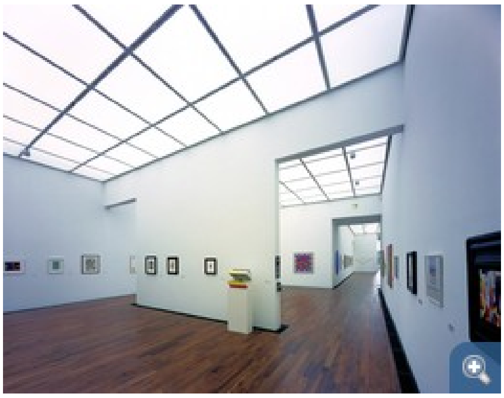
Energy efficiency now in the museum

EnBau

Square. Practical. Good. Directly alongside the Ritter Sport chocolate factory is the Museum Ritter, which was designed by the Berlin architect Max Dudler. In addition to a collection owned by Marli Hoppe-Ritter, the granddaughter of the founder of the Ritter chocolate factory, the building houses a visitor centre for the chocolate factory. Here the natural resources timber, solar energy and geothermal energy are deployed in the cutting-edge building services technology, whereby very high demands have been set for the indoor environment in the exhibition rooms for conservation reasons.



In addition to an art collection, the Museum Ritter houses a visitor centre for the chocolate factory.

Building summary

Project status	
Location	Alfred-Ritter-Straße 27, 71111 Waldenbuch, Baden-Württemberg
Completion	2005
Inauguration	2005
Building owner	Ritter Schönbuch Vermögensverwaltung (+ Betreiber und Nutzer)
Gross floor area	3.910 m^2
Heated net floor area	3.214 m^2
Gross volume	13.098 m^3
Work places	23
A/V ratio	0,54 m^2/m^3
Key aspects	Daylight planning, Daylight systems, Ventilation + heat recovery, Active cooling, Thermo-active building element systems, Heat pump, Combined heat and power generation, combined heating and cooling, Control technology, operational management, building automation, Solar thermal energy, Biomass utilisation

Project description

The Museum Ritter is situated on the edge of Waldenbuch, Germany, adjacent to the company's factory site. It houses an art collection of modern abstract art. In a deliberate analogy to the square design of the chocolate bars, the floor plan of the building is based on clear geometric forms. The 44 x 44 square metre floor area is divided into two trapezoidal-shaped wings divided by a passageway. The large wing houses the collection, temporary exhibitions, a museum shop and a café. The smaller wing contains the visitor centre for the Ritter Sport chocolate company, a 400 m² administrative area, a shop, exhibition areas and a workshop for children.

Building concept

In addition to the Museum Ritter, the new building also houses the visitor centre for the Ritter Sport company. The two different functions are, however, separated from one another within the building without disrupting the overall, unified form of the building.

The main part of the 700 m2 exhibition space is located on the first floor of the Museum Ritter. This is equipped with an illuminated ceiling that combines daylight with artificial light. Illuminating the often very sensitive artworks with daylight requires suitable technology for controlling the quantity of light. The available daylight is subject to considerable fluctuations during the course of the day or year, which should not be allowed to spoil the viewer's enjoyment of the works. This problem, however, must be weighed against the outstanding richness of colour provided by daylight under varying natural light conditions. Moreover, the luminous efficacy of natural light is far superior to that of artificial light sources. Overall, opting for daylight can save a considerable amount of electrical energy which would otherwise be required if there was permanent artificial light. To control the amount of light, electrically adjustable louvres are fixed to the underside of the ceiling glazing.

The exhibition spaces on the ground floor are entirely lit using electrical illumination, which is only used for the spaces on the upper floor when there is a lack of daylight. A substantial requirement of the illuminated ceiling is that the materials used provide good dispersion and transmission. The illuminated ceiling was optimised for this purpose together with the manufacturer. Highly efficient T5/ T16 fluorescent lamps are used with the light colours 940 and 965, which are equipped with dimmable, electronic ballasts. This enables the various illumination strengths required to be individually set in each exhibition space. On the first floor, the artificial light can be individually mixed in each room in accordance with the amount of daylight.

Energy concept

Very demanding requirements have been set for the indoor environment in the exhibition rooms for conservation reasons. This means that the temperature (20-22°C) and the relative humidity (50-55%) can only fluctuate across a narrow range. This requires air conditioning in summer (dehumidification) and in winter (humidification). This in turn requires a large amount of energy, which is intended to be reduced as part of this project.

In winter the air is humidified via a contact humidifier. The necessary evaporation energy is extracted from the air and is not provided by means of electrical energy as with a conventional steam humidifier. During this process the air is first heated to around 30°C and then transferred to the rooms at about 22°C. For recovering humidity in winter, a rotating heat/humidity exchanger is deployed which can recover about 50 % of the humidity. In summer it is not possible to dry the air with the rotating heat/humidity exchanger since high temperatures are required to dry the exchanger. For this reason, the air is dehumidified in summer by cooling the air to the dew point (8 to 9 °C) before reheating it with waste heat from the cooling system to around 16-18 °C. The required cold-water temperatures of 6 to 8 °C can only be generated using a chiller. It is not possible to use "high temperature cooling" from the ground (which is used, for example, for dissipating heat from the underfloor cooling) for the dehumidification process.

In summer the proportion of circulating air is increased (to approx. 70%) in order to reduce the dehumidification volume; the proportion of external air is regulated via CO2 sensors in the reference rooms.

The main component for providing heat is the absorption cooling system, which is operated as a heat pump in winter. It utilises the low-temperature heat from the ground which is trapped via 73 foundation piles connected by a circulating water supply, and is "driven" by high-temperature heat from an array of evacuated tube collectors (47 CPC evacuated tubes with a total output 100 kW) as well as from a wood pellet combustion unit (4 boilers with a total output of 120 kW). The collector array meets around 40 % of the overall heating requirement. Using the absorption chiller as a heat pump enables 160 % of usable heat to be generated from 100 % wood pellets.

In summer, higher temperature cooling (15-18 °C) is sourced directly from the foundation piles. It is estimated to provide around 65 % of the cooling requirements.

Since the exhibition rooms in the museum need to maintain very strict climate conditions, very cool temperatures of 6 to 12 °C must be provided for the air conditioning and to dehumidify the supply air. This cooling is provided by the absorption cooling system. This is primarily supplied with heat from the collectors with additional heat coming from the wood pellet boiler. The COP of the absorption cooling system is 0.75. A compression refrigeration machine is used to meet peak loads and as a replacement system. The dehumidified air for the exhibition spaces is additionally heated using waste heat from the chillers.

Performance

The sophisticated energy concept places very high demands, particularly on the building automation. The interrelation between the individual components did not function right from the start and it required considerable time before a satisfactory solution could be found, particularly concerning the transition between the different operating conditions (heating, cooling). In addition, shortly after opening it became clear that the decision to dispense with an additional compression refrigeration machine to meet peak loads, which was made in order to maintain the overall homogeneity of the concept, was not tenable.

After remedying the defects, the technology now functions as planned. The required room climate is maintained in the exhibition spaces. With the number of visitors double that originally envisaged, especially in the retail areas in the visitor centre, the cooling technology will inevitably have to be upgraded again.

Optimisation measures and possibilities

In particular, there is further potential for optimisation in terms of the interrelation between the two chillers. In order to make optimum use of the absorption chillers, these should be integrated in such a manner that they produce cold water at a temperature level that is as high as possible. This enables the COP – a measurement for the efficiency of the chiller – to be considerably improved.

Key energy data

Energy indices according to German regulation EnEV (in kWh/m²a)	
Heating energy demand	

Heating energy demand (according to EnEV)	69,60
Overall primary energy requirement (according to heated net floor area)	125,00
Measured energy consumption data (in kWh/m²a)	
Site energy for heating and domestic hot water (dhw)	94,50
Source energy for heating and domestic hot water (dhw)	23,40
Total source energy	344,00

Implementation costs

Costs of implementation in €/m²	
Construction (KG 300)	972
Technical system (KG 400)	384

These figures represent established costs
Net construction costs (according to German DIN 276) relating to gross floor area (BGF, according to German DIN 277)

Monitoring
Website museum Ritter