RoofVent® and TopVent® with heat pump, the energy-saving champions

Hoval

Decentralised systems for ventilation, heating and cooling large halls have proved themselves in practical applications alongside centralised systems due to their excellent ability to adapt to the many and varied prevailing ventilation requirements. Hoval has been manufacturing decentralised climate units for 40 years. From the very beginning, efficient energy consumption has been the guiding principle for the development of every generation of our units.

The proven RoofVent® supply and extract air handling units with air flow rates of 5500 m^3/h (size 6) and 8000 m^3/h (size 9) have undergone further development. The optional integration of reversible heat pumps will now enable them to operate as autonomous function units. Size 9 units can be fitted with either one or two heat pumps. The pumps use the air buffer storage tank with a COP value of 4.09 for heating and an EER value of 3.77 for cooling. More key data for the heat pumps is listed in Table 1:

Rated heat output [1)]	31.5 kW
Rated cooling capacity [2)]	28.0 kW
Condensation temperature	46 °C
Evaporation temperature	6 °C
[1)] tOUT = 7 °C, tEXT = 20 °C [2)] tOUT = 35 °C, tEXT = 27 °C / 45% rel. hum.	

Table 1: Data for the Daikin ERQ250 heat pump

Please refer to the Daikin "Air Conditioning, Technical Data" manual for heat output and cooling capacity values for fresh air and extract air states deviating from the values listed in Table 1.

The pumps can be combined with the energy recovery from plate heat exchangers with temperature efficiency values of 77% and 78% and performance coefficients of 26.0 and 27.7 to create an incredibly energy-efficient ventilation system.

Hoval's proven Air-Injector is used as the air distribution system for the entire range of units. The use of the Air-Injector enables the system to cover the hall areas quoted in Table 2 draught-free.

RoofVent®	Floor area covered		Associated specific air flow rate	
	min.	max.	max.	min.
RP-6	11 m x 11 m	22 m x 22 m	46 $m^3/(m^2 \cdot h)$	11 $m^3/(m^2 \cdot h)$
RP-9	13 m x 13 m	28 m x 28 m	48 $m^3/(m^2 \cdot h)$	10 $m^3/(m^2 \cdot h)$

Table 2: Areas covered draught-free by RoofVent® RP units

With air flow from top to bottom, (measured) temperature gradients in the range from 0.1 K/m to 0.15 K/m can be achieved. This opens up additional energy-saving potential compared with solutions with higher stratification values. The heat requirement in a hall can thus be reduced by up to 20%.

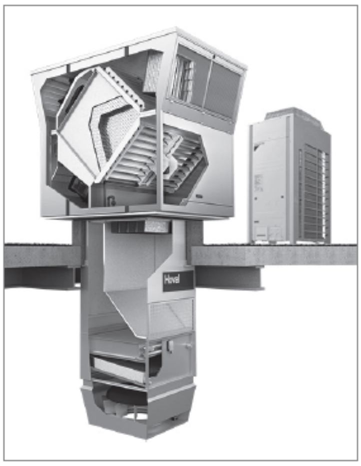

Figure 1: RoofVent® RP

The RoofVent® heat pump system is controlled with the TopTronic® C system which was specially developed for the needs of decentralised systems. It controls the heat output and cooling capacity of the reversible heat pump in the modulation range 0 … 100% as well as the energy recovery output and air distribution based on the difference between supply air and room temperatures. The final result of this cross-linking is a minimal energy consumption under all operating conditions, maximising the benefit to the operator.

The performance capacity of the RoofVent® RP system is illustrated below for a typical heating and cooling scenario. The solution involves a size 6 unit with one heat pump (RP-6-K) and a size 9 unit with two heat pumps (RP-9-M).

Heating

The values for a winter design point with an outside air temperature tOUT = -15 °C and an extract air temperature tEX = 20 °C are listed in Table 5. The outside air is heated from tOUT to tER with $\dot{Q}_{ERG}$ by means of heat recovery in the plate heat exchanger. The capacity of the heat pump at these temperatures is $\dot{Q}_{WP}$. It heats the outside air flow from tER to the supply air temperature tSUP.

The effects of another benefit, namely the dissipation of the fan power, are felt here. The kinetic energy discharged into the supply air flow by the supply air fan is converted into heat by matching the speed of the supply air to that of the room air. Its value $\dot{Q}_V$ is calculated from the power consumed by the motor and the fan efficiency. This leads to an increase in the temperature of the supply air by ΔtV from tSUP to tSUP eff. The values for the two sizes are listed in Table 4.

RoofVent® Size	$\dot{Q}_V$ [kW]	ΔtV [K]
6	1.3	0.7
9	2.1	0.8

Table 3: Fan power dissipation for RoofVent® units

The heat flow $\dot{Q}_{Trans}$, which is the result of the supply air flow and the difference between the effective supply air temperature tSUP eff and the extract air temperature tEXT, is made available for transmission coverage. The only energy requirement other than heating up the outside air from tOUT to tSUP is the electrical drive power required from the heat pump $\dot{Q}_{WP\,input}$.

RoofVent®	tOUT	tER[1)]	$\dot{Q}_{ERG}$	$\dot{Q}_{WP}$	tSUP	tSUP eff [2)]	$\dot{Q}_{Trans}$ [1)]	$\dot{Q}_{WP\,input}$
RP-6-K	-15 °C	14.0 °C	54 kW	22.1 kW	26.1 °C	26.8 °C	12.4 kW	7.5 kW
RP-9-M	-15 °C	14.0 °C	78 kW	44.2 kW	30.6 °C	31.4 °C	30.3 kW	15 kW
[1)] Reference: Extract air temperature tEXT = 20 °C, corresponding to a temperature in the occupied area of ≈ 18 °C [2)] According to Table 3								

Table 4: RoofVent® RP winter design point, temperatures and heating performance

Well insulated halls exhibit an average specific heat output of 45 W/m². It therefore follows with $\dot{Q}_{Trans}$ according to Table 5 that a size 6 unit can cover an area measuring 16.6 m x 16.6 m and a size 9 unit can cover an area measuring 26 m x 26 m. This corresponds to specific air flow rates of 20 m³/(h·m²) and 11.9 m³/(h·m²) for sizes 6 and 9 respectively.

Cooling

The values for a summer design point with an outside air temperature tOUT = 32 °C and relative humidity of 60%, as well as an extract air temperature tEXT = 28 °C and 50% relative humidity, are listed in Table 6. The outside air is pre-cooled from tOUT to tER with $\dot{Q}_{ERG}$ by means of energy recovery in the plate heat exchanger. The capacity of the heat pump at these temperatures is $\dot{Q}_{WP}$. Of this, only $\dot{Q}_{WP\,sen}$ is for sensible use. The difference is required to dehumidify the outside air. $\dot{Q}_{WP\,sen}$ cools the outside air flow from tER to the supply air temperature tSUP. The dissipation of the fan power is disadvantageous here, as it heats the cooled supply air flow back up by ΔtV (according to Table 4) from tSUP to tSUP eff.

Thus, the cooling power $\dot{Q}_{Kühl}$ is available as the sensible cooling load; it is calculated from the supply air flow and the difference between the effective supply air temperature tSUP eff and the extract air temperature tEXT. The only energy requirement other than heating up the outside air from tOUT to tSUP eff is the electrical drive power required from the heat pump $\dot{Q}_{WP\,input}$.

RoofVent®	tOUT	tER [1]	$\dot{Q}_{ERG}$	$\dot{Q}_{WP}$	$\dot{Q}_{WP\,sen}$	tSUP	tSUP eff [2]	$\dot{Q}_{Kühl}$ [1]	$\dot{Q}_{WP\,input}$
RP-6-K	32 °C 60% rel. hum.	28.9 °C 71.5% rel. hum.	6 kW	29.7 kW	12.4 kW	22.1 °C	22.8 °C	9.5 kW	7.5 kW
RP-9-M	32 °C 60% rel. hum.	28.9 °C 71.5% rel. hum.	9 kW	59.4 kW	25.6 kW	19.3 °C	20.1 °C	21.0 kW	15 kW

[1] Reference: Extract air temperature tEXT = 28 °C, 50% rel. hum. corresponding to a temperature of ≈ 26 °C in the occupied area

[2] According to Table 3

Table 5: RoofVent® RP summer design point, temperatures and cooling capacities

With a specific cooling load of 60 W/m² inside a hall, a size 6 unit can cover an area measuring 12.6 m x 12.6 m and a size 9 unit can cover an area measuring 18.7 m x 18.7 m.

Conformity with regulations

The units comply with the requirements of the ErP Directive 2018. With regard to conformity with the requirements of the EEWärmeG (German Renewable Energy Sources Act), this combination proves doubly advantageous. The EEWärmeG specifies that a minimum of 50% of the energies used to heat and cool a building must be renewable. In our case, the renewable energy component is supplied by the heat pump. The energy recovery capacity of the units can also be included in the alternative energy component as a compensating measure.

TopVent® range with heat pump

The same heat pump model (data as per Table 1) is available as an option for the TopVent® recirculation range with sizes 6 (6000 m³/h) and 9 (9000 m³/h). Here too, the size 9 unit can be fitted with either one or two heat pumps. Once again, we will illustrate the performance capacity of these autonomous function units for a typical heating and cooling scenario. The solution involves a size 6 unit with one heat pump (TP-6-K) and a size 9 unit with two heat pumps (TP-9-M).

Fig. 2: TopVent® TP

Heating

The values for a winter design point with an outside air temperature tOUT = -15 °C and an extract air temperature tEXT = 22°C (recirculation unit intake) are listed in Table 8. The capacity of the heat pump for these temperature conditions (outside/inside) is $\dot{Q}_{WP}$. It heats the circulating air flow from tEXT to the supply air temperature tSUP.

The effect of the dissipation of the fan power (rounded values shown in Table 7) is much less significant here due to the reduced power of the fan:

TopVent® Size	$\dot{Q}_V$ [kW]	ΔtV [K]
6	0.4	0.2
9	0.9	0.3

Table 6: Fan power dissipation for TopVent® units

The heat flow $\dot{Q}_{Trans}$, which is the result of the circulating air flow and the difference between the effective supply air temperature tSUP eff and the extract air temperature tEXT, is made available for transmission coverage. The only energy requirement other than heating up the circulating air from tOUT to tSUP is the electrical drive power required from the heat pump $\dot{Q}_{WP\,input}$.

TopVent®	tOUT	tEXT	$\dot{Q}_{WP}$ [1]	tSUP	tSUP eff [2]	$\dot{Q}_{Trans}$	$\dot{Q}_{WP\,input}$
TP-6-K	-15 °C	22 °C	21.9 kW	33.0 °C	33.2 °C	22.3 kW	8.3 kW
TP-9-M	-15 °C	22 °C	43.8 kW	36.6 °C	36.9 °C	44.6 kW	16.6 kW

[1] Reference: Outside temperature tOUT = -15 °C, extract air temperature tEXT = 22 °C, corresponding to a temperature of ≈ 20 °C in the occupied area

[2] According to Table 6

Table 7: TopVent® TP winter design point, temperatures and heating performance

Cooling

The values for a summer design point with an outside air temperature tOUT = 32 °C and an extract air temperature tEXT = 28 °C with 50% relative humidity are listed in Table 9.

The capacity of the heat pump for these temperature conditions (outside/inside) is $\dot{Q}_{WP}$. Of this, only $\dot{Q}_{WP\,sen}$ is for sensible use.

The difference is required to dehumidify the outside air. $\dot{Q}_{WP\,sen}$ cools the circulating air from tEXT to the supply air temperature tSUP. The dissipation of the fan power heats the circulating air flow by ΔtV (according to Table 7) from tSUP to tSUP eff. Thus, the cooling power $\dot{Q}_{Kühl}$ is available as the sensible cooling load; it is calculated from the circulating air flow and the difference between the effective supply air temperature tSUP eff and the extract air temperature tEXT.
The only energy requirement other than cooling the circulating air from tOUT to tSUP eff, and its dehumidification, is the electrical drive power required from the heat pump $\dot{Q}_{WP\,input}$.

TopVent®	tOUT	tEXT	$\dot{Q}_{WP}$ [1)]	$\dot{Q}_{WP\,sen}$	tSUP	tSUP eff [2)]	$\dot{Q}_{Kühl}$	$\dot{Q}_{WP\,input}$
TP-6-K	32 °C	28 °C 50% rel. hum.	28.0 kW	19.4 kW	18.3 °C	18.5 °C	18.9 kW	6.7 kW
TP-9-M	32 °C	28 °C 50% rel. hum.	56.0 kW	39.4 kW	14.8 °C	15.1 °C	38.6 kW	13.4 kW

[1)] Reference: Outside temperature tOUT = 32 °C, extract air temperature tEXT = 28 °C, 50% rel. hum., corresponding to a temperature in the occupied area of ≈ 26 °C

[2)] According to Table 6

Table 8: TopVent® TP summer design point, temperatures and cooling capacities

Summary

The RoofVent® RP and TopVent® TP are fully decentralised and thus most importantly autonomous ventilation and heating/cooling systems. They require neither a central hot and cold water supply nor an equipment room. Both system ranges are characterised by high efficiency.

The use of these systems offers additional customer benefits for

- Operators, because the use of multiple autonomous units makes the system highly reliable
- Planners, because configuration work is easier and thus less expensive thanks to the systems being integrated in terms of ventilation, heating, cooling and control
- Installers, who benefit from fast financial return as a result of short installation times

Hoval Group

Internationally, the Hoval brand is one of the leading companies for heating and room climate solutions. With more than 70 years of experience and a team culture with a family atmosphere, Hoval exceeds expectations time and time again with its extraordinary solutions and technically superior developments. This leading role obliges the company to take a responsible approach to energy and the environment, and it does so by intelligently combining different heating technologies and individual room climate solutions. Furthermore, personal consulting and extensive customer service are typical of the world of Hoval.

With about 1900 employees in 17 group companies worldwide, Hoval does not regard itself as a group but as a large family that thinks and acts globally. Hoval heating and room climate systems are exported to more than 50 countries nowadays.

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