RESULT 307

CADDET energy efficiency IEA OECD

cooling concept

Ventilated cooled-beam system with free cooling

Summary

A new ventilated cooled-beam system concept with free cooling has been installed and monitored in a retrofitted office building in the Wärtsilä NSD Finland complex in Vaasa, Finland. Good indoor air quality and individual room temperature control has been achieved using ventilated cooled beams. Both cooling- and supply-air distribution functions were integrated in the same room unit. No extra costs were incurred for the low-energy system's free-cooling loop. This new ventilated cooled-beam system concept offers a good indoor air quality and individual control facilities, up to 50% cooling energy savings due to free cooling, cost reduction, and system simplification.

Highlights

- **Simplified, energy- and cost-efficient air-conditioning system**
- **Free cooling without extra cost**
- **Modular and highly integrated room unit**
- **Good indoor air quality**

The Wärtsilä NSD Finland complex in Vaasa, Finland.

Aim of the project

Previous studies have shown the ventilated cooled-beam system to be the lowest cost alternative for office building air-conditioning systems requiring individual room temperature control and good indoor air quality. The introduction of the free-cooling concept and low-energy technologies improves the energy- and cost-efficiency of this system.

The Principle

Cooled beams can be dimensioned to use higher operating temperatures than typical fan coils (14-18°C vs. 7-10°C), increasing the available free-cooling time. In Scandinavia this means 20% and in Central Europe 30% more free-cooling operation time. System simplification is achieved by integrating the typically separate air-handling unit's cooling and free-cooling heat exchanger functions into a single coil. The principle of the ventilated cooled-beam system with free cooling is shown in Figure 1.

During free-cooling operation the cooling water from the water tank is circulated through the integrated cooling/free-cooling coil. The free-cooling coil transmits heat from the cooling water to colder outside air, preheating the air at the same time. Good indoor air quality and individual room temperature control were achieved by using modular and highly integrated ventilated cooled beams. Both cooling- and supply-air distribution functions were integrated in the same unit. Heating was produced by using existing radiators.

The Situation

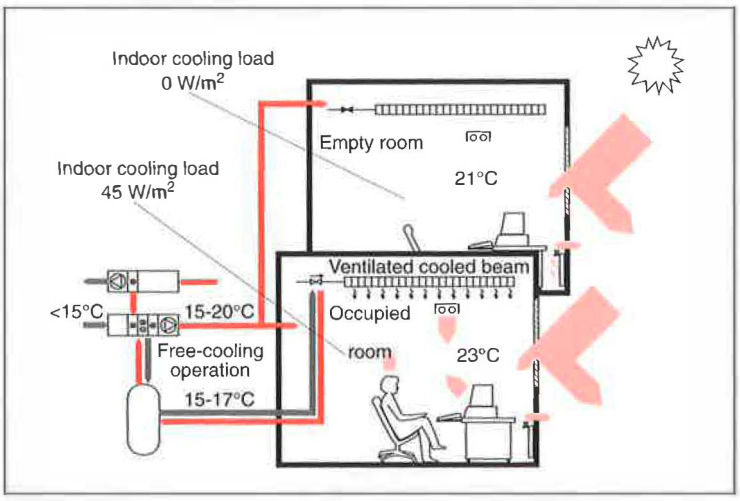
To improve the energy-efficiency of the cooled-beam system, the new concept of a ventilated cooled-beam system with free cooling was introduced in 1994. Theoretical calculations and measurements from the first demonstration project in Helsinki showed this new concept to be energy- and cost-efficient.

In 1995 the air-conditioning system on one floor of the Wärtsilä NSD Finland complex was renovated. The new ventilated cooled-beam system with free cooling was selected to achieve good indoor air quality with minimum energy use. New modular and highly integrated air-handling units (manufactured by Halton Oy) were installed in the office area before the end of 1995. Conventional air-conditioning systems produce all the cooling energy mechanically via a chiller (water systems) or with a chiller and fan (air systems).

Figure 2 shows the cooling efficiency (COP-value) of the ventilated cooled-beam system compared to conventional air-conditioning systems in different weather conditions. The free-cooling operation starts below 14°C outside temperature. Below this temperature the system is much more efficient (COP 29) than the most efficient air system, the variable air volume (VAV) system (COP 7-21). The warm weather conditions at the summer dimensioning point (25°C) mean that water systems are non-condensing and thus require less electric power than air systems. In the Wärtsilä building the installed cooling capacity for the ventilated cooled-beam system was 64.3 kW. Using air systems (VAV or constant air volume, CAV) the required cooling capacity would have been 23% higher (79.2 kW).

The cooling performance of the ventilated cooled-beam system was measured during spring,

Figure 1: The ventilated cooled-beam system with free cooling.



summer, and autumn 1996. The results show that the average free-cooling portion of the total cooling-energy consumption was 60% during the spring and 71% during the autumn period. The measurements indicated the quality of the indoor air to be good. The control system allowed individual room temperatures to be set.

The estimate of the cooling-energy savings potential was calculated by using the measured dependency between outside temperature and both the total cooling-energy consumption and the free-cooling portion thereof. The total annual cooling energy provided by the ventilated cooled-beam system was calculated to be 62.2 kWh/m², of which, on average, 29.6 kWh/m² can be produced by free cooling, furnishing a cooling-energy conservation of 48% (Figure 3). The electricity consumption of the ventilated cooled-beam system was estimated to decrease by 10.1 MWh and 9.9 kWh/m² annually through the use of the free-cooling concept.

Typical for the office area is the high indoor cooling load from office equipment. Most employees have two computers plus peripherals on their desks. The outdoor cooling load is much lower due to good solar shields, so cooling requirements are very stable throughout the year.

The Company

Wärtsilä NSD Finland is a manufacturer of large diesel engines in Vaasa, Finland. The office building was built as part of the Wärtsilä NSD plant in

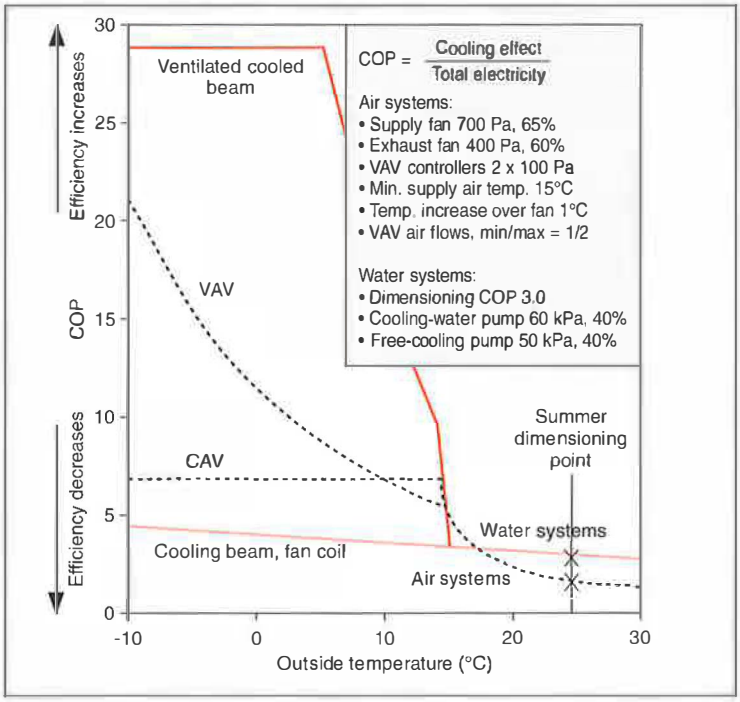


Figure 2: The cooling efficiency (COP-value) of the ventilated cooled-beam system compared to conventional air-conditioning systems in different weather conditions. Design values of the Wärtsilä NSD complex were used.

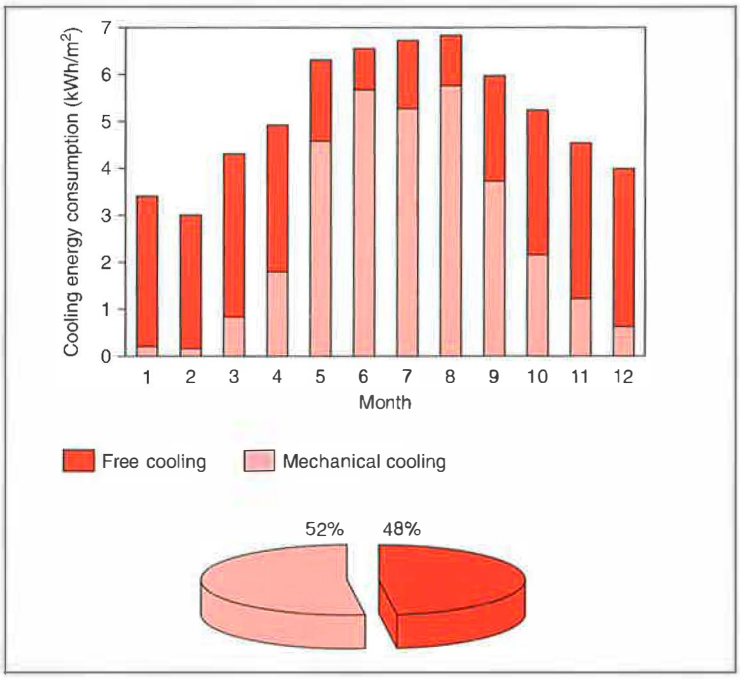


Figure 3: The annual cooling-energy savings potential in the Wärtsilä demonstration building by using the ventilated cooled-beam system with free cooling.

1950. The demonstration area (1,020 m²) is an open office space on the second floor accommodating approx. 60 employees.

Economics

Standard ventilated cooled beams were used in the Wärtsilä system concept, with no extra costs incurred for the ventilated cooled beam system's free-cooling loop. Integrating other functions (heating, exhaust air distribution, or heat recovery) in the air-handling units increases installation costs of the units, but may decrease the total system costs. Operating costs are lower compared to traditional systems. The new ventilated cooled-beam system concept with free cooling saves energy costs in the demonstration area of FIM 2.61/m² annually (ECU 0.44/m² annually).

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* IEA: International Energy Agency
OECD: Organisation for Economic Co-operation and Development

IEA

The IEA was established in 1974 within the framework of the OECD to implement an International Energy Programme. A basic aim of the IEA is to foster co-operation among the 24 IEA Participating Countries to increase energy security through energy conservation, development of alternative energy sources, new energy technology, and research and development (R&D).

This is achieved, in part, through a programme of energy technology and R&D collaboration currently within the framework of 40 Implementing Agreements, containing a total of over 70 separate collaboration projects.

The Scheme

CADDET functions as the IEA Centre for Analysis and Dissemination of Demonstrated Energy Technologies. Currently, the Energy Efficiency programme is active in 15 member countries.

This project can now be repeated in CADDET Energy Efficiency member countries. Parties interested in adopting this process can contact their National Team or CADDET Energy Efficiency.

Demonstrations are a vital link between R&D or pilot studies and the end-use market. Projects are published as a CADDET Energy Efficiency 'Demo' or 'Result' respectively, for ongoing and finalised projects.

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