CADDET energy efficiency
IEA
OECD
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Recirculation ventilation system in hotel

Energy conservation in hotels using an air recycling system

Summary

As an alternative to a conventional ventilation system with a plate heat exchanger, a leading hotel in Switzerland has installed a so-called 'recirculation' ventilation system. The main feature is the recirculation of return air, with the resulting mixed air processed using fine particle, electrostatic and activated carbon filters.

The heating energy required to heat the outdoor air in re-circulation ventilation systems is zero. Savings in cooling energy compared to a conventional system are 10%, while savings in electricity consumption are 7-20%. The system is not only suitable for hotels, but also for a wide range of additional applications.

Highlights

- **Zero energy demand for heating outdoor air**
- **Excellent indoor air quality**
- **Capital investment reduced by 10%**
- **Operating costs reduced by 40%**

Ventilation plant with air recycling.

Aim of the Project

The aim of the project is to show that recirculation ventilation plants can satisfy the following criteria in a hotel context:

- reduced energy consumption;
- provision of high indoor air quality;
- reduced capital investment and operating costs.

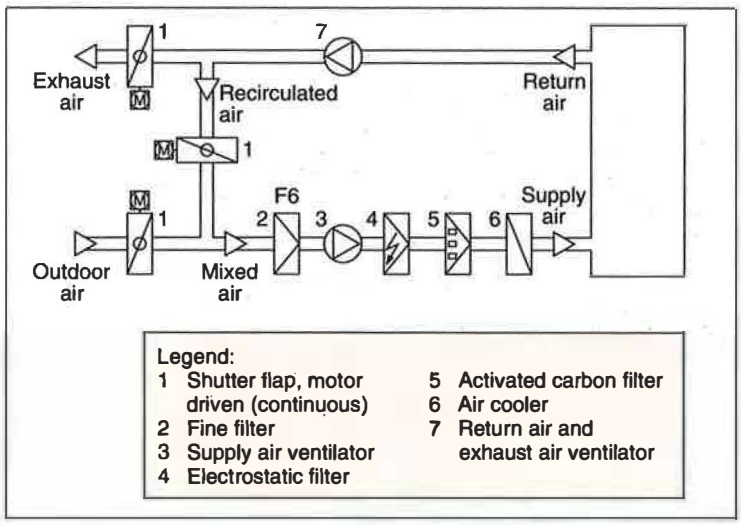
The Principle

Recirculation ventilation plants are based on the principle of air recycling. This involves an air-processing system containing fine particle, electrostatic and activated carbon filters (see Figure 1). Heat recovery is achieved simply by re-circulating a fraction of the return air. Thanks to the high quality air-processing system, there is no reduction in the quality of the air.

Under cold weather conditions, there is always a certain amount of recirculation. The recirculated air is mixed with outdoor air, the quantity being adjusted to provide the desired supply air temperature. Under steady-state conditions, the heat rejected with the exhaust air corresponds exactly to the unwanted heat from internal and solar gains within the building. As the ventilation system merely removes the superfluous heat (i.e. in excess of that required for building heating), the heating demand of the system itself is zero.

In warm weather conditions, operation of the air recirculation system depends on several factors. In situations when the outdoor air is cooler than the return air, 100% outdoor air is used. However, when the outdoor air is hotter than the return air, the control system reduces the fraction of outdoor air to 10-15%, the remaining ventilation air being made up by recirculated air. This diminishes the cooling energy required and reduces the necessary cooling capacity.

Figure 1: Schematic of a typical recirculation ventilation system.



The Situation

The hotel management's operation is centred on the concept of 'wellness' (i.e. a combination of well-being and fitness) and health. In compliance with this, the management emphasised the need for energy-saving installations that are both environmentally sound and economic. The hotel complex includes a variety of new and retrofitted buildings in which recirculation ventilation systems have been installed as an alternative to conventional ventilation systems with a plate heat exchanger.

The various buildings are used for very different purposes, e.g. foyer, dining hall, restaurant, bar, boutique, hairdresser, cloakroom and fitness club, and are thus ideal for testing the functional capability of recirculation ventilation. Nineteen recirculation plants were installed, with two being chosen for detailed study in a three-year research project supported by the Swiss National Energy Research Fund.

It was found that the plant not only saves energy, but capital and operating costs are also lower than for a conventional plant, while indoor air is of very high quality.

Energy savings

The systems investigated show increased energy savings compared to a conventional system: heating of outdoor air, 100%; cooling of outdoor air, 10%; electricity consumption (fans, electrostatic filter), 7-20%.

The reduction in electricity consumption results from the lower pressure head. Although the electrostatic and activated carbon filters produce an additional pressure loss, this is more than compensated for by the absence of other components (i.e. heat exchanger, air heater, fine particle filter for the return air).

Indoor air quality

The research project included detailed measurements and studies of indoor air quality by the Institute of Hygiene and Applied Physiology of the Swiss Federal Institute of Technology in Zürich. The main quantities measured were: carbon dioxide, air quality, suspended particles, nitrogen dioxide and volatile organic compounds (benzene, toluene and xylene).

The results generally showed excellent indoor air quality. No cases were found of air quality falling below that of conventional ventilation systems. On the contrary, in view of the high levels of outdoor air pollution often encountered, a properly designed recirculation system may prove better than a system using only outdoor air. This benefits those particularly susceptible to air pollution (e.g. asthmatics, anyone allergic to dust and pollen, the sick and the elderly).

The Company

The hotel management operate both a four-star and a five-star hotel in the health resort of Bad Ragaz in Switzerland. They have approximately 130 single-bed rooms and 110 double-bed rooms for guests demanding very high standards of service. The hotel complex includes a variety of new and retrofitted buildings in which recirculation ventilation systems have been installed as an alternative to conventional ventilation systems using a plate heat exchanger.

Cost category	**Recirculation ventilation** (CHF/a)	**Conventional ventilation** (CHF/a)
Installation	5,960	6,800
Operation		
• *energy*	830	2,240
• *materials*	660	620
• *labour*	330	270
Total operating costs	1,820	3,130
Maintenance	1,370	1,560
Total	9,150	11,490

Table 1: Comparison of the annual costs for a recirculation ventilation system and a conventional system with a plate heat exchanger.

Economics

In the cases studied, the capital investment was 7-12% below that of a conventional system using a plate heat exchanger (see Table 1). Electrostatic and activated carbon filters naturally lead to additional costs. However, these costs are more than compensated for by savings in other components, e.g. heat exchanger, fine particle filter for the return, and in apparatus for outdoor air heating (heat generation plant, air heater and heat distribution system).

Operating costs for energy, materials and labour proved to be 34-42% lower than for a conventional system (see Table 1). The following energy prices were assumed in the calculation: heating energy (user end) 0.05 CHF/kWh, cooling energy 0.05 CHF/kWh, and electricity 0.13 CHF/kWh. The savings result entirely from reductions in energy consumption, the costs of material and labour being similar for both systems.

In conclusion, the recirculation ventilation system not only leads to a marked reduction in energy consumption and to excellent air quality, but is also considerably less expensive than conventional systems.

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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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