Fraunhofer IBP

FRAUNHOFER INSTITUTE FOR BUILDING PHYSICS IBP

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DECENTRALIZED CIRCULATION PUMPS

COMPARATIVE MEASUREMENTS OF A CONVENTIONAL HEATING SYSTEM AND A SYSTEM USING DECENTRALIZED PUMPS

BACKGROUND

As yet, most central heating plants have been supplied through centralized circulation pumps. Now there is an alternative: decentralized miniature circulation pumps, which are attached to every radiator. This will completely change the pressure management within the pipework. So far, the central circulation pump was required to permanently maintain a specified pressure to ensure the supply of the radiator with the least favorable fluid flow conditions. As the decentralized pumps only circulate the amount of water required for the respective radiator, a reduction in the energy demand is to be expected. Measurements are performed to determine the potential savings in electricity and heating energy compared to a heating system using a central pump and manually adjustable thermostatic valves.

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 have the same orientation. These identical twin buildings allow to perform comparative measurements on two different heating systems under identical boundary conditions. In the ground floor of each building, the living conditions of a real-life home situation are created. Set-point temperature profiles are specified for all rooms. The power consumption (electric auxiliary energy, gas consumption, primary energy consumption) and the actual temperature profiles of both buildings are compared to each other. There is no window ventilation.

TEST BUILDINGS

The size of the twin houses corresponds to that of a typical single-family home. Both buildings are constructed with a basement, they share the same orientation and their location is free of shading. The ground floor area is sized 82 m², approximately. For the tests only the ground floor is heated. The temperature in the basement is maintained at 15 °C by using additional electric radiators. The temperature in the attic (which is almost adiabatically separated from the ground floor) is heated to 21 °C. The electric radiators in the basement and in the attic are not included in the energy balance; they only serve to ensure identical boundary conditions.

INVESTIGATED HEATING SYSTEMS

Both buildings are heated by an identical gas condensing boiler in the basement, fuelled by liquid gas (propane gas). The condensing boiler is operated according to factory settings. In the ground floor of both buildings there are identical panel radiators with valves. The distribution lines for the radiators are laid in the basement. Their thermal insulation meets the current requirements.

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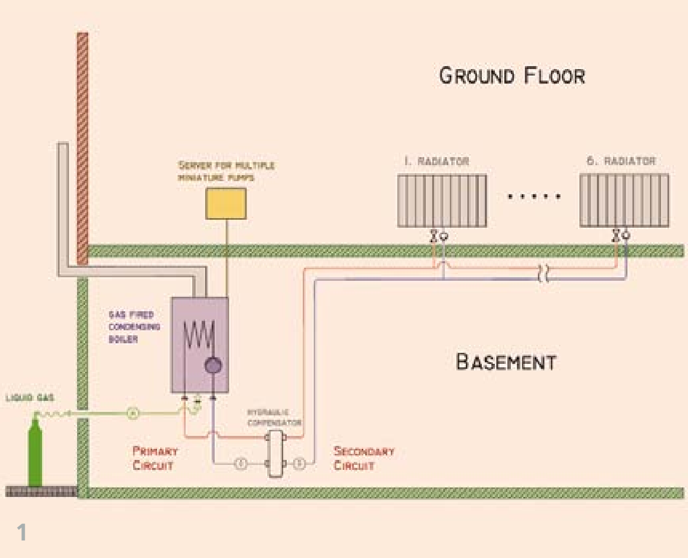

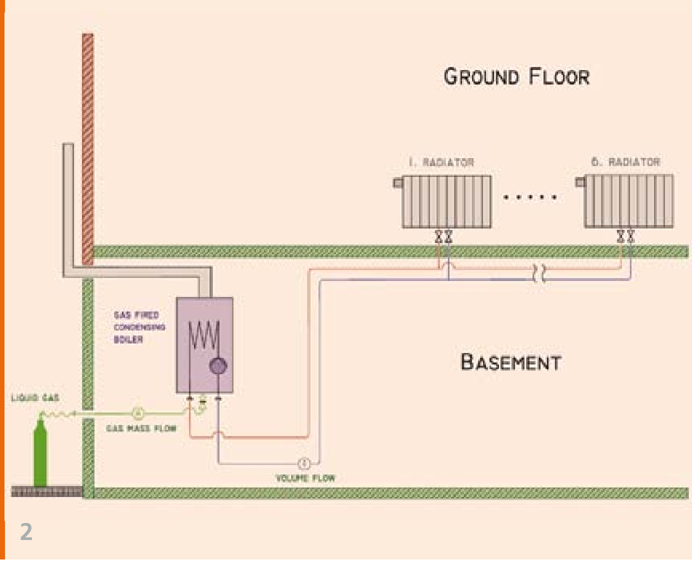

Heating system with decentralized circulation pumps

The radiators in the test house are provided with decentralized miniature pumps, which are controlled via a central server. In each space there is a room control unit that has been programmed with the set-point temperature profile, comparing this profile to the existing space temperature. If there is demand for heat, the server will control the speed of the individual pumps and specify a supply set-point temperature and defined periods of set-back operation for the condensing boiler. A hydraulic compensator separates the primary circuit from the secondary circuit. There is an automatic hydraulic adjustment.

Conventional heating system

The radiators in the reference building are provided with manually adjustable thermostatic valves. The heating system is hydraulically adjusted. Night-time set-back periods are specified for 10 p.m. to 5:30 a.m. and for 11 p.m. to 7:30 a.m. at weekends. There is only one heating system with one central pump.

SET-POINT TEMPERATURE PROFILES

Various set-point temperature profiles (for the bathroom, bedroom, living rooms) are required. Diagram 1 represents exemplary set-point temperature profiles of the habitable spaces.

INTERNAL HEAT SOURCES

Both buildings are unoccupied when the tests are 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

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

RESULTS

In the survey period from September 1, 2009 to April 29, 2010, the heating system in the test house saved 19 % of gas and 53 % of electricity. In total, the system under test saved 22 % of absolute primary energy compared to the reference system. Extrapolated to an entire year, savings in primary energy will result to 21 % – even if the server in the test building is assumed to be in continuous operation (the reference system is switched off in summer). Comparing the specified temperature profiles with the actually measured space temperatures clearly shows the test system's better ability to map the set-point temperature profiles and the periods with reduction of power, in particular (daytime absence of users, night-time set-back).

1 *Test building heating system.*

2 *Reference building system.*

Diagram 1: Set-point temperature profiles of living room, kitchen, children's room

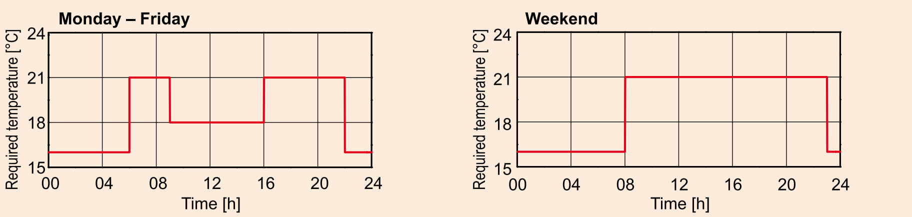

Table 1: Gas and power consumption September 2009 to April 2010

	Test building	Reference build.
Gas	313 kg	386 kg
Electric auxiliary energy	95 kWh	201 kWh

Diagram 2: Gas consumption

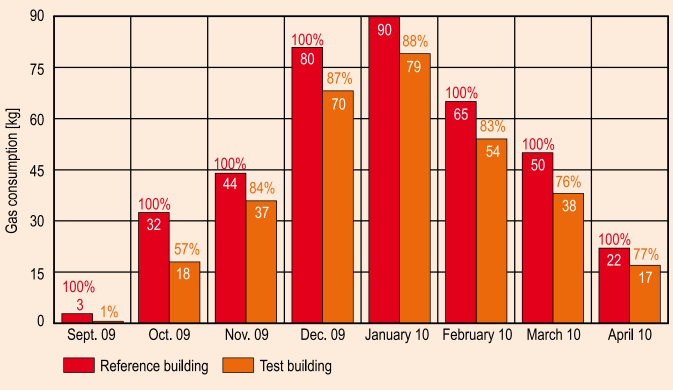

Diagram 3: Auxiliary power