Virtual Simulation of Air Ventilation, Convection and Conditioning in Private Premises (ANSYS/CFX Software Package)

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Problem description, geometry and grids

ANSYS/CFX software package allows virtual numerical simulating of air flow and air convection in building interiors inclusive of air stratification and technical parameters of conditioners, air-fans, air-ducts, air-coolers; inclusive of heat conduction of walls and separating walls and insolation flux through glassed-in windows.

Numerical calculations allow to obtain three-dimensional distributions of air temperature, pressure, velocity and to visualize air flow streamlines and trajectories.

To demonstrate the abilities of ANSYS/CFX software package we consider the model problem of air conditioning and ventilation in a modern five-room apartment module with air conditioning systems mounted in two rooms.

Figure 1 shows flat geometry (5 rooms and 2 kitchens, houseroom area is equal to 250 m^2, stud is 3.5 m) and computational domain, green needles demonstrate cooled air fluxes from air conditioning systems.

On the two adjacent walls there are two windows (elongate rectangles) with insolation fluxes through these windows.

Computational grid on the walls, floor and ceiling surfaces is shown in the Figure 2. Volume grid in the computational grid consists of 162,000 hexahedra.

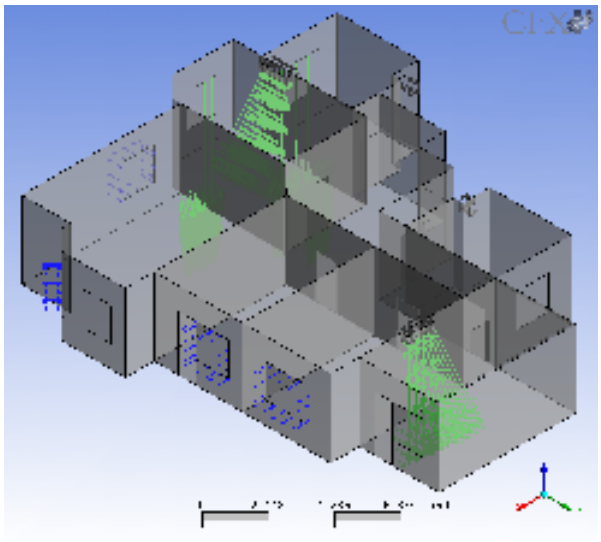


Figure 1. Computational domain (green needles – cooled air fluxes)

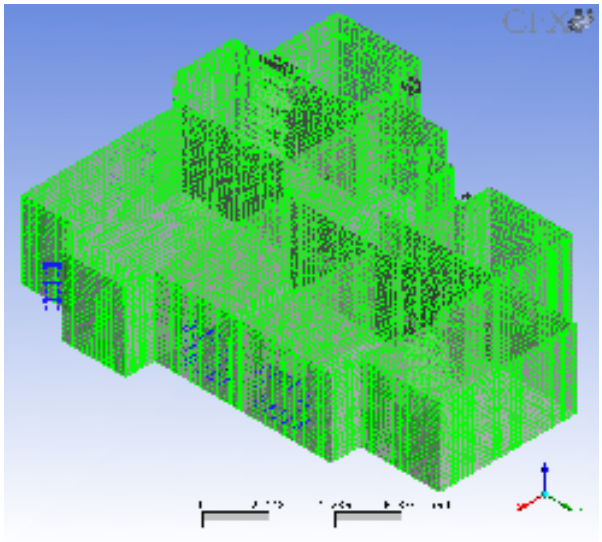


Figure 2. Computational grid

The following parameters have been downloaded in the numerical calculation:

- 300 W – the air-conditioner power
- 600 W/m^2 – heat radiation flux through windows
- 0.06 m^3/c – the flowrate of air through the room

Calculations results

ANSYS/CFX calculations were carried out on the Pentium IV PC under Windows XP operation system.

Air flow was calculated by solving three-dimensional Navier-Stokes equations describing compressible viscous flows.

The finite volume method, node centered high-resolution scheme for convective and viscous parts and k-ε turbulence model were used.

The problem was solved as transient one, time integration step was equal to 5 s, 1000 time iterations have been carried out, this has required 8 hours of computer working.

At the time moment t=0 two air conditioning systems are switched on and four windows are opened.

Figure 3 (left column) depicts calculation results for temperature fields at the horizontal plane at the height equal to 1.5 m from the floor.

Air streamlines are shown in the right column.

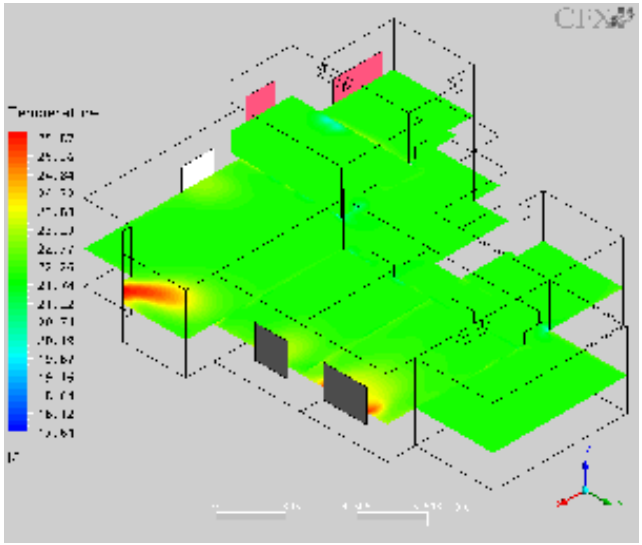
The results are presented for various time intervals t=10 s, 1 min, 2 min, 3 min, 5 min from air–conditioner starting.

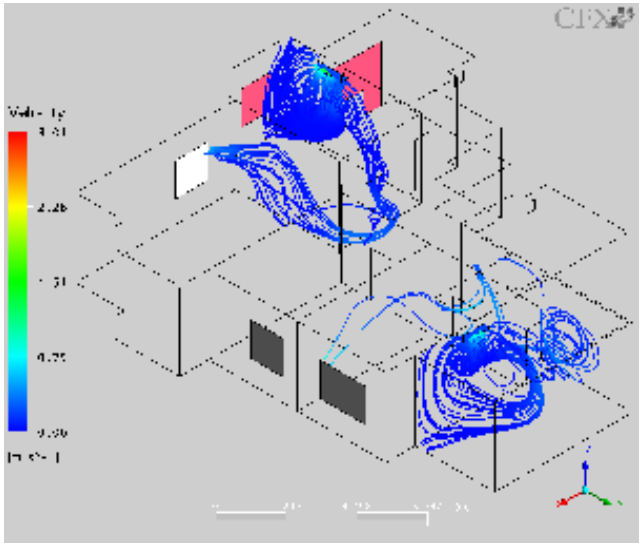
Before conditioner actuation air in the rooms was not disturbed and his temperature was 22°C. The air temperature in the street was 26°C.

Temperature distribution **Streamlines**

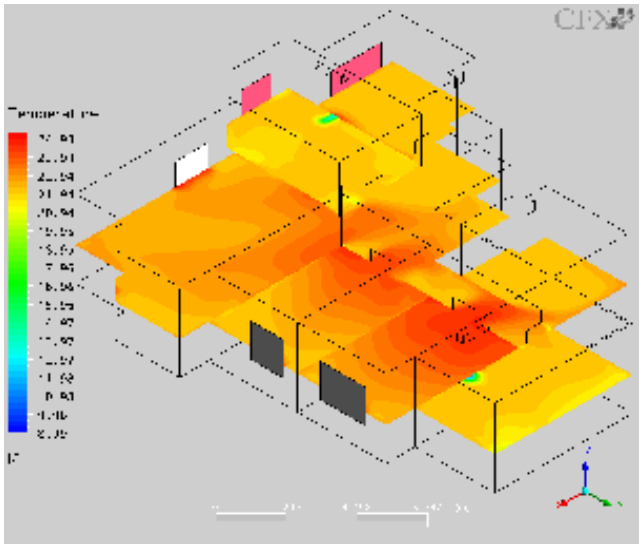
at the height of 1.5 m from the floor

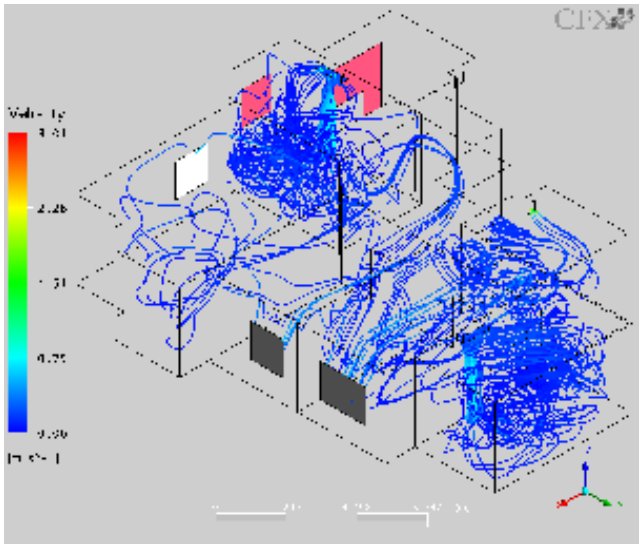
t=10 s



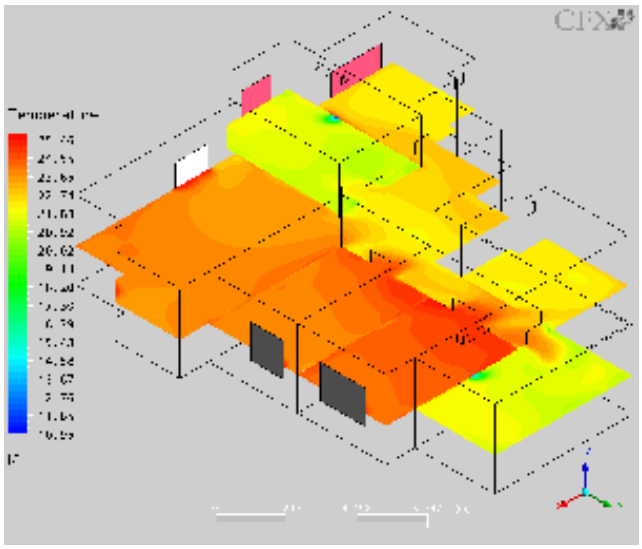


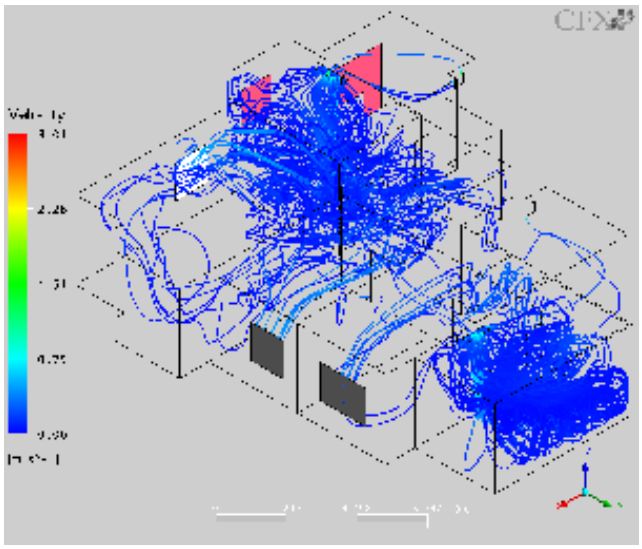
t=1 min



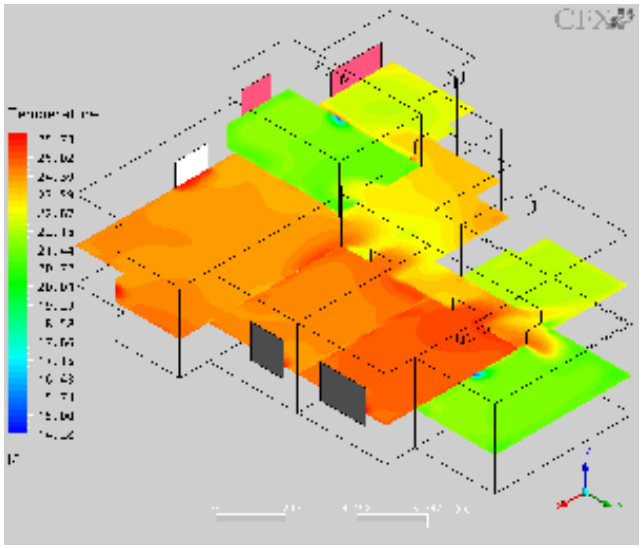


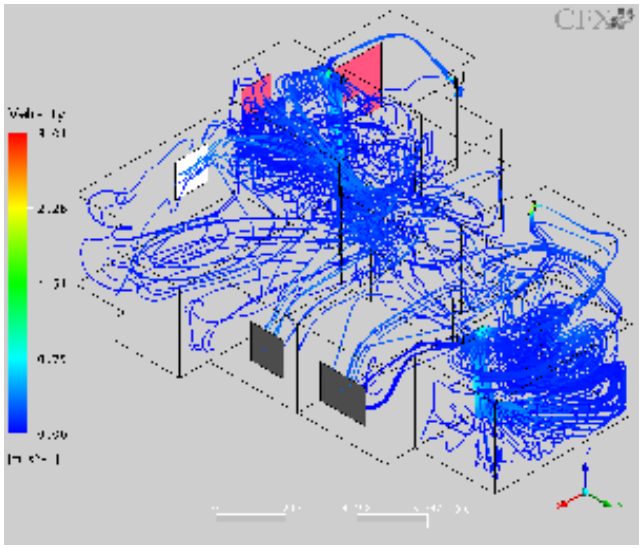
t=2 min





t=3 min





t=5 min

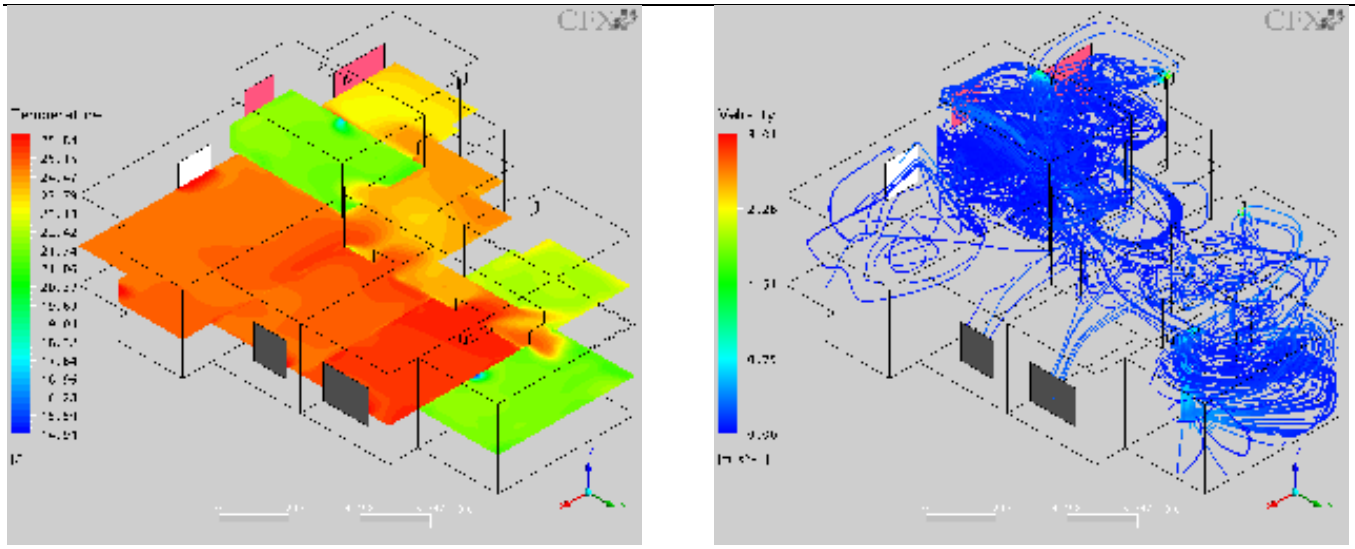


Figure 3. Temperature fields and streamlines