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THERMAL COMFORT EVALUATION IN OFFICE SPACES USING A CFD MODEL

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EXTENDED ABSTRACT

A CFD code is used to evaluate the thermal comfort in a mechanically ventilated office space. CFX calculates the 3-D flow field and heat transfer using the continuity, momentum and energy equations. The code employs an automatic, unstructured hybrid element mesh generator with an adaptive mesh refinement algorithm, which permits a very accurate representation of the boundaries. For the solution of the equations, a scalable and fully implicit coupled solver is used. Turbulence is modeled with the Shear Stress Transport (SST) k-ω based model.

First, CFX is verified against experimental data obtained in an office space with a relatively simple rectangular geometry. A satisfactory agreement of calculated air velocities and temperatures with measurements is observed.

The code is then applied to evaluate the thermal comfort in a mechanically ventilated office space of the Laboratory of Applied Hydraulics of the National Technical University of Athens (NTUA). The dimensions of the office space are: width=5.0 m, length= 6.0 m and height=3.25 m. The main components are: (1) an air-supply inlet, (2) an exhaust outlet, (3) two fluorescent lamps, (4) two PCs and (5) two occupants. The boundary temperatures are specified to represent the actual summer temperatures of the room surfaces. Heat fluxes are modelled to represent the actual amount of heat generated by objects in the office space.

Flow field calculations show a complicated flow pattern with a significant number of re-circulation regions, which result in well-mixed conditions of the air. Calculated velocities in the office space are very high (up to 0.78 m/sec) in the region of the inlet, moderate (0.10 to 0.23 m/sec) in the floor and ceiling layers and low (0.05 to 0.20 m/sec) in the region of the occupants. Air velocity values at the occupants' region are within the recommended limit of less than 0.25m/s by the ISO Standard 7730. However, the occupants are expected to experience discomfort due to draught in the region of entrance (just below the inlet), because of the relatively high air velocities, up to 0.50 m/sec.

Air temperature values at the occupants' region are within the recommended limits (22.5 to 26.0°C for summer conditions) by the ISO Standard 7730. Difference in values at the occupants' head (23.8°C) and feet levels (22.4°C) was minimal (1.4°C).

Key words: Computational Fluid Dynamics (CFD), mathematical models, indoor environment, office spaces, thermal comfort, CFX