CZECH TECHNICAL UNIVERSITY IN PRAGUE
Faculty of Mechanical Engineering
Department of Environmental Engineering

Technische Universiteit Eindhoven University of Technology

Simplified modeling of heat sources for indoor air flow design support

Name: Ing. Petr Zelenský
Contact info: petr.zelensky@fs.cvut.cz

1th Promoter: prof. dr. ir. J.L.M. Hensen
2th Promoter: Ing. Barták Martin, Ph.D.

Project duration: 01-10-2011 to 01-10-2015
Research group: Building Performance

Subject

Heat plumes generated by heat sources in ventilated and air-conditioned rooms may have a significant influence on the indoor air flow pattern; their momentum is comparable with that of air flow supplied by ventilation systems. Effective removal of heat gains can contribute to the reduction of energy need for cooling or mechanical ventilation.

CFD simulations can be used in design and optimization of air distribution, providing that the computations are reliable and at the same time fast enough to enable comparison of alternative system solutions. Simplified representation of indoor heat sources can have great use as a design support. It can also facilitate variant comparison and system robustness testing.

Goal

The aim of this project is to propose and test a new approach to simplified numerical modeling of heat sources, in order to reduce the requirements for computing power and time without a significant influence on the results accuracy.

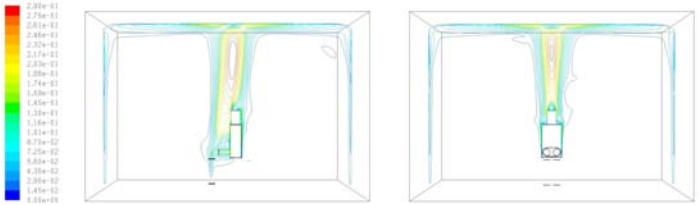

Figure 1. Thermal plume visualization above sitting thermal manikin.

Methodology

The project comprises three parts closely linked together:

Critical review of literature

A detailed literature review will be elaborated in order to get a better insight into the problematics and to summarize current practice of the heat soure modelling for the CFD simulations.

Development and optimization of the new approach to simplified numerical models of heat sources

New approach of simplified modelling will be proposed and tested for selected cases of applications. Based on literature review appropriate performance indicators will be chosen to evaluate the approach.

Method validation

The approach will be validated using data published in literature and also experimental data from measurements.

First steps[1]

The proposed solution is based on the replacement of a heat source (thermal manikin in the current case) by a simple boundary condition, which induces the rising thermal plume. The original heat source can be substituted by a simplified object with adiabatic surface.

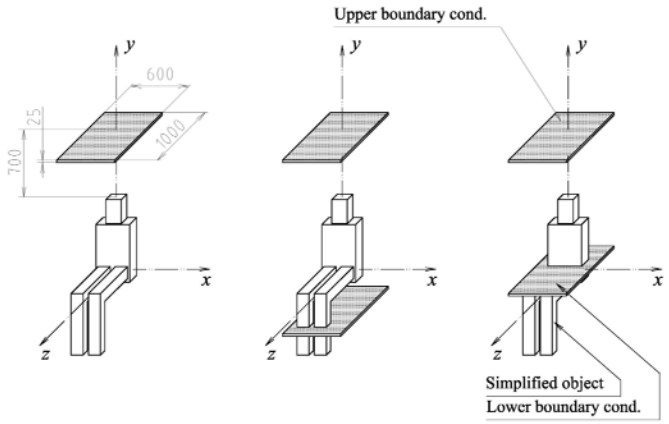

Figure 2. Three variants of proposed simplification

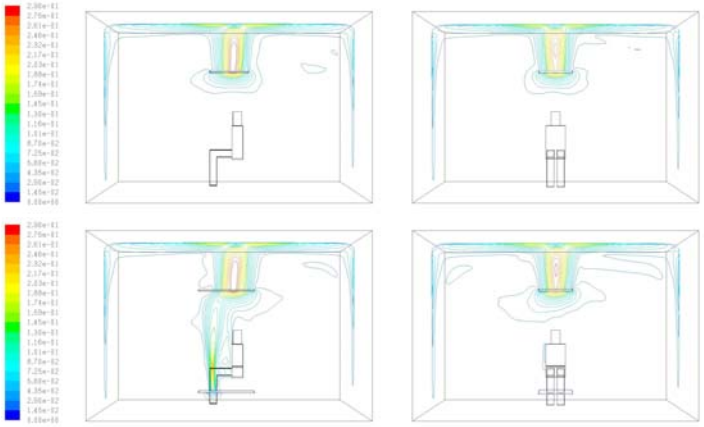

Figure 3. Thermal plume visualization for simplified cases.

Expected results

The result of the research project will be a methodology of appropriate simplification of indoor heat sources for particular cases of applications. The author will elaborate a guideline summarizing current ways of simplification and also propose and describe a new approach to simplified numerical modeling.

References

1) ZELENSKY, P.; BARTAK, M.; HENSEN, J. Model sedící osoby jako zdroje tepla ve vnitřním prostředí. 20th conference Klimatizace a větrání, 2012, Prague.