The improvement of the annual energy performance of an existing student room

Application of MATLAB and Simulink in building system design

Existing Building and Systems

Description

For the course of Sustainable Building and Systems Modeling (7Y700) the annual energy demand of an existing student room (figure 1) is defined and sustainable measures are applied to the existing system. The investigated student room is situated on the first floor in a corner of the house that is part of an building block located in Eindhoven. The room has the dimensions of 5.4 x 3.5 x 2.7 (WxLxH, m) with a window located on the south-west side with the dimensions of 2.8 x 1.4 (WxH, m). Two walls are external, oriented on the south-west and south-east.

Figure 1: Layout of the room and building systems overview

Simulated current energy usage and comparison with hand calculations

The energy use of the student room is indicated by a HAMbase model created in MATLAB R2010 and by a hand calculation for validation of the created model. The results of the simulated energy usage and hand calculation illustrated in figures 2 and 3 are in compliance with each other.

Figure 2: Overview of the results of the simulation and hand calculation

New Sustainable Measures

Description of the models

The system includes the aquifer representing heating and cooling energy source, heat pump functioning during heating season to supply the demand and PVC pipes integrated into the wall for water heating and cooling.

Figure 4: An overview of the models

The integrated model in Simulink

The room is represented by HamBase file and integrated into the applied systems in Simulink. Heating and cooling modes are switched between each other by sensors controlling air temperature in the room.

Figure 5: An overview of the integrated model in Simulink

Simulated improved energy usage

By applying sustainable measures the annual gas consumption for heating is totally eliminated and replaced by electricity consumption for heat pump of 180 kWh. Almost 80% of heating energy is supplied by water from aquifer. Moreover, cooling load is totally assured by aquifer and zeroes the overheating period from the initial value of 1481 hours.

Figure 6: Overview of the results