Experimental apparatus for Experimental Studies of Natural and Mixed Convection Along Vertical Thermo Active Room Surface

Instalacija za Eksperimentalna Istraživanja Prirodne i Prirodno-Prinudne (Mešovite) Konvekcije duž Vertikalne Termo-Aktivne Sobne Površine

dr. Samo Venko
Belgrade, Serbia, 2.12.2016
Natural and mixed convection on room surfaces: 
*Literature review*

- High efficient heating and cooling by TABS
- Empirical models for CHTC:
  - **Natural convection:**
    - Studies in opened rooms
    - Heated surfaces
    - Horizontal surfaces (floor, ceiling)
    - Average room air temperature as a reference air temperature
    - Average CHTC
  - **Mixed convection:**
    - Mechanically or hybrid ventilated rooms
    - Lack of studies under different boundary conditions
- Cooled and heated vertical thermo active room surface

dr. Samo Venko (samo.venko@lindab.com); Belgrade, Serbia 2.12.2015
Experimental Apparatus

Lindab‘s R&D Centre in Godovič, Slovenia

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Experimental Apparatus

- Thermostatic chamber
- Vertical Thermo Active Room Surface (TARS)
- Setup for Measurements of Velocities and Temperatures of Room Air
- Setup for Measurements of Temperatures and Heat Fluxes on Vertical TARS
- Supply Air Diffusor and Ventilation System
- Setup for Temperature and Flow Rate Control of the Supply Air
- Data Acquisition and Control System

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Thermostatic chamber (TC)

TC outside

TC inside

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Vertical Thermo Active Room Surface (TARS)

Dirichlet boundary condition

\[
\frac{\partial \theta_{TARS}}{\partial x} = \frac{\partial \theta_{TARS}}{\partial y} = 0
\]

Heat flux sensors over TARS

TARS coated with low-\(\varepsilon\) coating

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Measurements of Velocities and Temperatures of Room Air

Heat flux sensors over vertical TARS

Heat flux sensors with dimensions 120 mm × 30 mm
Heat flux sensors with dimensions 120 mm × 120 mm

Used heat flux sensors

Schematic cross-section of heat flux sensor
ref: http://www.phymeas.de/

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Supply Air Diffusor and Ventilation System

1 – supply air diffusor

2, 3 – exhaust air diffusors

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Supply Air Diffusor and Ventilation System

Velocity vectors inside diffusor’s chamber and at slot

Smoke test before installation

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Measurements of Velocities and Temperatures of Room Air

- Zone at the vertical TARS where temperature and velocity fields are measured with moving sensors
- Combined sensors for temperature and velocity
- Temperature sensors Pt-100 Class A installed into the radiant shield

### Distances from Vertical TARS for Temperature Measurements

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<th>30</th>
<th>35</th>
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### Distances from Vertical TARS for Velocity Measurements

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Temperature and Flow Rate Control of the Supply Air

1 – mass flow rate measuring
2 – supply air duct
3 – exhaust air duct

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Data Acquisition and Control System

- Desktop computer
- Siemens Simatic S7-300
- Siemens A/D, D/A modules

- Data Acquisition:
  - A/D conversion 40 … 400 Hz
  - data storage 2 Hz

- Control System:
  - maintaining steady state boundary conditions
  - due point control

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Conclusions

- Experimental apparatus was designed based on our own theoretical and practical knowledge
- Extensive usage of CFD during designing phase
- Design allows studies of natural and mixed convection under variety of boundary conditions
- We hope that this paper will be useful also for other researchers
Thank you for your attention