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INFORMATION AND MANAGEMENT SYSTEM FOR CENTRAL HEATING

COMPARATIVE MEASUREMENTS OF A CONVENTIONAL HEATING SYSTEM AND A SYSTEM USING THE INVESTIGATED SOLUTION

BACKGROUND

In most cases, traditional heating systems are controlled by the current outdoor air temperature. The heating curve is set, according to outdoor air temperature, a feed line temperature. This curve is set once and should be adjusted respectively to heating system and building. However, the dynamic response of the building to changes in environmental influences; e. g. internal heat sources and weather conditions, is not taken into consideration. The investigated system optimizes the energy consumption in buildings using thermodynamic calculations, actual weather data and weather forecasts. It calculates how quickly the building loses heat in relation to weather conditions and internal heat sources and adapts feed line temperature. Heat sources can therefore be more efficiently used. The implementation in an existing heating system is technically simple, involving no direct intervention in the system. The targeted focus of the system is on an already existing, multi-storey building.

Test concept

The outdoor testing site of the Fraunhofer Institute for Building Physics IBP at Holzkirchen hosts two buildings that are equal in construction and technical equipment and have the same orientation. These twin buildings allow to perform comparative measurements on two different heating systems under identical boundary conditions. On the ground floor of each building living conditions of a real-life home environment has been created. Set-point temperatures have been specified for all rooms. There is mechanical ventilation with heat recovery but no window ventilation. Power consumption (gas mass, auxiliary energy) and actual temperature profiles (room and system temperatures) of both buildings are measured and compared to each other.

Test buildings

Both buildings have been constructed with a cellar and an attic. They share the same orientation and their location is free of shading. The area of the ground floor of each building is approximately 82 m². For the tests, only the ground floor is heated. The cellar temperature is maintained at 16 °C through the use of additional electric radiators. The attic is heated to a temperature of 21 °C. The electric radiators in the cellar and attic are not included in the energy balance; they only serve to ensure identical boundary conditions.

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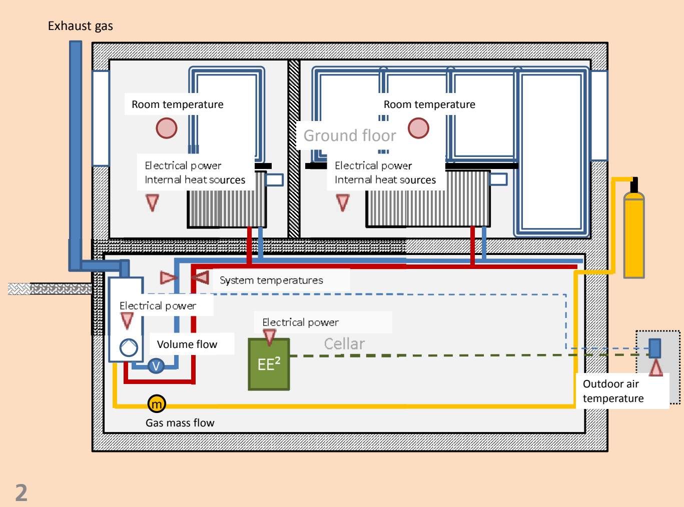


Heating system

Both buildings are heated by an identical gas condensing boiler in the cellar, fuelled by liquid gas (propane gas). The heating curve of the condensing boiler has been adapted to the heating system. A night time reduction has been set. The remaining settings have been left at the factory setting. There are identical panel radiators with thermostat valves on the ground floor of both buildings. Distribution lines for the radiators have been laid in the cellar. The heating system is hydraulically adjusted. There is only one heating circuit. The unregulated central pump has been integrated in the gas condensing boiler.

Investigated System

The outdoor air temperature box of the heating system has been replaced by a temperature chamber. This box can be heated by a Peltier element; whereby, the measured outside air temperature and, thus, feed line temperature can be influenced. The temperature chamber is connected to the server of the system which is located in the cellar. Feed and return line temperature contact sensors measure system temperatures. Wireless temperature sensors in the individual rooms of the ground floor transfer their measurement values to a receiver. A small weather station provides weather data.

Table 1: Room air temperatures (without night time reduction)

Mean value of room air temperature	Test building	Reference building
Children's bedroom	20.7	21.2
Living room	21.2	21.5
Kitchen	20.9	21.4
Bathroom	23.3	24.2
Parent's bedroom	18.7	18.8
Weighted average	**20.8**	**21.2**

Set-point temperatures

Various set-point temperatures (bathroom 24 °C, parent's bedroom 18 °C, other rooms 21 °C) have been defined and thermostat heads adjusted.

Internal heat sources

Both buildings were unoccupied when tests have been performed. Using electrically heated simulators, heat emissions of persons, domestic appliances and the lighting system are introduced into the space (according to a defined time profile).

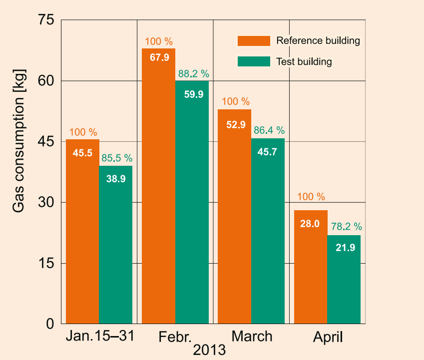
Measurement equipment

Both buildings are extensively equipped with measurement instruments. This technology allows for the recording of air and operative temperatures (in the individual spaces), the electric power used by internal heat sources, all relevant system temperatures, gas and water mass flows and electric power consumption of the heating system. The institute's own weather station provides local climate data.

Zero Measurement

A nine day zero measurement in the two buildings was performed at the beginning of the test. It checks comparability of the two buildings (including building services) before the investigated system will be installed. The result of the comparison is that the later test building consumes about two percent less gas than the reference building.

Diagram 1: Monthly gas consumption



RESULTS

As the sunshine hours in the first quarter of 2013 were below average, the use of solar gains was shortened. During the survey period, January 15 to April 30, 2013, the heating system in the test building saved 14.4 % in gas. In consideration of the results of zero measurement, the reduction in gas consumption was about 12.8 %. Volume flow rates were higher, due to lower feed line temperatures, but the operating times of the pump during transition months were reduced. The additional electrical energy needed by the investigated system (server plus temperature chamber) was about 44 kWh. The room temperatures are, in comparison to the reference building, a bit lower (Table 1). In the bathroom, the difference is higher. This deviation is due to the orientation of the bathroom, which has a window to the east. This is why solar gains can only be used in the morning hours. The living room, kitchen and children's bedroom (windows to the south and west) can use solar gains from late morning till late afternoon. This is a special problem of the test facility (i. E. only one heating circle but rooms facing all four directions). The testing system has been designed for use in multi-storey housing. Usually, there are several heating circles which makes it possible to better adapt the system to different conditions. The testing system (EE²) is a product of the Swedish-German company ECOFECTIVE.

1 Southwest view of the test buildings.

2 Heating system with measuring point.