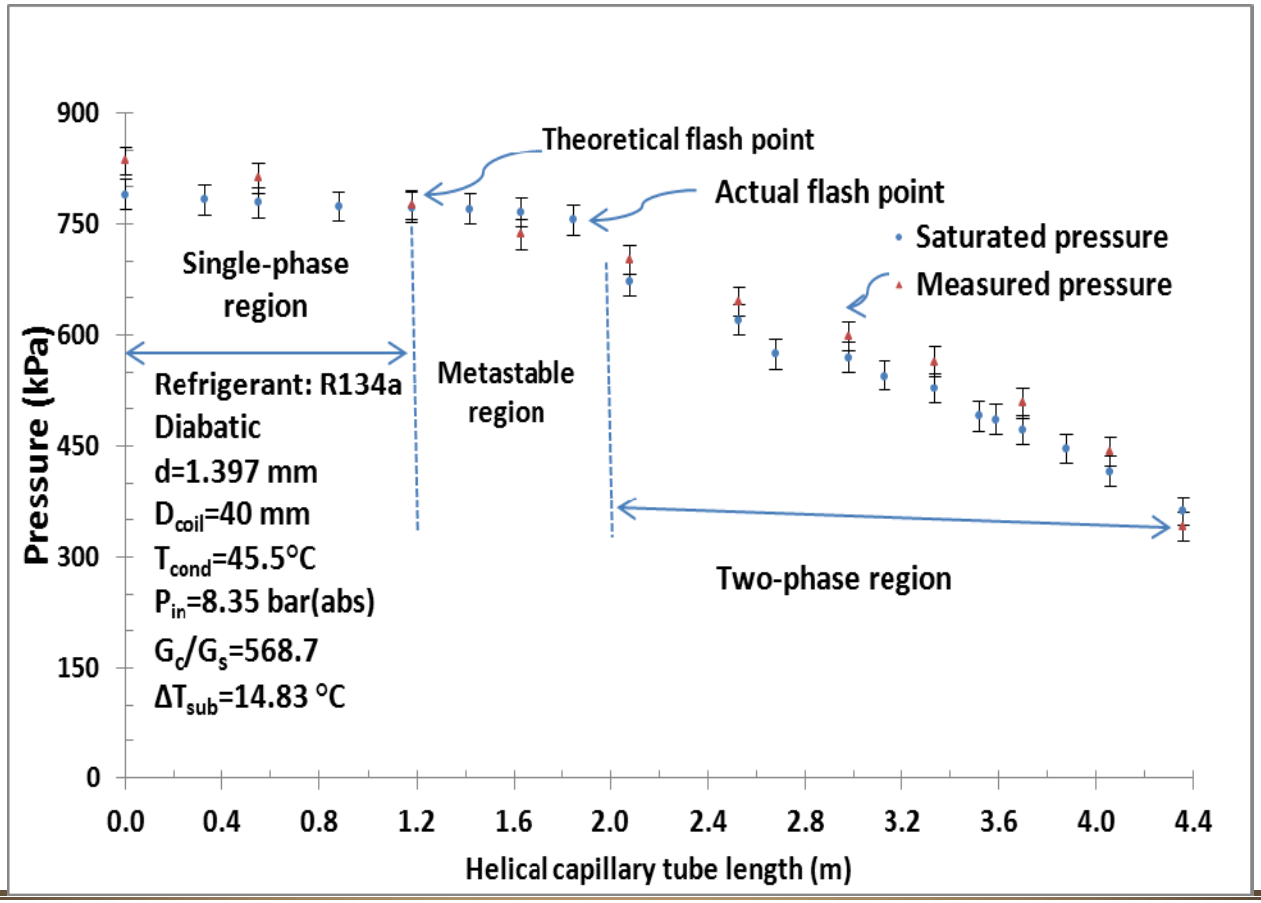
(Chen and Lin, 2001)





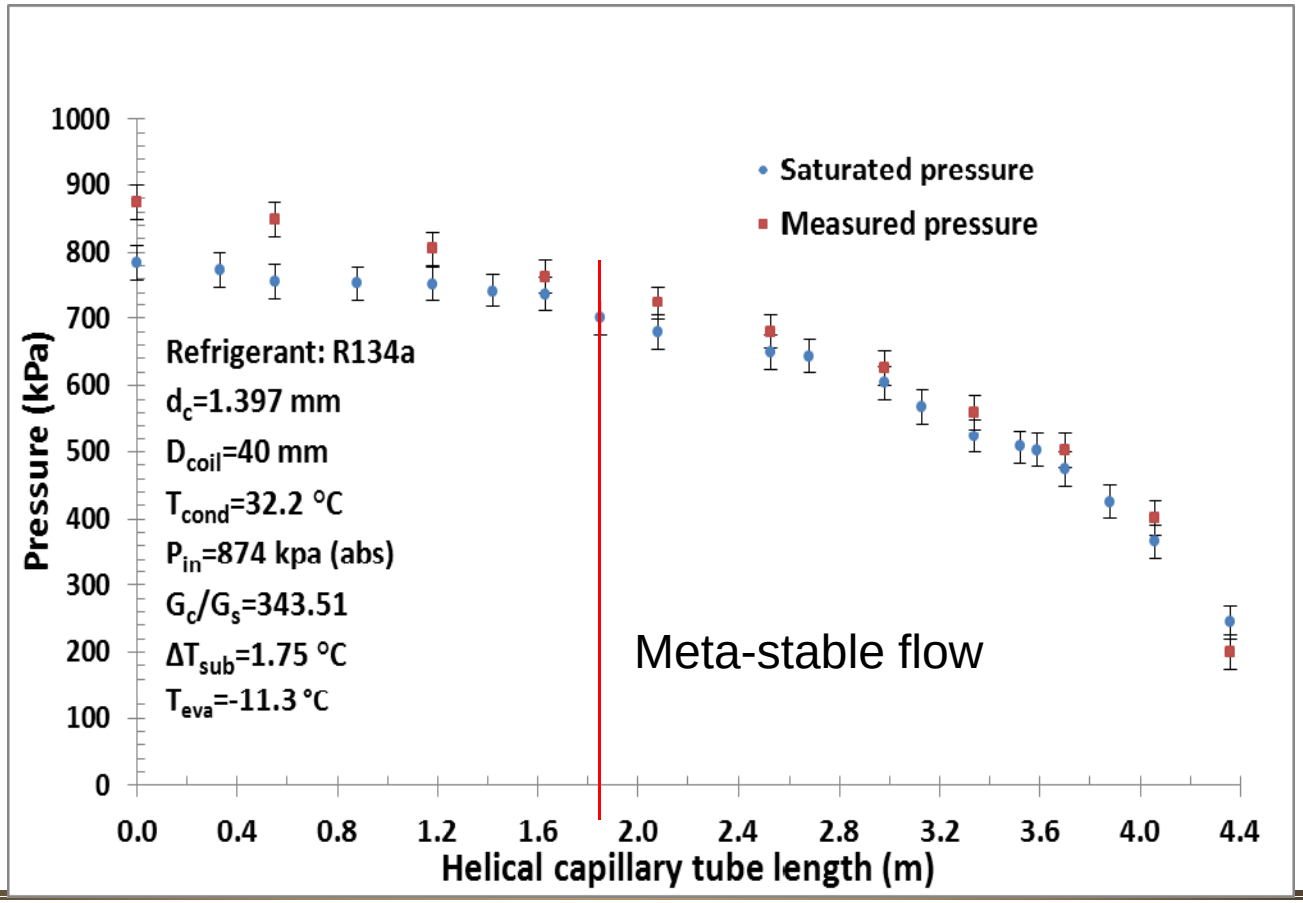
Results:

Flash point position on adiabatic flow for mass flux ratio=568



Results:

Flash point position on adiabatic flow for mass flux ratio=343



CONCLUSIONS

1. Experimental study was presented for R134a flow through both non-adiabatic and adiabatic coiled capillary tubes
2. Maximum error of 9.5% between present and previously published data
3. Increase of heat transfer rate by decrease of the mass flux ratio in non-adiabatic condition
4. Weak heat transfer rate and metastable phenomena occurrence in mass flux ratio greater than 343
5. The present model can be used as a suitable tool for design and optimization of the vapor compression refrigeration systems (VCRS) with helical capillary tubes

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Thank you for your attention