Prof. Ing. Pavel Šafařík, CSc.
Radomská 469
18100 Praha 8

The Review

of Doctoral Thesis

Ing. Petr Zelenský : *Optimum Representation of Heat Sources in Simulations of Air Flow in Indoor Environment*, Czech Technical University in Prague, Faculty of Mechanical Engineering, Prague, 2018.

The submitted Doctoral Thesis contains 118 page of text with the title page, Summaries in Czech and English languages, Declaration of Authorship, Acknowledgement, Table of Contents, List of Figures, List of Tables, Nomenclature, References, and five Appendices.
The topic of the Doctoral Thesis is numerical modelling of natural convection in indoor environment. A new computation method based on representation of heat sources and thermal plumes is presented. The method is verified at solution of flow and temperature conditions in a room with the thermal manikin or two or four manikins. The method was applied to solution of indoor flow fields and temperature distributions in model of concert hall in church with a different number of seated visitors.
Introduction is brief and describes aiming of this Doctoral Thesis.
In Chapter 2 the background and current state of the art of the issue arc summarized. The CFD approach is described. Experimental studies are described as well.
Chapter 3 introduces the goals of the Doctoral Thesis.
Methods and tools used for numerical solution of tasks are described in Chapter 4.
Chapter 5 describes development of the new modelling method to represent heat sources in indoor air flow simulations.
Chapter 6 presents results of solution of several tasks to test the proposed method and to reveal limits of this method.
In Chapter 7 the CFD simulation of flow fields and temperature distributions in concert hall housed in a former church is described. Attained results are discussed.
The achievements and contributions are discussed in Chapter 8 with differentiation of contributions for theory and for practice.
Chapter 9 summarizes conclusions of the Doctoral Thesis and also proposes directions for possible future development of the new modelling method.
Technical drawings, numerical mesh of simulated rooms, user defined function, St. Anna church – building constructions and compact disc are presented in Appendixes.

Assessment

A modern computational technology equipped with sophisticated programmes for solution of flow fields and heat transfer parameters is a very effective tool for acquirement of data on indoor environment conditions. Results of numerical simulations of flow processes beside theoretical knowledge and results of simplified calculations and results of special experiments become a basis for investigations in the field of environmental engineering. The author chose as a main goal of his Doctoral Thesis to develop a new computational method based on representation of heat sources and thermal plumes to solve air flow fields and temperature distributions in indoor environment. He prepared and used numerical modelling and

simulation of natural convection by means of the CFD software ANSYS Fluent. The proposed modelling method is characterized by special boundary conditions substituting the heat sources. Obtained results from solutions of the case thermal manikins in a room confirm this well done approach. An application of this method should offer data for design and operation of heating, ventilation and air conditioning systems. It is possible to state that the goals proposed by the author of the Dissertation Thesis were achieved.

The submitted Doctoral Thesis is topical contribution to investigations and design of indoor environment conditions. Undoubtedly, further research and technical projects will follow this achieved experience and knowledge. The author proved his good knowledge in the field of environmental engineering and his computing skills. Interesting are author´s studies on application of different turbulence models.

The reviewed thesis has logical structure. But the reader looks up boundary conditions laboriously. The thesis is understandable. It can be to point out that in view of the readers in English, titles and literature sources of Czech references should be translated into English. The reviewer found misprints, inconsistencies in the thesis and is ready to put the author wise to them. This note does not affect outstanding achieved results.

For defence, the author of Doctoral Thesis

- should give explanation whether Fig. 6.19 is in order.
- should explain his special boundary condition – subsidiary zone with simple boundary condition (SBC) – and its consequences at its application in numerical modelling. The reviewer´s opinion is that the SBC is an artificial computational condition useful for accomplishment of demanding calculations. But SBC´s physical principle should be explained. For example, similar problem (but not the same) is in numerical modelling by means of so called "mixing plane" in the flow field between stator and rotor of a turbomachine.
- is asked whether it is possible from results of calculations to create space shapes of vortex filaments of vortices observed in Figs. 7.5 and 7.6?
- is asked whether it is possible to evaluate integral parameters of thermal plumes (for example, integral flow rate, heat flux, entropy increase, etc.) from his calculated data?

Conclusion

Submitted Doctoral Thesis is on very good level and contributes to research and design in the field environmental engineering. The author fulfilled set down goals. The author developed and verified new calculation method based on representation of heat sources and thermal plumes and solved air flow fields and temperature distributions at natural convection in complex indoor environments. The author proved his creative capacities and his very good professional knowledge. The reviewer

recommends Doctoral Thesis by Mr. Petr Zelensky for defence

before the committee for defence of PhD. theses in the study field Environmental Engineering. After successful defence it is recommended to award a degree

Philosophiae doctor (PhD.).

to Mr. Petr Zelensky.

Prague December 9th, 2018