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WHOLE YEAR SIMULATION OF HUMIDITY BASED DEMAND CONTROLLED HYBRID VENTILATION IN MULTIAPARTMENT BUILDING

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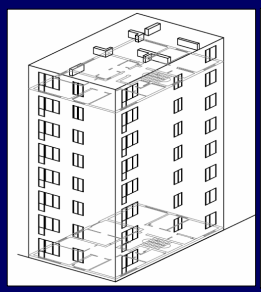
Summary

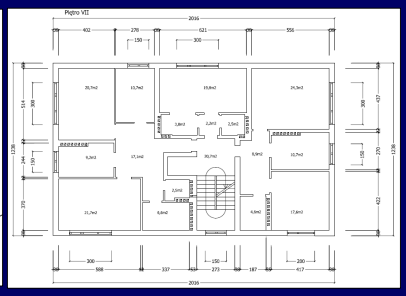
The paper presents the whole year simulation of humidity based demand controlled hybrid ventilation in multiapartment building. The simulation was performed for NAPE (National Energy Conservation Agency) multifamily residential reference building. This allowed the authors to compare obtained results with earlier investigated behaviour of the NAPE building with passive stack ventilation and mechanical exhaust ventilation.

Simulations were performed using computer programme CONTAM (developed by NIST). In CONTAM environment the building together with analysed ventilation system has been idealized as 127 zones and 884 flow paths. Simulations were performed with 5 min time step (results were stored with 1 h time step). Huge set of results allow the authors to compare behaviour of the analysed ventilation systems depending on the number of storey, size of the apartment, type of space etc. CONTAM does not allow users to perform thermal analysis of the buildings, but thermal and energetic analyses can be performed separately at second step (using airflows calculated by CONTAM). The 6R1C model developed at Warsaw University of Technology was used for this purpose. The model is the further development of simple hourly method described in ISO FDIS 13790:2007. Developed model has been successfully verified with the BESTEST

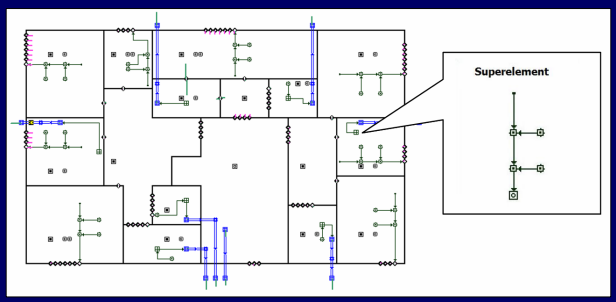
Methods

The NAPE reference building is a virtual, residential building with 8 storeys, located in Warsaw. The building has the total volume of Ve = 5865 m3, surface of envelope Ae=2028.5 m2 (shape ratio Ae/Ve = 0.35) and usable area Af = 1634 m2. All assumed parameters fulfil minimum requirements for new buildings described in Polish building codes and related ministerial ordinances.
There are 3 different small flats at each storey with 1, 2 and 3 rooms respectively. Altogether there are 23 flats, occupied by 47 persons.
The NAPE reference building is equipped with two optional systems of ventilation. Option 1 is passive stack ventilation, option 2 is exhaust mechanical ventilation

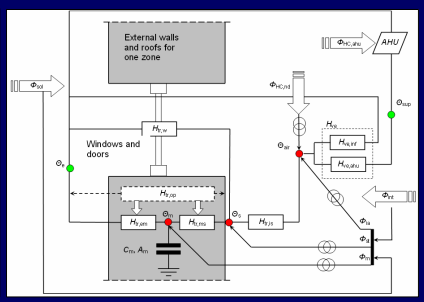




The NAPE (National Energy Conservation Agency) reference building - view and plan of the typical storey.



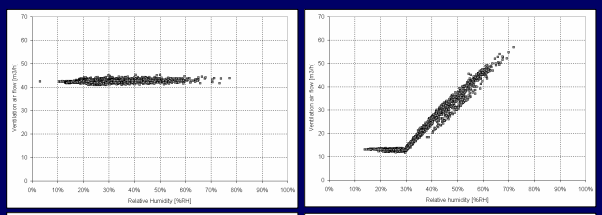
Airflow simulation: Sketchpad (CONTAM) presenting 8th floor of analyzed building for variant with humidity based demand controlled hybrid ventilation.



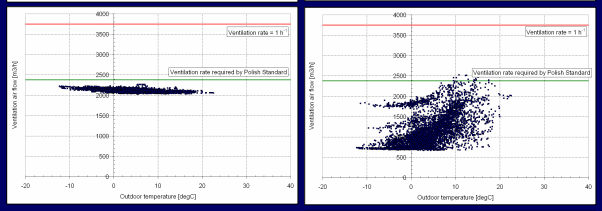
Energy calculation: Lumped capacitance building 6R1C heat exchange model used for energetic analyses.

Results

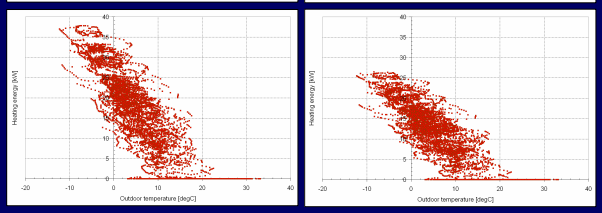
The difference between performance of exhaust grill (one of the kitchen in M3 type flat at 8th floor) used in regular exhaust mechanical ventilation (left) and humidity based demand controlled ventilation (right)

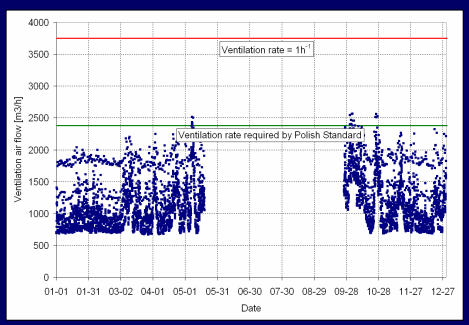


The difference between ventilation air flow rate (as a function of outdoor temperature) for whole building for regular exhaust mechanical ventilation (left) and humidity based demand controlled ventilation (right)

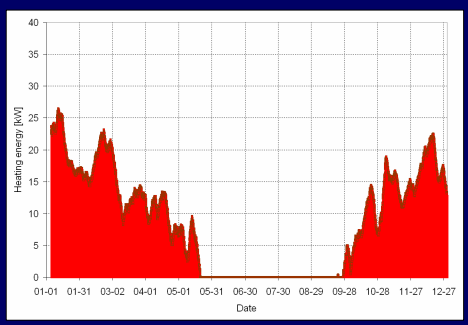


The difference between heating energy consumption (as a function of outdoor temperature) for whole building for regular exhaust mechanical ventilation (left) and humidity based demand controlled ventilation (right)





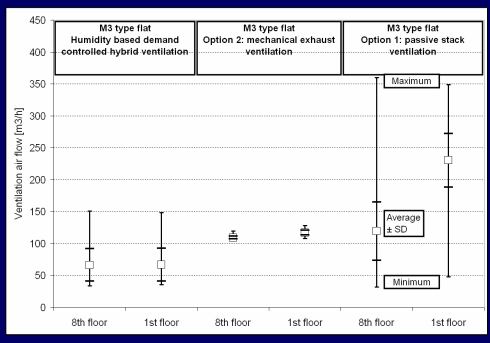
Ventilation rate for whole building during the heating period for humidity based demand controlled ventilation.



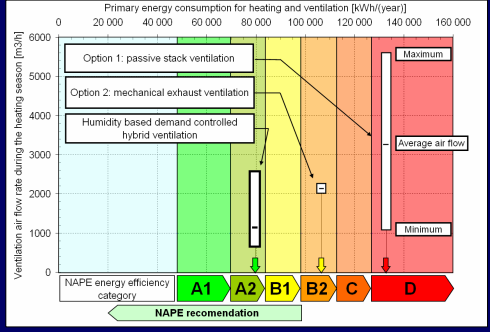
Heating energy consumption for whole building during the heating period for humidity based demand controlled ventilation.

Conclusion

Performed simulations presented the possibilities of utilisation computer programme CONTAM for modelling behaviour of humid air in buildings, even when they are huge and complex.
Obtained results give possibility to investigate air distribution between rooms, flats or differences between floors.
Additionally obtained results indicated once again that humidity based demand controlled hybrid ventilation systems can reduce substantially amount of energy in residential buildings.



Analysis of ventilation air flow difference between flors for one M3 type flat for three ventilation systems.



Proposal of NAPE energy efficiency categories for ventilation systems based on the presented method.