Energy-optimised sports hall

Sports hall built using passive house construction methods with sophisticated energy concept

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Short Title: EnOB: Monitoring Sporthalle Dresden

Running Time: 04/2011 bis 03/2015

Location: Helmholtzstr. 14, 01069 Dresden

Topics:
- Construction of individual buildings
- Building operation & automation
- Solar heat
- Heat from soil, groundwater and sewage
- Monitoring & balancing
- Optimisation of operations

Innovation:

The energy losses from the ventilation are almost completely balanced out using an efficient ventilation system with a heat recovery rate of 93% and a ground-air heat exchanger.

Keywords:
- Passive house
- Heat pump
- Ground heat
- Ventilation system
- Gymnasium

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Quintessence

- The concrete outer walls are designed as thermally activated components
- Humidity-controlled ventilation in the sanitary and changing room areas and CO\textsubscript{2}-controlled hygiene ventilation in the hall
- The ventilation system has a 93 per cent heat recovery rate
It was intended that the new two-field sports hall in Dresden-Weixdorf should cause the lowest possible operating costs. In spite of the large building volume, it was planned to have a heating demand less than 20 kWh/m² p.a. and a primary energy requirement that was about 50 % lower than that of a passive house (120 kWh/m² p.a.). The operating experience in the first year showed that the targeted energy efficiency goals were not achieved. After an initial evaluation of the measured data, optimisation proposals for the system operation were developed. This enabled the gas consumption to be reduced by about 35 %.

Project context

The new Gerhard Grafe Sports Hall is situated in the heart of the Weixdorf district of Dresden. The SG Weixdorf sports association first considered building a new sports hall back in 2005, because they were dissatisfied with their existing training and competition environment. It was also intended that the school sports provided by the neighbouring primary and secondary school should benefit from it. It was therefore decided to construct a new two court sports hall in 2006. In addition to the SG Weixdorf sports association, the Sächsische AufbauBank, the City of Dresden and the District of Weixdorf also participated in the investment costs for the new-build scheme.

Research focus

The research project encompasses the monitoring of the two court sports hall, the analysis of the building operation and the optimisation of the systems. The measurement data derived from the monitoring will undergo model-based data evaluation to enable the measurement data for the sports hall to be compared with similar building types in terms of the energy characteristic values and the overall energy efficiency. This is intended to identify initial potential for optimising the building and system operation. By evaluating the system technology during actual use, the intention is to provide proposals for improving the system operation, identify potential for optimising the general concept and gain information for future designs of system components. In addition, the indoor environmental and the comfort conditions in the sports hall will be analysed. The assessment of local comfort criteria will be supported by the use of mobile measurement technology. The optimisation measures will be conceived so as to achieve the intended energy efficiency goals and the desired thermal comfort. The largely automated building operation will be made more resilient to operating errors.

Concept

Building concept

A central element of the building concept is provided by the concrete perimeter walls that are designed as thermally activated components. Their considerable thermal mass and associated inertia enable the indoor environment to be kept constant for several hours even with strongly fluctuating outdoor temperatures. In addition, the high thermal mass resulting from the monolithic structure also contributes to energy-saving passive cooling. However, sufficient thermal protection in summer would not be achieved by using just solar shading and night ventilation alone. The transmission heat losses are reduced by using an extremely compact structure with the partial use of double storeys. Rainscreen cladding on the facade ensures that the weather protection, insulation and structural (building mass) functions are separated.

The window surface areas on the south and east elevations were reduced to approximately 20% in comparison with the high proportion on the west and north elevations (40%). The glare-reduced glass has a low solar energy transmittance factor. In order to provide homogeneous and glare-free lighting in the hall, two series of vertically angled ribbon windows were installed around the building. The daylight-dependent lighting control system further reduces the electrical energy consumption for the hall illumination.

Further images
Energy concept

The ventilation heat losses were reduced by limiting the number of areas where it was essential to provide air conditioning: the moisture-led ventilation in the sanitary and changing room areas and the CO₂-led hygiene ventilation in the hall. The ventilation system was designed so that it works as much as possible without external heat supplies. The energy losses are almost completely balanced out using a highly efficient heat recovery system (93% recovery rate) and a ground-air heat exchanger. The low-temperature heating system is merely intended for covering transmission heat losses. For the heat generation, an absorption heat pump was installed that is operated with natural gas. Boreholes in the ground are used both as a heat source for the heat pumps as well as a heat sink for providing base load cooling using the thermally activated concrete external walls.

The heat is distributed via a collector and distribution centre. This system enables specific temperatures to be defined for various thermal zones. Its unique feature is that neither the supply nor return systems generate any mixed temperatures. This also prevents mutual influencing of the various pumps. The collector and distribution system provides the hydraulic zero point and consists of a steel distributor/collector with 5 thermally separated temperature chambers.

The energy required for domestic water heating is partly provided by a solar thermal system, with the remaining energy requirement provided by the gas heat pump. In the event of damage, a modulated peak-load condensing boiler provides the heat source for the surface heating systems and the ventilation system. Two buffer storage tanks, each with a volume of 1,200 litres, have been provided for temporarily storing surplus solar thermal heat and for balancing out switching differences when operating the heat pump.

Performance and optimisation

Information on this subject will become available as the project continues.

Further optimisation measures and possibilities

Information on this subject will become available as the project continues.

Project data

Building data
Building owner: SG Weixdorf e.V.

Investor: Sächsische Aufbaubank (Freistaat Sachsen), Landeshauptstadt Dresden, Ortschaft Weixdorf

Occupant: Grund- und Mittelschule Weixdorf

Year of construction: 2009

Inauguration: 11.2009

Measures

Gross floor area: 1,710 m²

Heated net floor area: 1,608 m²

Gross volume: 11,231 m³

Usable floor area (according to EnEV): 3,594 m²

Energy reference area PHPP: 1,494 m²

A/V ratio: 0.39 m²/m³

Energy data

Energy indices according to German regulation EnEV

Heating energy demand: 57.00 kWh/m²a

Overall primary energy requirement: 87.00 kWh/m²a

Measured energy consumption data (in kWh/m²a)

Site energy for heating and domestic hot water (dhw): 22.60 kWh/m²a

Total source energy: 76.70 kWh/m²a

Implementation costs
Net construction costs (according to German DIN 276) relating to gross floor area (BGF, according to German DIN 277)

<table>
<thead>
<tr>
<th>Construction (KG 300)</th>
<th>971 EUR/m²</th>
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<tbody>
<tr>
<td>Technical system (KG 400)</td>
<td>253 EUR/m²</td>
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These figures represent established costs

Operating costs

<table>
<thead>
<tr>
<th>Total energy costs</th>
<th>5.09 EUR/m²a</th>
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<tr>
<td>Heating</td>
<td>1.21 EUR/m²a</td>
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<tr>
<td>Total electricity consumption</td>
<td>3.88 EUR/m²a</td>
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Contacts for the project

Project management

- TU Dresden, Professur für Gebäudeenergietechnik und Wärmeversorgung

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