Opponent's Assessment of the Doctoral Thesis

Programme of Study:
P3710 Technique and Technology in Transport and Communications
Branch of Study:
3706V005 - Transport Means and Infrastructure

Supervisors:
doc. Ing. Petr Tomek, Ph.D.
University of Pardubice, Faculty of Transport Engineering

Supervisor specialist:
RNDr. Mgr. V´aclav M´acha , Ph.D.
Institute of Mathematics of the Czech Academy of Sciences.

Dissertation Title:
CFD model of vehicle condenser

Oponent:
doc. Ing. Jan Novotný Ph.D.
opponent's affiliation: FSI UJEP

General Summary of the Submitted Thesis

This doctoral thesis focuses on a comprehensive study of heat transfer modeling in automotive air conditioning condensers and its measurement, with the aim of improving the accuracy of AC condenser models used in 3D fluid flow simulations. The primary objective was to create a model capable of predicting local heat transfer between the refrigerant and cooling air with enhanced accuracy, which should positively impact the accuracy of air flow simulations and improve temperature and performance predictions for other vehicle components, including the cooling system, cooling fluid, and oil.

One of the main contributions of this work was the creation of a model that directly uses measured overall heat transfer coefficients instead of relying on literature data or separately measured convective/condensation heat transfer coefficients. This method allows for greater generality while reducing the need for input information. These innovations served as the foundation for a model that could better predict local refrigerant and air temperatures, leading to improved air flow simulation accuracy and better results for other vehicle components.

A significant part of this work was the design and implementation of a measurement system to gather the necessary parameters from the condenser. This experimental aspect of the work is a substantial contribution to the field, and its results are invaluable for further analysis. The results demonstrated the sensitivity of the model to the prescribed heat dissipation and the need for further investigation in future research. Improved agreement with measured data was

achieved by reducing the prescribed heat dissipation, particularly for the refrigerant inlet temperatures.

Overall, it can be concluded that this doctoral thesis has made a significant contribution to the modeling and measurement of heat transfer in AC condensers, with the potential for successful industrial applications. The results have provided valuable insights and contributed to improving the accuracy of condenser modeling in fluid flow simulations, which has the potential to enhance the efficiency and performance of cooling systems in the automotive industry.

Language and Presentation:

The graphical and linguistic quality of the submitted doctoral thesis is very good. The work contains well-prepared diagrams, images, and graphs. The thesis is logically structured, and the individual chapters are interconnected. However, there are some minor graphical errors in the work: the photographic documentation of the test bench is insufficient (Fig. 23), Fig. 11 and 17 deserve revision, and there is a typographical error on Fig. 20. Nevertheless, these are minor issues.

Thesis Oral Defense Questions

1. What influenced the non-uniform velocity profile at the condenser inlet, and how do you propose to eliminate this non-uniformity in future work?
2. How do you explain the temperature differences at the condenser inlet?
3. A comparison of numerical simulations and experiments reveals a difference in identifying the superheated vapor region in the condenser. CFD shows a clearly rectangular area, while the thermographic image identifies a triangular area. Can you explain this difference?

Conclusion

All the stated objectives in the doctoral thesis have been successfully met, and I highly appreciate the integration of experimental and numerical work, including measurements on a real device. The author has demonstrated the ability for independent creative work in the field. The thesis meets the standard requirements for doctoral theses in this area.

I recommend Ing. Michal Schmid's work for defense.

V Praze 1.11.2023
Doc. Ing. Jan Novotný Ph.D.