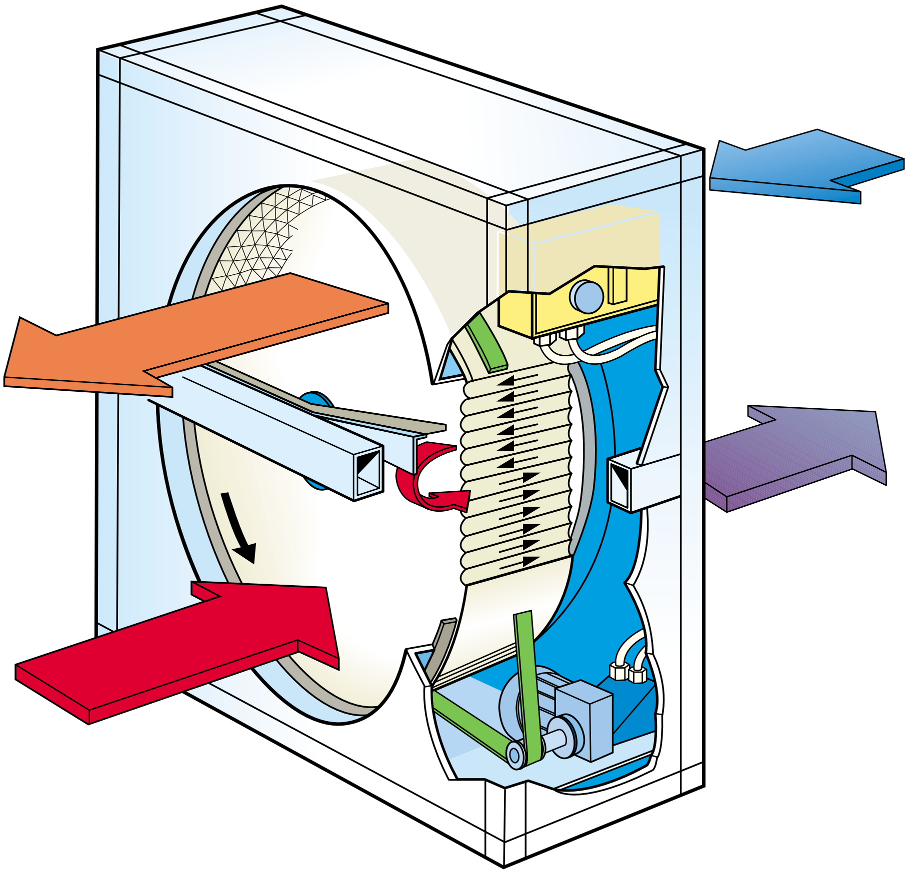
ECONOVENT® – PUM

Rotary heat exchanger
Technical handbook



FläktWoods

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Design

The ECONOVENT unit is a regenerative heat exchanger comprising a rotor which transfers heat and moisture from the exhaust air to the supply air as it rotates.

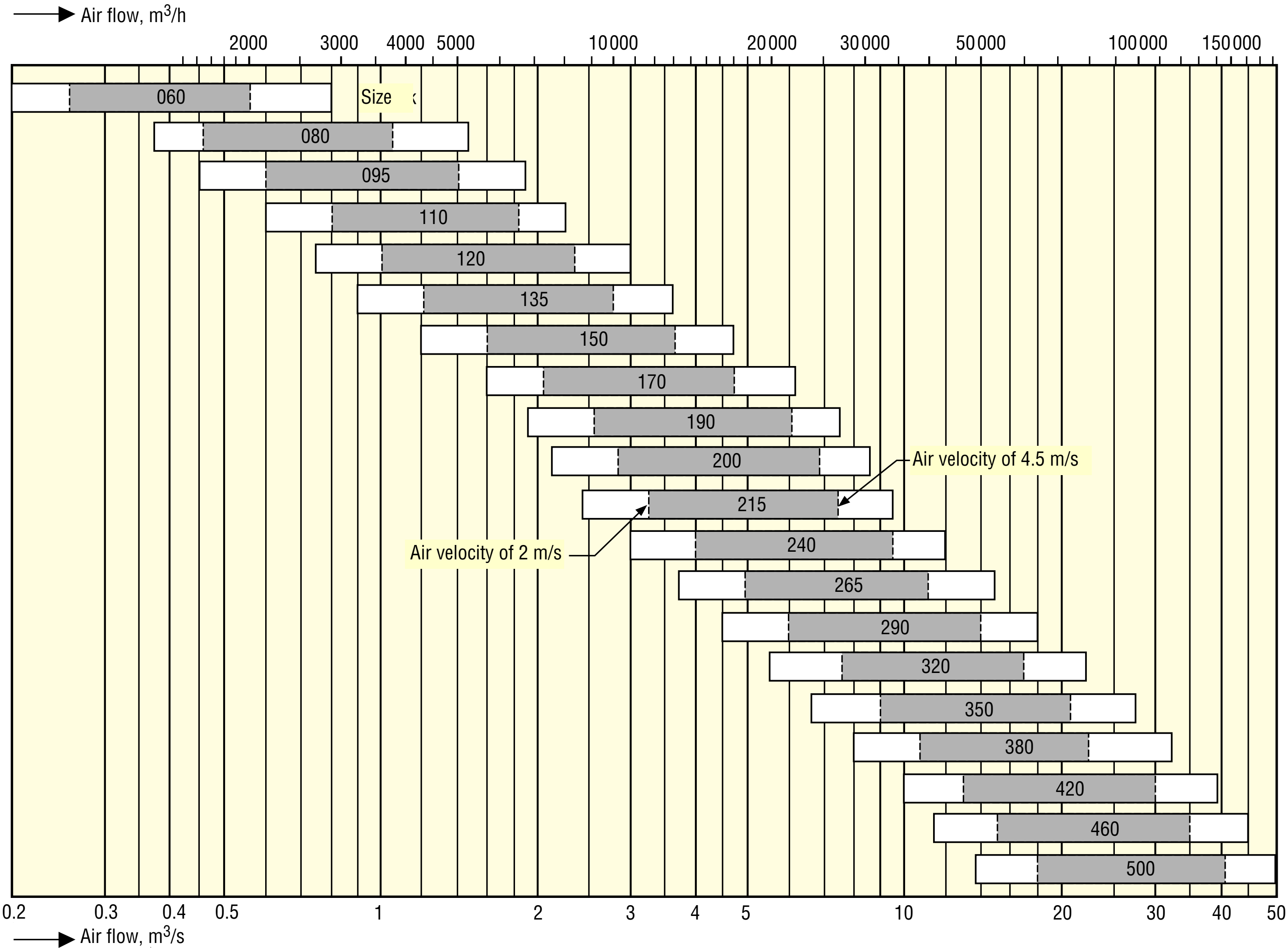
The supply air flows through one half of the heat exchanger, and the exhaust air flows in counterflow through the other half. Supply air and exhaust air thus flow alternately through small passages in the rotor in opposite directions.

Most important benefits:
Reduced heat demand which, in turn, reduces the size and thus also the investment cost for the boiler station or the connection charge for tariff-linked heat, such as electric power and heat from the district heating system. In addition, the sizes and thus also the investment costs of air heaters, pipes and pumps are also reduced.

- Reduced heat energy demand, which reduces the operating costs, i.e. the oil consumption or the conumption charge for electrical energy or heat from the district heating system.
- Reduced energy consumption for humidification (hygroscopic rotors) of the air, since moisture is also recovered.
- Reduced cooling power demand (hygroscopic rotors) which reduces the size and thus also the investment cost of the refrigeration system (compressor, cooling tower, etc.), air coolers, pumps and pipes.
- Reduced energy consumption for refrigeration (hygroscopic rotors).
- General reduction in environmental pollutants.

ECONOVENT is a complete product range of rotary heat exchangers for air handling systems in various types of environments and plants. ECONOVENT is available with six different materials for the rotor, and the right material can therefore always be specified to suit most environment.

GENERAL SURVEY - SIZES - FLOW RANGES (MINIMUM - MAXIMUM AIR FLOW RATES)



Design

General
The heat exchanger consists of a casing, a rotor of hygroscopic or non-hygroscopic type, and a rotor drive unit.

Adjustable seals are fitted between the casing and the rotor on both sides, in order to minimize the leakage. The heat exchanger can be ordered either with or without purging sector.

The purging sector is adjustable and prevents the carry-over of exhaust air to the supply air.

Casing for sizes 060–240
The casing is of single-skin design and is made as one unit. An inspection panel (2 panels for size 190 and larger sizes) is located on the end wall or front (optional) of the casing as shown in Fig. 1. The drive motor and speed controller (for a variable speed unit) are fitted and tested at the factory. Note that a split casing as shown in Fig. 2 is available for size 150 and larger sizes.

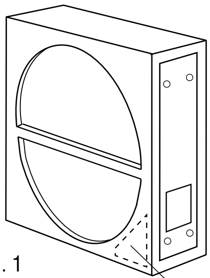


Fig. 1

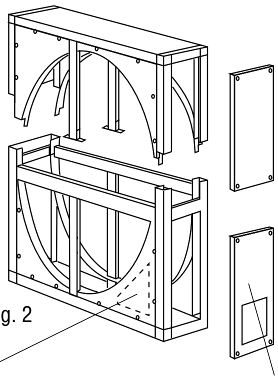


Fig. 2

Inspection panel, optional

Inspection panel standard

Casing for sizes 265–500
The casing is of single-skin design and is delivered split, as shown in Fig. 3. Size 265 and 290 units can also be ordered assembled at the factory. Inspection panels are located on the front or on the end wall (optional) of the heat exchanger as shown in Fig. 3. The drive motor is installed on the inside of the inspection panel. Access panels are provided on the front of the casing for installation of the rotor sector.

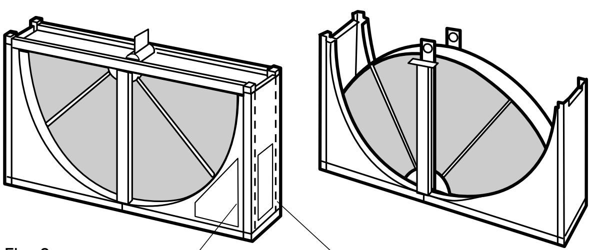


Fig. 3.

Delivery form in split version.

Delivery
The ECONOVENT PUM(A-F) HEAT EXCHANGER is delivered as shown in Table 1.

Size Code suffix aaa	One factory-assembled unit: One-piece rotor [1]	One factory-assembled unit: Sectorized rotor	One factory-assembled unit: Split casing Sectorized rotor	Split casing (2 units) Sectorized rotor
060	●			
080	●			
095	●	●		
110	●	●		
120	●	●		
135	●	●		
150	●	●	●	●
170	●	●	●	●
190	●	●	●	●
200	●	●	●	●
215	●	●	●	●
240	●	●	●	●
265			●	●
290			●	●
320				●
350				●
380				●
420				●
460				●
500				●

● Standard. 1) A composite rotor (PUMF) is always sectorized.

Drive system
The drive system consists of an electric motor (constant speed or variable speed) with reduction gear, driving the rotor by means of a jointed V-belt. The V-belt is kept automatically tensioned by the spring-mounted motor bracket.

Temperature limit
The heat exchanger is suitable for use at temperatures up to +75°C.

The temperature in the motor compartment must not exceed +40°C. If the supply or exhaust air temperature exceeds +40°C, see further under Temperature limit on page 21.

Materials and finish
Frame Sizes 060–240: hot-dip galvanized sheet steel

Sizes 265–500: rotor support steel beams, primed with anti-corrosion paint.

Cover panels, inspection panels and purging sector: hot-dip galvanized sheet steel.
Hub (one-piece rotor): aluminium
Hub (sectorized rotor): steel, primed with anti-corrosion paint.

Design - description - accessories

Rotor material

ECONOVENT rotors of aluminium.
ALUMINIUM ROTORS (A, C and E rotors) are non-hygroscopic, i.e. they recover only sensible heat, as long as condensation does not occur.
ALUMINIUM ROTORS (B and D rotors) are hygroscopic and recover both sensible heat and latent heat (on changing moisture content).

COMPOSITE ROTORS (F) rotors are hygroscopic, i.e. they recover both sensible heat and latent heat. The composite material is incombustible and contains no metals, which means that the material cannot corrode.
The material is treated with silica gel-based substances.

GENERAL SURVEY OF ROTORS

ECONOVENT rotor designation	Material	Property	Temperature - range, °C	Application
A	Aluminium	Non-hygroscopic	<75	Heating and cooling energy recovery in air handling systems - without moisture transfer.
B	Aluminium	Hygroscopic	<75	Heating and cooling energy recovery in air handling systems - with moisture transfer.
C	Edge-reinforced aluminium	Non-hygroscopic	<75	Heating and cooling energy recovery in air handling systems - without moisture transfer in a corrosive environment.
D	Edge-reinforced aluminium	Hygroscopic	<75	Heating and cooling energy recovery in air handling systems - with moisture transfer in a corrosive environment.
E	Epoxy-coated aluminium	Non-hygroscopic	<75	Heating and cooling energy recovery in air handling systems - without moisture transfer in corrosive environment.
F	Composite	Hygroscopic	<75 1)	Heating and cooling energy recovery in air handling systems - with moisture transfer in corrosive, city, marine and coastal environments.

1) Available for a max. temp. of 135°C. Get in touch with ABB Ventilation Products, Division ECONOVENT.

Accessories

PUMZ-17 Duct connection frames
PG type of flange connection, made of hot-dip galvanized sheet steel and fitted to the heat exchanger at the factory.

PUMZ-20 Speed detector
Used for continuous monitoring of the rotor speed, with automatic alarm if the rotor should stop when heat recovery is needed.
An alarm relay and sensor unit are needed for a constant-speed exchanger. Only the sensor unit is needed for a variable-speed exchanger.

PUMZ-21 Differential thermostat
In cooling energy recovery, used for switching the heat exchanger to maximum speed when the outdoor temperature is higher than the exhaust air temperature. Two sensors are included for fitting in the outdoor air and exhaust air ducts upstream of the heat exchanger.

PUMZ-27 Cleaning equipment
For automatic purging of the air passages in the rotor.

With compressed air nozzle which is moved by means of a pneumatically actuated cylinder in a radial direction along the face of the rotor. Nozzle, cylinder and control unit are included.

For assistance in selecting the variant and locating the equipment, please get in touch with your nearest ABB Ventilation, Division ECONOVENT representative.

PUMZ-28 Condensate tray
For collecting and disposal of the condensate from the rotor.

The process in the mollier chart

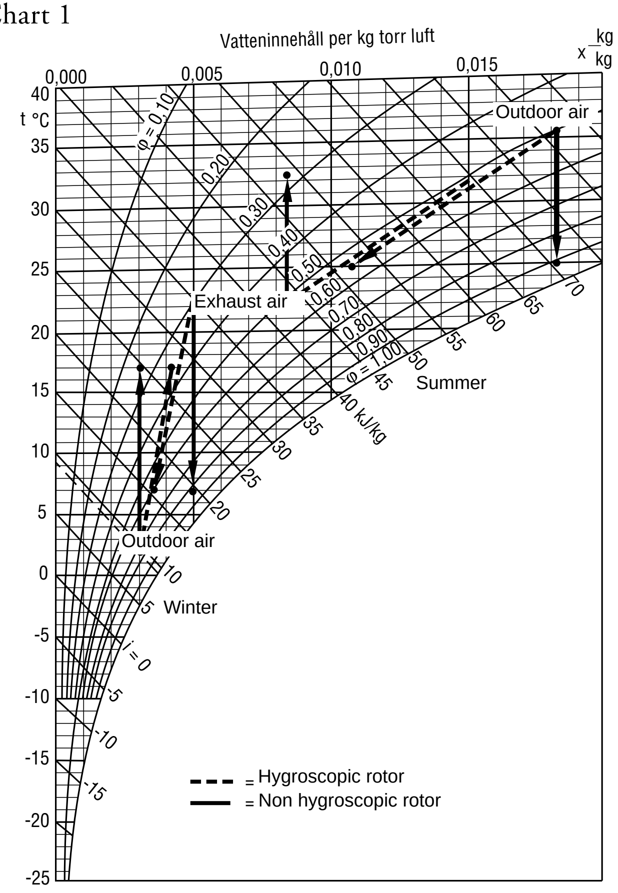
Non-hygroscopic rotors - type A, C and E

In type A, C and E NON-HYGROSCOPIC rotors, only sensible heat exchange takes place as long as no condensation takes place. As soon as condensation occurs, the condensate will evaporate in the supply air. The graphic presentation of the process in the Mollier chart when condensation takes place varies with the operating conditions and therefore cannot be specified generally.

Hygroscopic rotors - type B, D and F

In type B, D and F HYGROSCOPIC ROTORS, the moisture and temperature efficiencies at full speed are equal. As a result, the process in the Mollier chart runs along the interconnecting line between the inlet conditions for the supply and exhaust air.

Chart 1



The chart above shows various operating conditions in A, B, C, D, E and F rotors, all based on an efficiency of 75%. The dashed lines show the hygroscopic process, whereas the solid lines show the non-hygroscopic process.

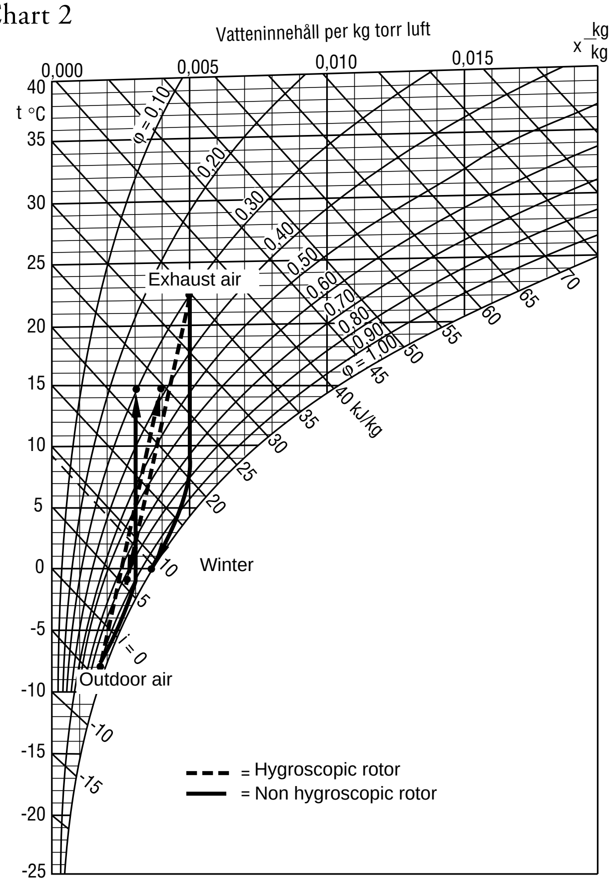
Summer operation

Chart 1 shows summer conditions in which the outdoor air is warmer and more humid than the exhaust air. The hygroscopic rotor lowers both the moisture content and the temperature to the vicinity of the exhaust air conditions, and gives an enthalpy efficiency of 75%. The non-hygroscopic exchanger lowers the temperature by the same amount, but does not change the moisture content. So the supply air enthalpy efficiency will be only 25%. The example illustrates the significance of the high moisture efficiency of the hygroscopic rotor, above all in humid, warm climates.

Winter operation

Chart 1 shows a winter case with moderately low outdoor temperatures. No condensation takes place in the non-hygroscopic rotor, which therefore does not contribute to the moisture content of the supply air. On the other hand, the hygroscopic rotor raises the moisture content of the supply air by almost 1.5 g/kg of air, which usually offers welcome humidification of the supply air.

Chart 2



Winter operation

The non-hygroscopic rotor can operate without risk of freezing even when condensation takes place at temperatures below 0°C.

Chart 2 shows such a case, in which the supply air can absorb the condensate precipitated out, without coming into contact with the saturation curve.
In this case, the moisture efficiency of the non-hygroscopic rotor will be 45%.

Under these operating conditions, the hygroscopic rotor with a moisture efficiency of 75% will recover 1 g of water more per kg of air than the non-hygro-scopic rotor, which contributes substantially to maintaining a higher humidity in the ventilated premises.

The process in the mollier chart

Frosting - Defrosting

Rotor temperatures below 0°C need not necessarily cause frosting in the rotor. Moisture transfer then takes place by the moisture which has been deposited as frost on the rotor surface being evaporated on the supply air side. For frosting to occur, there must also be excess water in the rotor. This will take place if the supply air is incapable of absorbing the moisture that has condensed out of the exhaust air.

The frosting process, which causes an increase in pressure drop across the rotor, normally takes many hours. The frosting problem is therefore often relieved by the outdoor temperature varying over a 24-hour period, or because the heat exchanger is in operation during only part of the 24-hour period.

Frosting limit

Frosting will occur if excess water should occur, at the same time as the supply air inlet temperature is below

-10°C. This temperature applies with relatively good accuracy at different air flow rates, full speed and typical exhaust air temperatures occurring in comfort ventilation systems.

Excess water will occur in the hygroscopic rotor as soon as the interconnecting line between the inlet conditions for the two air streams intersects the saturation line in the Mollier chart (see Chart 3).

In the case of a non-hygroscopic rotor, excess water will form approximately when the interconnecting line between the supply air inlet conditions (1) and the exhaust air conditions at $t = t_{d3} + 4°$ C and $x = x_3^{(3')}$ intersects the saturation line in the Mollier chart as shown in Chart 4 (t_{d3} denotes the dew point of the exhaust air). Charts 3 and 4 show examples of the sequence of events during frosting in hygroscopic and non-hygroscopic rotors respectively.

Frosting time

As an example, it will take about 8 hours for the pressure drop to increase by 50% if the saturation curve is intersected as shown in Chart 3, and about 4 hours if the saturation curve is intersected as shown in Chart 4.

Note that the frosting time will be as specified if the temperature and moisture conditions are constant throughout the frosting time. But since the temperature often varies, the frosting time may be appreciably longer.

As a result of factors such as operating time and supply air temperature variations, experience shows that a minor intersection of the saturation curve is permissible without significant frosting occurring, even if the design outdoor temperature is below –10°C.

Defrosting - avoidance of frosting

Frosting can be totally avoided by preheating the outdoor air to the temperature that specifies the limit for excess water, but to a maximum of around –10°C, even if excess water then occurs. The rotor can be defrosted, normally within 5–10 minutes, in several ways.

- By reducing the rotor speed to around 0.5 r/min (see example 4 on page 20).
- By preheating the incoming outdoor air to around –5°C.
- By by-passing a sufficient amount of supply air across the rotor that the outlet temperature on the exhaust air side will be at least around +5°C. As an example, the supply air flow rate would have to be reduced to around half for defrosting to take place at the normal exhaust air temperature, around 75% temperature efficiency and an outdoor temperature of about –20°C.

All three methods can be used for a variable-speed rotor, while the last two can be used at constant speed.

Chart 3.

Frosting process in a hygroscopic rotor

Mollier chart for moist air
Air –25° to +40°C

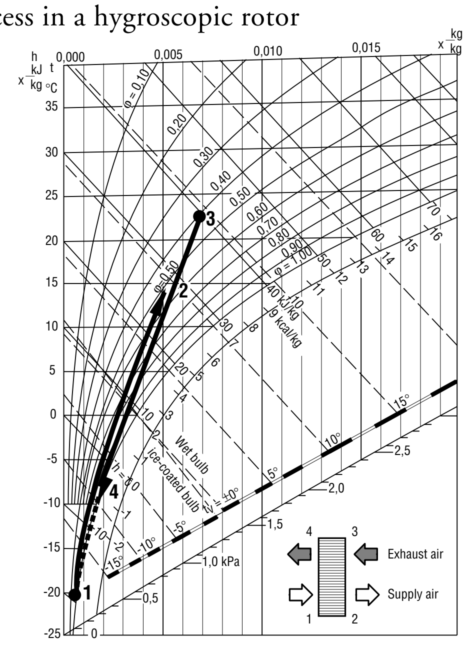
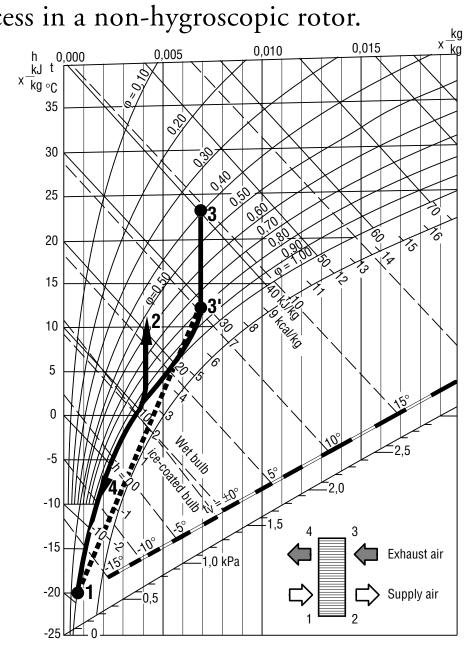


Chart 4.

Frosting process in a non-hygroscopic rotor.

Mollier chart for moist air
Air –25° to +40°C



Thermal calculations

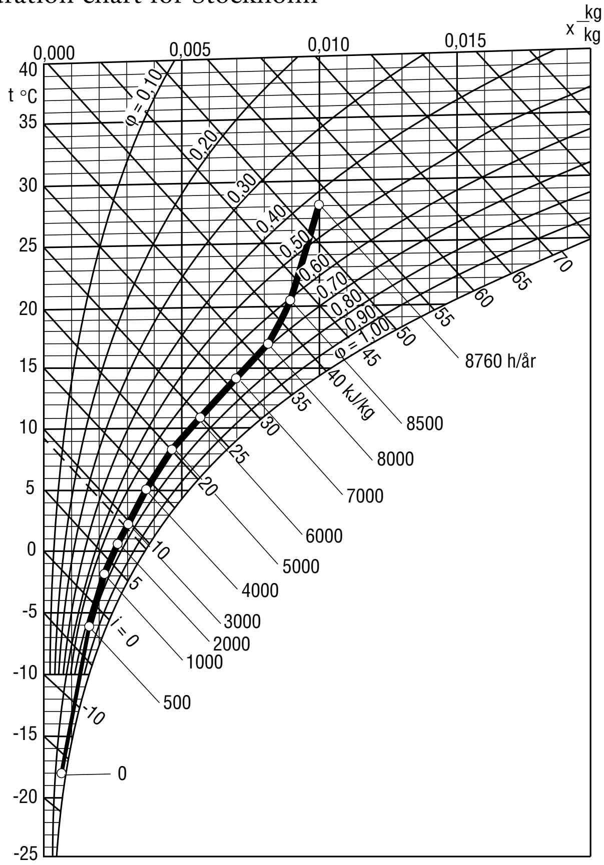
General

1. Duration chart for outdoor air

The duration chart for outdoor air is the measured relationship between time and the temperature or moisture content of the air. The duration is the number of hours during which the outdoor air is at the same or lower temperature or humidity than the specified value. If the values for the duration are plotted as a function of time, a duration curve will be obtained. Different geographical regions have different duration curves.

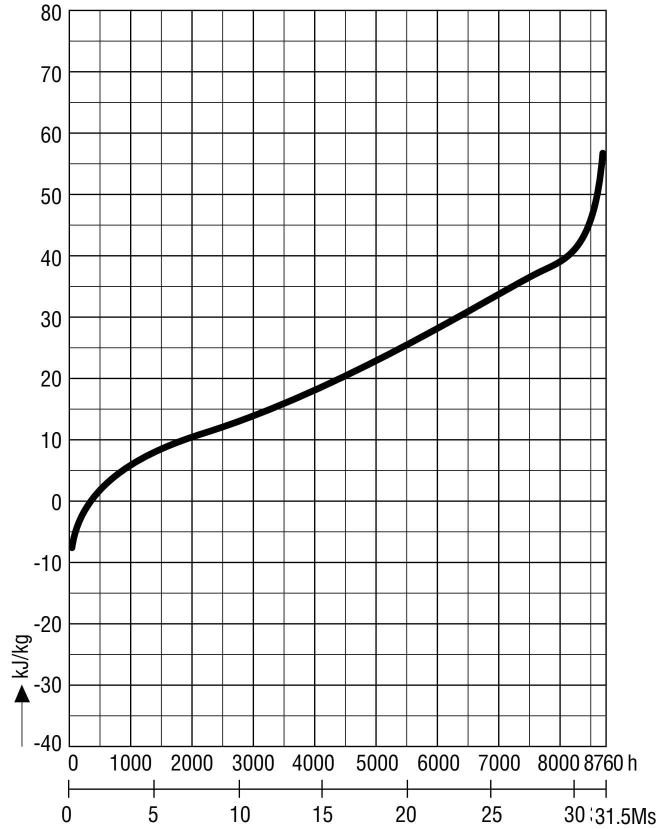
The values for duration can also be plotted in a Mollier chart, and the time is then specified as shown in Chart 5. From this curve, duration curves can then easily be plotted for temperature, moisture or enthalpy. The objective is to calculate the reduction in heating or cooling outputs but, above all, the reduction in energy consumption and thus the annual saving in monetary terms.

Chart 5
Duration chart for Stockholm



The duration curve for outdoor air enthalpy is shown in Chart 6:
This relationship is particularly suitable for calculating the cooling energy recovery.

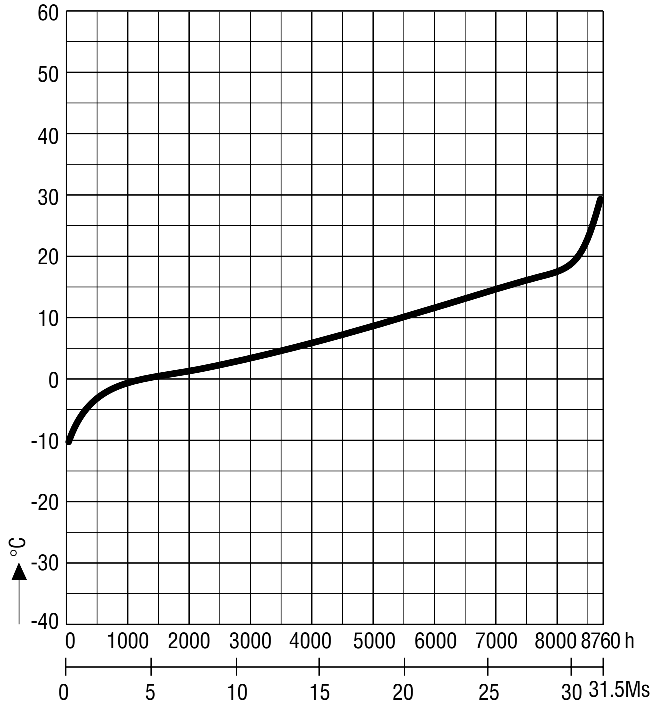
Chart 6
Duration chart for outdoor air enthalpy



Thermal calculations

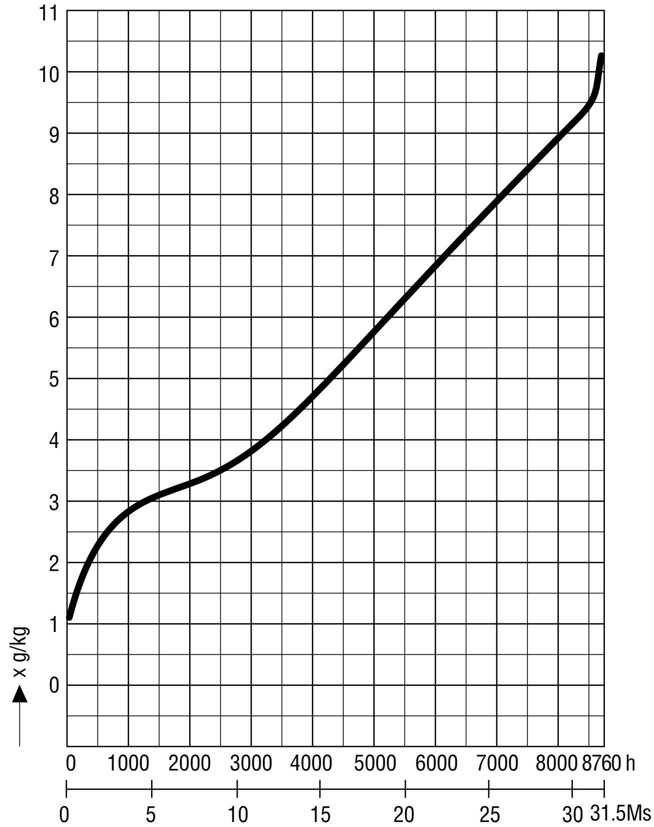
The temperature curve is used for calculating the sensible energy saving and the energy demand in an air handling system with non-hygroscopic rotor. As mentioned earlier, the non-hygroscopic rotor re-covers only sensible heat as long as no condensation occurs in the rotor. This rotor type is thus used if moisture recovery is not necessary or desirable. No general formula can be specified for the moisture conditions of the supply air downstream of the rotor.

Chart 7.
Duration chart for outdoor air temperature



Against this background, it is neither possible nor meaningful to calculate anything other than the sensible energy saving or demand.
The temperature curve is shown in Chart 7. The moisture duration curve is shown in Chart 8.

Chart 8.
Duration chart for outdoor air moisture content



2. Calculation methods

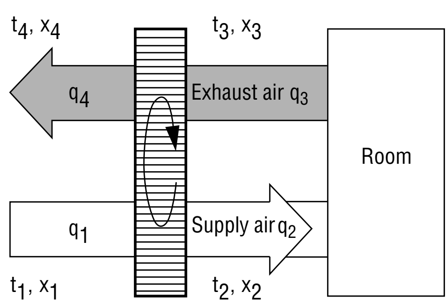
2.1 Systems for recovering only sensible heat

Symbols used

- q_1 = Supply air flow upstream of the heat recovery unit, m^3/s
- q_2 = Supply air flow downstream of the heat recovery unit, m^3/s
- q_3 = Exhaust air flow upstream of the heat recovery unit, m^3/s
- q_4 = Exhaust air flow downstream of the heat recovery unit, m^3/s
- t_1 = Supply air temperature upstream of the heat recovery unit, °C
- t_2 = Supply air temperature downstream of the heat recovery unit, °C
- t_3 = Exhaust air temperature upstream of the heat recovery unit, °C
- η_t = Temperature efficiency, %
- η_x = Moisture efficiency, %
- φ = Exhaust air relative humidity, %

$$\eta_t = \frac{t2 - t1}{t3 - t1}$$

$$\eta_x = \frac{x2 - x1}{x3 - x1}$$



Power saving P (kW or kJ/s) = supply air flow q_1 (m^3/s) x density ρ (kg/m^3) x specific heat of air cp (kJ/kg, °C) x temperature recovery Δ_t (°C).

Temperature recovery Δ_t (°C) = [design out-door temperature t_1 (°C) - design exhaust air temperature t_3 (°C)] x rotor efficiency η_t.

The energy saving is represented in the temperature chart by the area between the duration curve and the line for the supply air temperature downstream of the heat exchanger. The area must thus be determined, which can be done by means of a planimeter.

Energy saving Q (kJ/year) = actual energy area A (mm^2) x horizontal scale factor hs (seconds per mm) x vertical scale factor vs (°C per mm) x density ρ (kg/m^3) x cp (kJ/kg °C) x supply air flow q_1 (m^3/s) x ventilation factor k.

$$\text{Ventilation factor } k = \frac{\text{actual operating time (h)}}{\text{total number of hours in a year (h)}}$$

Cost saving K (SEK/year) = energy saving Q (kJ/year) x energy cost (SEK/kJ)

Pay-off time T (years) = Cost saving (SEK/year)/price of heat exchanger (SEK).

Thermal calculations

2.2 Plants for both temperature and moisture recovery

Power saving in this case consists of the enthalpy recovered at the design outdoor temperature. At this temperature, the rotor runs at full speed, and the temperature and moisture efficiencies are approximately the same.

Power saving P (kW or kJ/s) = supply air flow q_1 (m^3/s) x density ρ (kg/m^3) x enthalpy recovery Δh (kJ/kg).

Enthalpy recovery Δh (kJ/kg) = indoor-outdoor enthalpy difference, h_i - h_u (kJ/kg) x efficiency on page 14 of the heat exchanger at full speed.

The energy saving consists of both temperature recovery and moisture recovery.

The saving due to temperature recovery Q_t is calculated in the same manner as in 2.1 on page 9.

The moisture recovery Q_f is calculated as follows: From the plotted temperature chart, the necessary temperature efficiency η_t is determined at different times of the year. The corresponding moisture efficiency η_x at the same relative rotor speed is calculated from efficiency chart 13 on page 14.

Moisture recovery Δx (g/kg) = (indoor air moisture x_i - outdoor air moisture x_u) (g/kg) x actual moisture efficiency η_x.

Supply air moisture content x (g/kg) = (moisture recovery Δx (g/kg) + outdoor air moisture x_1 (g/kg). The line for the supply air moisture content can thus be plotted in the duration chart, and the recovery during the year can be calculated. This is represented by the area between the outdoor air and the supply air moisture contents and can be determined by means of a planimeter.

Moisture recovered during the year x (g/year) = actual moisture area F (mm^2) x horizontal scale factor h_s (s/mm) x vertical scale factor (g/kg, mm) x supply air flow q_1 (m^3/s) x density ρ (kg/m^3) x ventilation factor k.

Heat recovered Q_f (kJ/year) due to moisture recovery = moisture recovered x (g/year) x latent heat r = 2.50 (kJ/g).

Total energy recovery Q_{tot} (kJ/year) = temperature recovery Q_t (kJ/year) + moisture recovery Q_f (kJ/year).

The cost saving and the pay-off time for the heat exchanger can then be calculated in the same way as in 2.1 on page 9.

2.3 Plants for cooling energy recovery

In such systems, the heat exchanger runs at full speed, and the temperature and moisture efficiencies are approximately the same. The cooling recovery can thus be calculated directly by the enthalpy recovery.

Read the outdoor air enthalpy at various times during the cooling period and plot them in Chart 9.

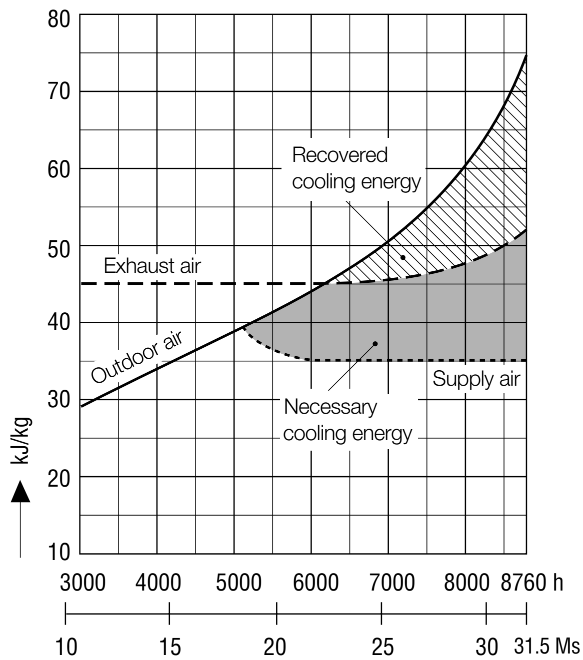
Calculate the supply air enthalpy downstream of the heat exchanger as follows:

Supply air enthalpy h_t (kJ/kg) = outdoor air enthalpy $h_{outdoor}$ (kJ/kg) - [outdoor-indoor enthalpy difference h (kJ/kg) x heat exchanger efficiency η].

Power saving for the cooling installation: P (kW or kJ/s) = supply air flow q_1 (m^3/s) x density ρ (kg/m^3) x enthalpy recovery at the design outdoor air enthalpy, design $i_{outdoor}$ (kJ/kg).

The cost saving and pay-off time for the heat exchanger are then calculated in the same way as in 2.1 on page 9.

Chart 9.
Outdoor air enthalpy



Computer program

We have designed a computer program with the aim of eliminating the relatively time-consuming manual work of calculating the energy and power demand. This program calculates automatically the power and energy savings on the basis of the given data (geographical area, air flows, operating times, air conditions, etc.) entered on an input data form. The makeup of the computer program is basically the same as the manual calculation method.

Climatic data for a large number of representative places in Europe has been included in the computer program.

For further information, please get in touch with your nearest Fläkt Woods representative.

Rotor selection

Selection of the rotor material to suit the application. Take great care to select the right material for every environment. If in doubt, consult your nearest Fläkt Woods representative.

Key to markings

- (light grey) = Right choice
- (dark grey) = Satisfactory
- (hatched) = Inadvisable

Rotor material	Aluminium		Edge-reinforced aluminium		Epoxy-coated aluminium	Composite
Application \ Rotor version	PUMA	PUMB	PUMC	PUMD	PUME	PUMF
Non-hygroscopic (recovery of heat)	Right choice	Inadvisable	Right choice	Inadvisable	Right choice	Inadvisable
Hygroscopic (recovery of heat + moisture)	Inadvisable	Right choice	Inadvisable	Right choice	Inadvisable	Right choice
Marine - coastal	Inadvisable	Inadvisable	Right choice	Right choice	Right choice	Right choice
Inland	Right choice	Right choice	Satisfactory	Satisfactory	Inadvisable	Inadvisable
Heavy industry	Inadvisable	Inadvisable	Satisfactory	Satisfactory	Right choice	Right choice
Light industry	Satisfactory	Satisfactory	Right choice	Right choice	Inadvisable	Inadvisable
Urban	Satisfactory	Satisfactory	Right choice	Right choice	Satisfactory	Satisfactory
Rural	Right choice	Right choice	Satisfactory	Satisfactory	Inadvisable	Inadvisable

Selection of heat exchanger type and size

1. Selection of heat exchanger

1.1 No moisture transfer required.
Plants intended for:
comfort air handling
exhaust air with solvents or
exhaust air with dry, granular dust.
Select the ECONOVENT with A rotor or possibly C rotor.

1.2 No moisture transfer required.
Plants with risk of corrosion and intended for:
comfort air handling
exhaust air with corrosive solvents
exhaust air with corrosive dust.
Select the ECONOVENT with E rotor.

1.3 Moisture transfer required.
Plants with humidification of the supply air and intended for:
comfort air handling,
light industry inland.
Select the ECONOVENT with B rotor or possibly D rotor.

1.4 Moisture transfer required.
Plants with humidification of the supply air and intended for:
comfort air handling
heavy industry in a coastal environment or
corrosive urban environment.
Select the ECONOVENT with D rotor or possibly F rotor.

1.5 Moisture transfer required.
Plants with high risk of corrosion and intended for:
comfort air handling
heavy industry in a coastal environment or
corrosive urban environment
Select the ECONOVENT with F rotor

2. Selection of heat exchanger size

System description
Air handling system with a reheater designed to maintain a constant supply air temperature of +16°C during the cold season of the year.
Given
Supply air flow q_1 = 3.06 m^3/s = approx. (11 000 m^3/h)
Exhaust air flow q_3 = 2.78 m^3/s = approx. (10 000 m^3/h)
Exhaust air temperature at the design outdoor temperature in the winter t^3 = 22°C.
Air velocity - heat exchanger size
The heat exchanger size is selected to suit the air flow rate, efficiency, pressure drop and the significance of the installation cost.
However, practical and economic experience shows that, for optimum results, the heat exchanger size should be selected so that the face velocity is 2.2–4.5 m/s. In the example (see Chart 13 on page 15), size 170 should thus be selected. Since the exhaust air flow rate is lower than the supply air flow rate, the supply air efficiency will decrease.

Example of the determination of the heat recovery and profitability

Efficiency of a non-hygroscopic rotor
The design chart on page 13 is used for calculating the temperature efficiency. However, the relationship between the supply air and exhaust air flow rates must first be calculated. In the example, the flow rate ratio is 3.06/2.78 = 1.1. Knowledge of this and of the rotor size being 170 with a supply air flow rate of 3.06 m^3/s, η_t = 72% is obtained from the chart on page 15. The air velocity through the rotor is 2.9 m/s.
Determine the supply air condition after the heat exchanger at the winter design outdoor temperature t_1 = –10°C

$$\eta_{tt} = \frac{t_2 - (-10)}{22 - (-10)} = 0.72$$

t_2 is found to be = 13°C.

Heat recovery with a hygroscopic rotor

Given:
Supply air flow rate q_1 = 3.06 m^3/s
Exhaust air flow rate q_3 = 2.78 m^3/s

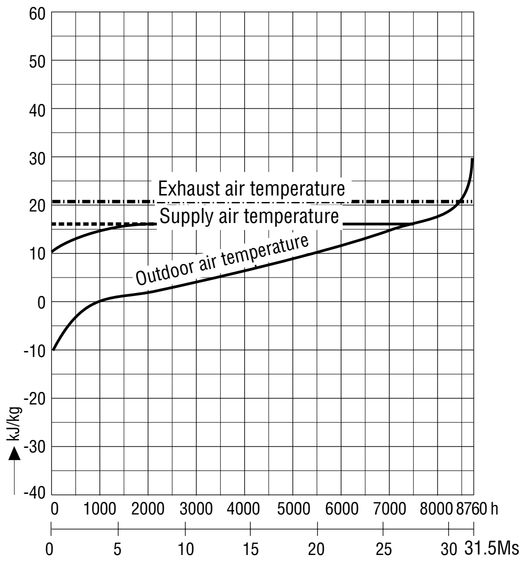
Ventilation factor = 10h, 5 days/week = $\frac{10 \times 5}{168}$ = 0.3

Room air conditions = 21°C, 45% RH

Constant t_2-temperature = 16°C

Plot the room air conditions and temperature t_2 in the temperature duration curve as shown in Chart 10.

Chart 10.
Temperature curve (for caculation)



The design winter outdoor temperature can be obtained from Chart 10 and is found to be t_1 = –10°C

Selection of heat exchanger type and size

The related values of time, temperature and moisture can be read from Chart 5 on page 8. The values for time and temperature should be plotted in Chart 10 on page 12, and the time and moisture in Chart 11 below.

The temperature and moisture efficiencies of the heat exchanger must then be determined for different times of the year. This is done by calculating the necessary temperature efficiency ηt of the exchanger, and the moisture efficiency ηx can be read in chart 12 on page 14 at the same relative speed.

Time h	η_t necessary	η_t	η_x for B and D rotors	η_x for F rotors
0	0.84	0.72	0.70	0.71
500	0.78	0.72	0.70	0.71
1000	0.76	0.72	0.70	0.71
2000	0.74	0.72	0.70	0.71
3000	0.70	0.70	0.55	0.62
4000	0.64	0.64	0.40	0.54
5000	0.55	0.55	0.26	0.43
6000	0.38	0.38	0.09	0.24
7000	0.17	0.17	0.02	0.06

The supply air temperature and moisture content downstream of the heat exchanger can now be calculated and plotted in Charts 10 and 11.

The area between the outdoor air and supply air temperatures downstream of the heat exchanger in Chart 10 is the sensible energy recovery during the year. In the same manner, the area between the outdoor air and supply air moisture contents in Chart 11 represents the moisture recovered during the year.

Energy recovery with the ECONOVENT hygroscopic rotor (B and D rotors)

$Q_{sensible}$ = 263.3 x 1.2 x 1 x 3.06 x 0.3 = 290.05 GJ
$Q_{moisture}$ = 37.2 x 1.2 x 3.06 x 0.3 x 2.5 = 102.44 GJ

Q_{total} = 392.49 GJ

Heat energy recovery with the ECONOVENT composite rotor (F rotor)

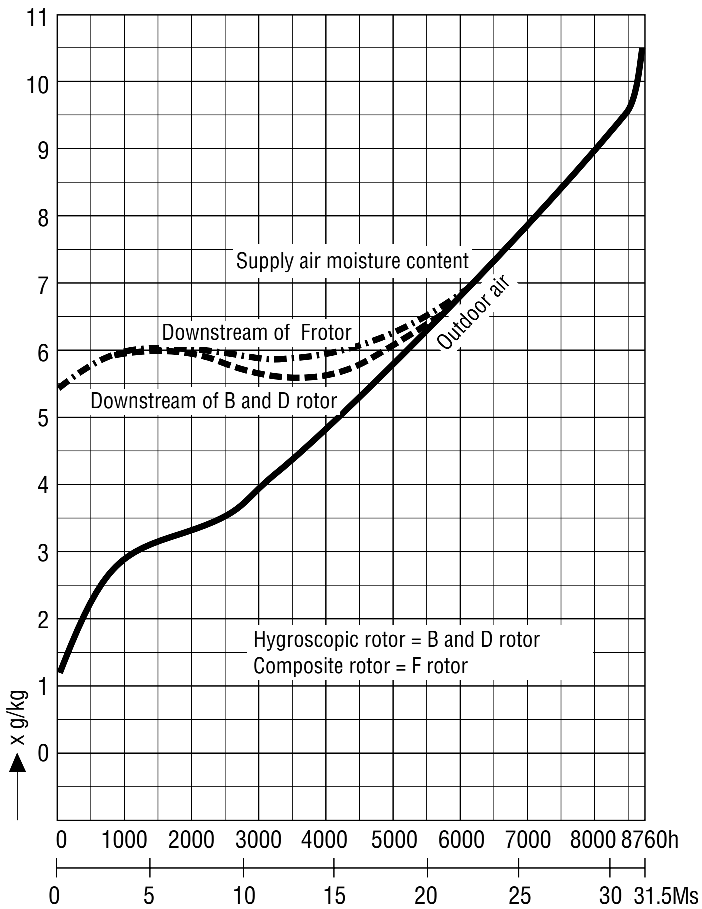
$Q_{sensible}$ = 263.3 x 1.2 x 1 x 3.06 x 0.3 = 290.05 GJ
$Q_{moisture}$ = 40.3 x 1.2 x 3.06 x 0.3 x 2.5 = 110.98 GJ

Q_{total} = 401.03 GJ

Profitability

The profitability and the pay-off time can be calculated in the same manner as in 2.1 on page 9.

Chart 11
Moisture curve for Sweden (for calculation)



Efficiency

For a non-hygroscopic rotor (A, C and E rotor):

The temperature efficiency can be obtained from the design chart on page 15. At maximum speed and for equal supply and exhaust air flow rates

$$\eta_{tt} = \eta_{tf}$$

The procedure for calculating the temperature efficiency at different air flow rates is given in the design chart on page 13. If the rotor size and the supply and exhaust air flows are given, the temperature efficiency is independent of the conditions of the supply and exhaust air.

A non-hygroscopic rotor recovers only heat as long as condensation does not occur in the rotor. There is no generally applicable formula for calculating the moisture content of the supply air downstream of the rotor when condensation takes place. If the rotor speed is reduced, the supply and exhaust air temperature efficiencies will decrease. This phenomenon is used for controlling the supply air temperature downstream of the heat exchanger.

The temperature efficiency is the same for all rotor types at a given face velocity.

For a hygroscopic rotor (B, D and F rotor):

The temperature efficiency for a given rotor size and a given supply air flow is obtained from the design chart on page 15. At maximum speed and for equal supply and exhaust air flows:

$$\eta_{tt} = \eta_{tf}$$

where

η_{tt} = supply air temperature efficiency and

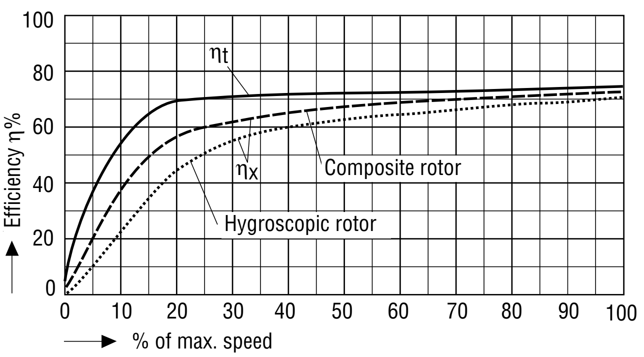
η_{tf} = exhaust air temperature efficiency.

At maximum speed and at different supply and exhaust air flow rates, the supply air efficiencies are linked, and so are those of the exhaust air.

$$\eta_{tt} \approx \eta_{xt} \quad \eta_{tf} \approx \eta_{xf}$$

How the temperature efficiency changes at different flow rates is shown in the design chart on page 15.

Chart 12
Temperature and moisture efficiencies at different rotor speeds



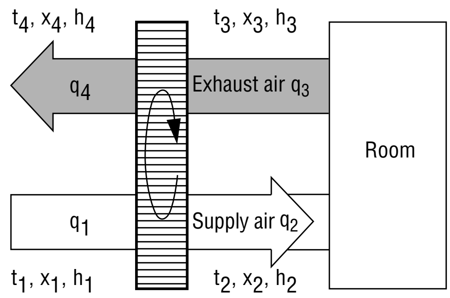


Fig. 4

Temperature and moisture recovery

The temperature efficiency η_t and the moisture efficiency η_x at different rotor speeds are shown in Chart 12. The chart is valid for normal changes in condition in climate systems and at an air velocity v = 3 m/s through the rotor. If the velocity in the planned rotor deviates substantially from that shown in Chart 12, the new efficiency at reduced speed can be calculated by proportioning.

Definitions:

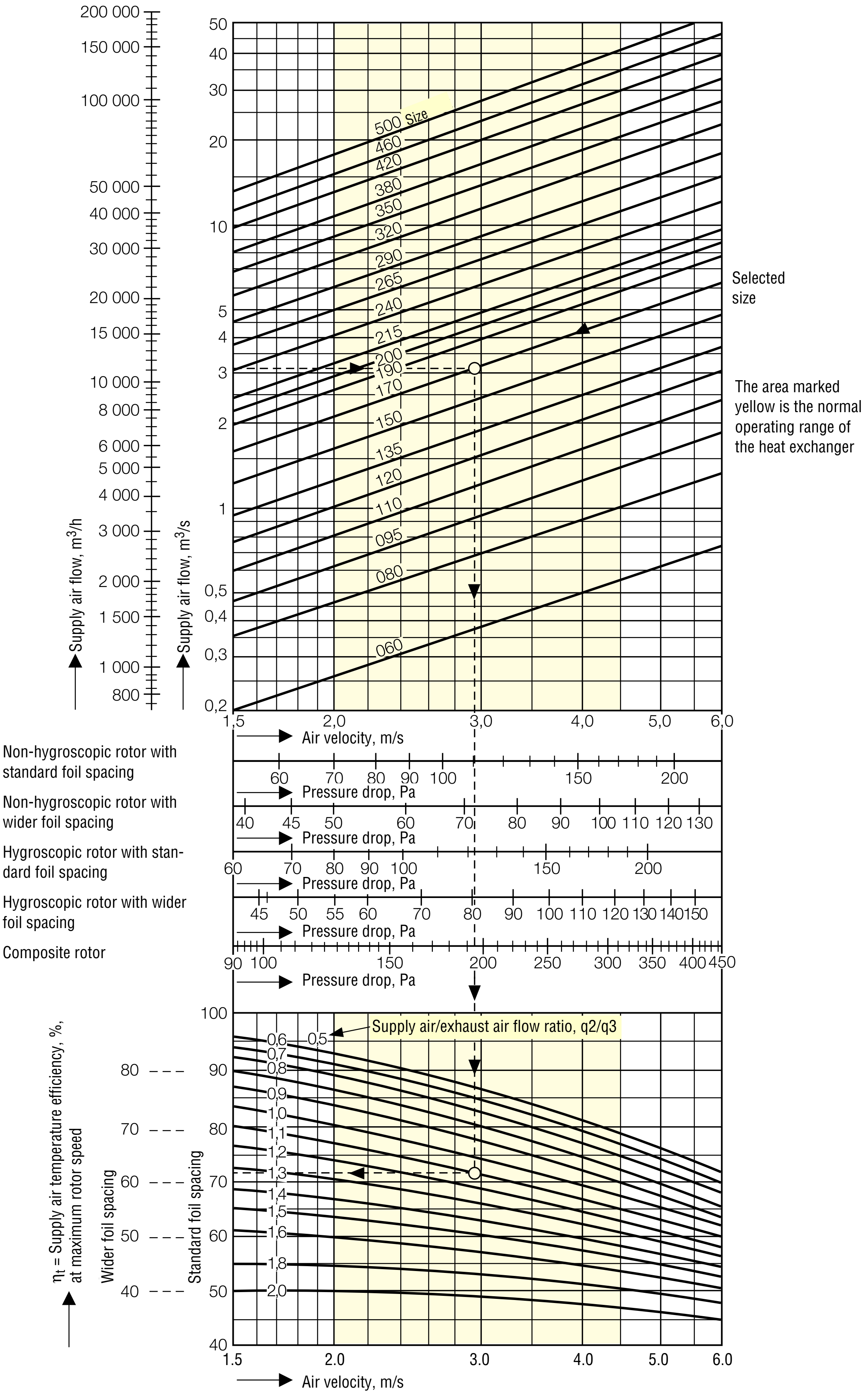
	Efficiency
Supply air temperature efficiency	$\eta_{tt} = \frac{t_2-t_1}{t_3-t_1}$
Supply air moisture efficiency	$\eta_{xt} = \frac{x_2-x_1}{x_3-x_1}$
Supply air enthalpy efficiency	$\eta_{ht} = \frac{h_2-h_1}{h_3-h_1}$
Exhaust air temperature efficiency	$\eta_{tf} = \frac{t_3-t_4}{t_3-t_1}$
Exhaust air moisture efficiency	$\eta_{xf} = \frac{x_3-x_4}{x_3-x_1}$
Exhaust air enthalpy efficiency	$\eta_{hf} = \frac{h_3-h_4}{h_3-h_1}$

t = temperature (°C)
x = water content per kg of dry air (g/kg)
h = enthalpy (kJ/kg)

A common feature of all hygroscopic aluminium rotors is that when the rotor speed is reduced, the moisture efficiency also drops below the temperature efficiency. However, with the ECONOVENT F rotor of composite material, the difference between the two efficiencies on a drop in speed is appreciably lower.

Design chart

Chart 13



Project design advice

Leakage flow rates and fan sizing

Leakage between the supply and exhaust air sides cannot be entirely eliminated in a rotary heat exchanger. But by locating the fans as shown in Fig. 5, the carry-over of exhaust air to the supply air can be eliminated. The pressure differential between the supply and exhaust air ducts on both sides of the exchanger should be such that $p_1 > p_4$ and $p_2 > p_3$. If necessary, an adjusting damper is installed as shown in Fig. 5 to achieve this.

Leakage at the seals can be minimized by the pressure differential between the supply and exhaust air ducts being as small as possible. Chart 14 shows the leakage flow across the seal as a function of pressure differential p_1 - p_3.

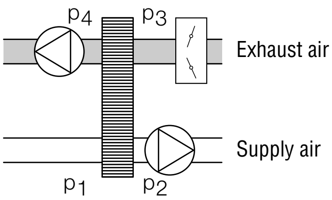


Fig. 5. Heat exchanger on the suction side of both fans

Purging sector – carry-over flow

The purging sector is located on the supply air outlet side, at the point where the rotor passes from the exhaust air flow path to the supply air flow path. The sector, which is adjustable between 0 and 6°, should be set to suit the pressure differential p_1 - p_3 in the system (see table below).

If the purging sector of the heat exchanger is set to 0°, a certain volume of exhaust air will always be transferred to the supply air, and a certain volume of supply air will always be transferred to the exhaust air by carry-over. However, these volumes are equal and cancel one another out. If the purging sector is correctly adjusted to suit the prevailing pressure conditions (see the table), complete purging of the rotor will take place without any air being lost. However, a certain amount of supply air will be transferred to the exhaust air by carry-over. This takes place at the point where the rotor moves from the supply air duct to the exhaust air duct as it rotates.

The volume carried over is approximately 3% of the supply air flow at Δp = 100 Pa, and approximately 1.5% at Δp = 200 Pa, regardless of the heat exchanger size (rotor speed = 10 r/min.).

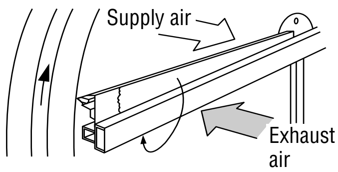
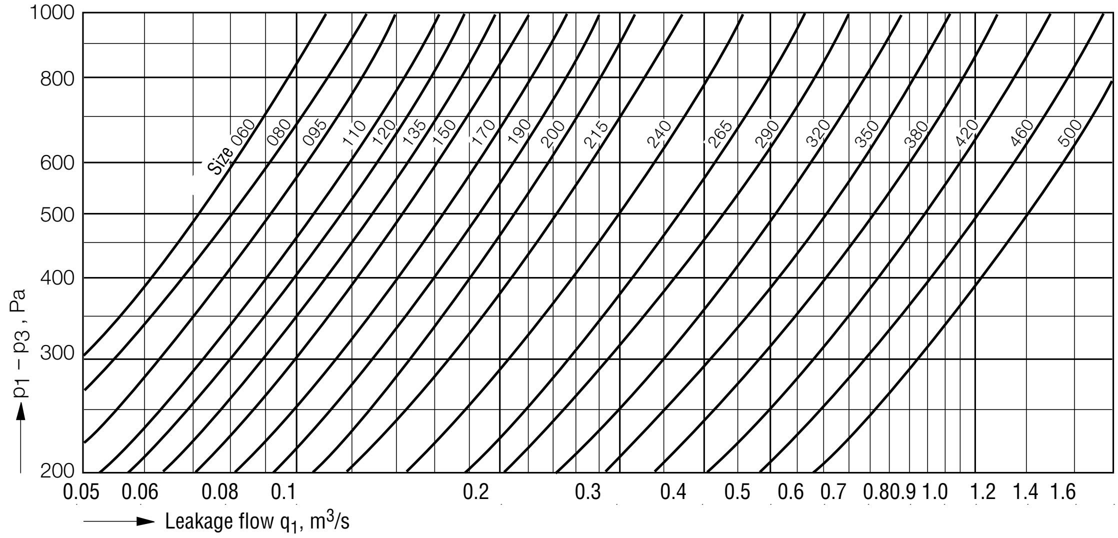


Fig. 6.
Purging sector

		Angle, degrees 1°– 6°					
		1	2	3	4	5	6
Pressure differential, p_1-p_3, Pa	Standard foil spacing	1200	500	320	230	180	150
	Wider foil spacing	700	250	150	110	90	70

Chart 14.
Leakage flow q_1



Symbols used:

Rotor pressure drop on the supply air side, Δp_{1-2}, Pa
Pressure differential across the purging sector, p_1 - p_3, Pa
Supply air flow downstream of the heat exchanger, q_2, m^3/s
Exhaust air flow upstream of the heat exchanger, q_3, m^3/s
Leakage flow, q_l, m^3/s
Carry-over flow, q_m, m^3/s

Calculation example:

Given: The PUMB-240 installed as shown in Fig. 5
$q_2 = q_3 = 8.5\ m^3/s$
$\Delta p = 165$ Pa
$p_1 - p_3 = 400$ Pa

Solution: From Chart 14, ql = 0.255 m3/s
Rating factor for the exhaust air

$$\text{fan} = \frac{q_3+q_l+q_m{*})}{q_3} = \frac{8,5 + 0,255 + 0,015}{8,5} = 1,032$$

The exhaust air fan thus operates at a flow which is around 4% higher than the exhaust air flow rate from the room (q_3).

*) As outlined above, the carry-over flow of supply air to the exhaust air amounts to around 1.5% of the supply air flow rate at Δp = 165 Pa.

Project design advice

Location of the fan

Question: Is air recirculation permissible?

If air is recirculated, the fans can be located in any position. If air recirculation is not permissible, the fans should be installed as shown in Fig. 7 or Fig. 8 if particularly high purging pressure is required.

Note that the installation shown in Fig. 7 may cause subatmospheric pressure in the building during the winter.

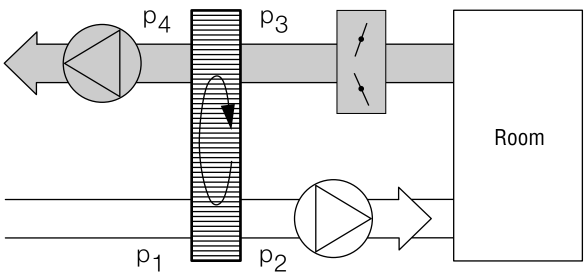


Fig. 7

This is the most common location of the fans. The pressure can be lowered by installing an adjusting damper in the exhaust air duct upstream of the heat recovery unit.

Question: Is maximum cooling energy recovery desirable?

If the fans are installed as shown in Fig. 8, all of the losses in the motor and the exhaust air fan and almost all of the losses in the motor and the supply air fan will be dissipated with the exhaust air.

These locations give constant pressure conditions in the building throughout the year.

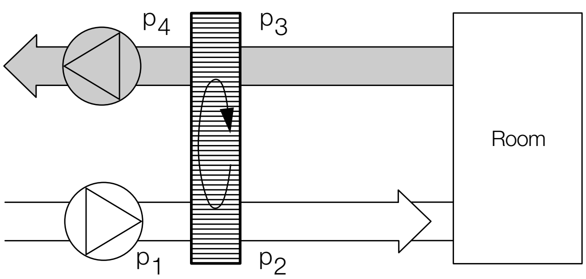


Fig. 8

Maximum cooling energy recovery will be achieved if the fans are located so that the heat in the outdoor air and the fan-generated heat are both transferred to the exhaust air. This location is also suitable for premises in which high air cleanliness is demanded.

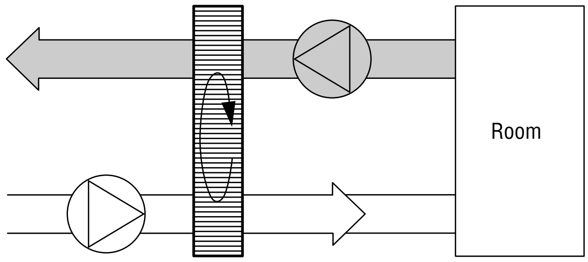


Fig. 9

The fan locations shown in Fig. 9 may give rise to problems, since it may be difficult to achieve correct pressure balance.

Question: Is maximum heat recovery desirable?

If the fans are installed as shown in Fig. 10, all of the power supplied to the exhaust air fan motor and almost all of the power supplied to the exhaust air fan motor will be utilized.

The location provides constant pressure conditions in the building throughout the year.

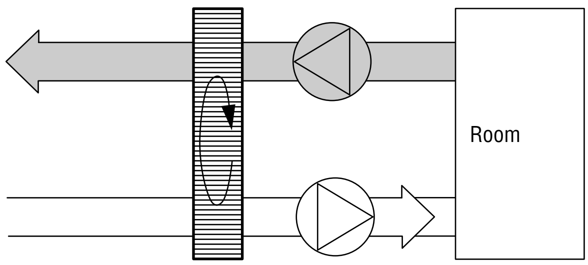


Fig. 10

Maximum heat recovery will be obtained if the fans are installed so that the heat from the exhaust air fan is utilized (Fig. 10). This fan location can be used only in systems in which air recirculation is permissible.

If the exhaust air is polluted and air recirculation is thus not permissible, pressure balance must be maintained on both sides of the heat exchanger.

Pressure conditions: $p_1 > p_4$, $p_2 > p_3$.

INSERTION LOSS ΔL_w, dB

Rotor version	Insertion loss ΔL_W, dB							
	Octave band, mid-frequency, Hz							
	63	125	250	500	1000	2000	4000	8000
Non-hygroscopic rotor, aluminium	3	4	4	3	4	5	6	9
Hygroscopic rotor, aluminium	3	2	3	4	5	6	7	9
Composite rotor	3	3	3	4	5	6	10	14

Project design advice

Filters

Experience has shown that the ECONOVENT rotor is very insensitive to clogging during operation, in spite of the dense structure of passages. This is due to the fact that the direction of air flow through the rotor is continually reversing, which has an excellent self-cleaning effect. The laminar flow through the rotor is also a contributory factor to the very rare occurrence of clogging of the rotor.

If either of the air streams has a high dust content, the particles usually adhere to the rotor surface, and very rarely settle inside the passages. As a result, the particles are blown away from the rotor surface when the direction of air flow reverses.

In many installations, the rotor is stationary during parts of the year. To protect the rotor from deposits and clogging, the supply air filter of the system should be located upstream of the rotor.

If the rotor should become clogged, it can normally easily be cleaned by vacuum cleaning. Compressed air, low-pressure steam and certain types of grease solvents can also be used.

Clogging problems may nevertheless occasionally occur in practice. In the event of doubt, it is therefore better to fit a filter rather than determine at a later date that a filter is needed (see Fig. 11 above).

In order to prevent fouling and clogging of the rotor during the construction period, the regular filters should be in position, and the rotor should always be rotating when the fans in the system are running.

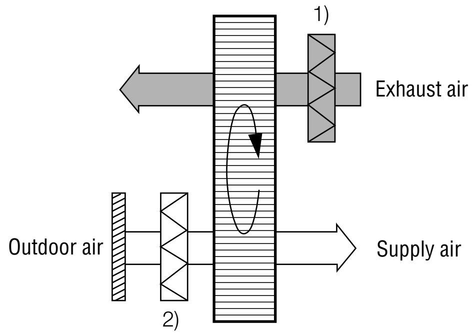


Fig. 11

1) A basic filter should preferably be installed, particularly if the dust consists of large particles, or of oily, tacky or adhering particles. If a filter is not installed, space should be left for installing a filter at a later date.

2) The filter class should be selected to suit the requirements of the premises.

Inspection facilities

An inspection section or a duct with inspection cover should be connected to the heat recovery unit to enable the rotor to be inspected and serviced. However, if unit sections with good access facilities are connected directly to the heat recovery unit, these may be used for inspection.

If the air is admitted at an angle to the rotor face

In systems in which the air impinges on the rotor face at an angle as shown in Fig. 12, the rotor could start to turn because of this inclined angle of flow. This may cause undesirable heat recovery due to the rotor rotating even when the heat exchanger is shut down.

In such installations, guide vanes should be fitted at the rotor inlet in order to deflect the air so that it will flow at right angles to the rotor face.

If the heat exchanger is located on the delivery side of the fan, a space should always be provided between the fan outlet and the rotor to enable the air leaving the fan outlet to distribute itself evenly over the whole of the rotor area.

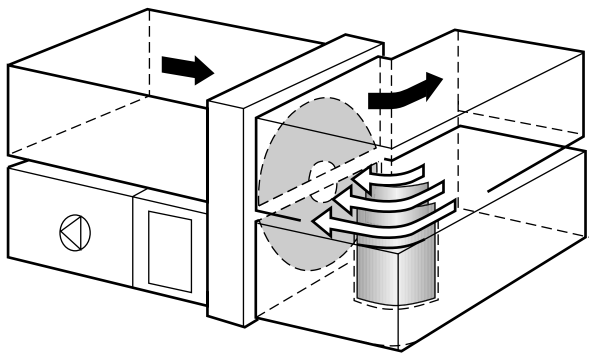


Fig. 12.

Control

Control of rotary heat exchangers

Either on/off or continuously variable control can be employed for controlling the rotor speed.

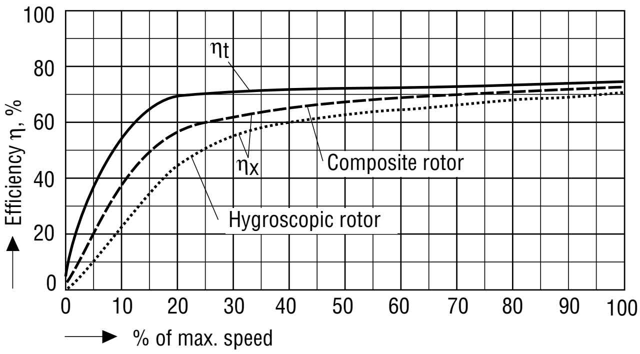
If on/off control is employed, the temperature efficiency will be either zero or a maximum.

In continuously variable control, the rotor speed is varied from rest to maximum speed in a continuous manner. The temperature and moisture efficiencies as a function of the rotor speed are shown in Chart 15.

During periods when no heat recovery is required, the rotor speed will be so low that the efficiency will be close to zero, although the rotor will still be purged.

For particulars of selecting the drive equipment for on/off or continuously variable speed, refer to separate instructions from Fläkt Woods.

Chart 15



RC RPM = Speed controller
ST = Temperature sensor
RC T = Temperature control unit
= Proportional thermostat
DM = Heat exchanger drive motor
DT = Differential thermostat
SV = Damper motor
K = Contactor

Example. Heat recovery - Variable speed

The heat exchanger rotor speed is controlled steplessly by temperature sensors for constant supply air temperature, constant room temperature or constant exhaust air temperature.

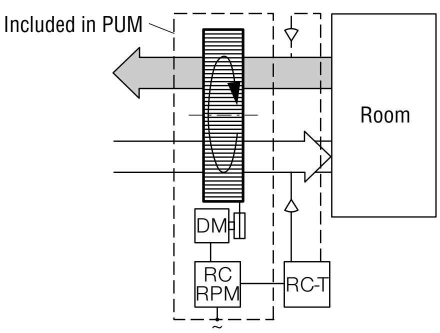


Fig. 13

Example 2. Heating and cooling energy recovery

The temperature sensor ⑤ maintains the supply air temperature or room temperature constant via the control unit ④ which, on a drop in outdoor air temperature, begins by reducing the cooling output. If the sensor ② senses a higher temperature than sensor ③, the rotor will run at maximum speed, which is known as summer case control. If no cooling is carried out and the temperature drops further, the rotor speed will increase. At maximum speed and increased heat demand, the supply air temperature is controlled by means of the reheater.

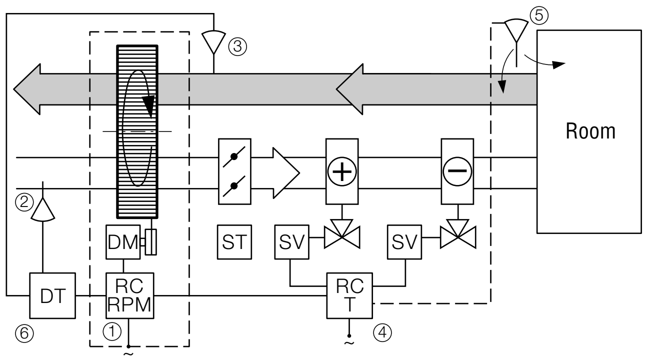


Fig. 14

① Speed controller
② Temperature sensor
③ Temperature sensor
④ Control unit of a make available on the market
⑤ EGL, TA or equivalent temperature sensor
⑥ Danfoss RT 270 or equivalent differential thermostat

Example 3. Cooling energy recovery - maximum speed

If the temperature sensors ② and ③ of the differential thermostat sense that the supply air temperature is higher than the exhaust air temperature, the motor will run at

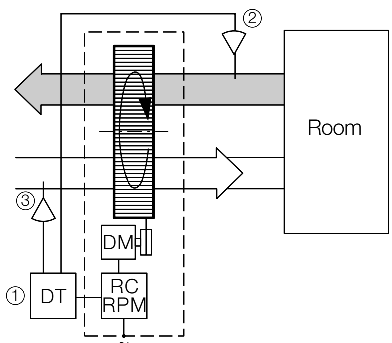


Fig. 15

maximum speed for cooling energy recovery.

① Danfoss RT 270 or equivalent differential thermostat
② Temperature sensor
③ Temperature sensor

Control

Example 4. Speed detector

Variable speed: The speed detector monitors the rotor speed. An alarm will be initiated if the rotor speed is lower than that demanded by the speed controller. The magnet, magnetic sensor and mounting bracket are included in the supply.

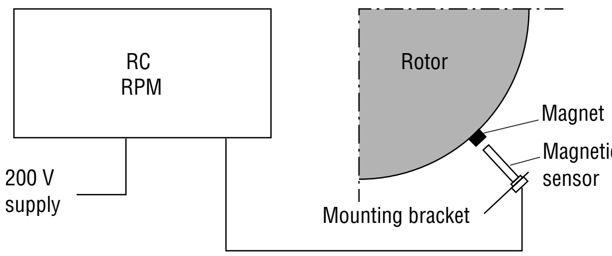


Fig. 16a

Constant speed: The speed detector consists of a magnet, a magnetic sensor and an alarm relay. The alarm relay is preset for an alarm delay time of 120 seconds. This time corresponds to the lowest rotor speed of approximately 0.25 r/min. In order to avoid an alarm when the rotor is intended to be stationary, the alarm relay should be wired so that an alarm can be initiated only when the system requires heating or cooling energy recovery (see the instructions).

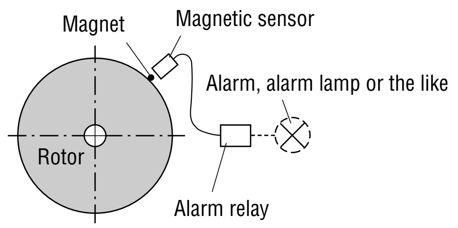


Fig. 16b

Example 5. Frosting monitor

Variable speed: The frosting monitor is used for indicating frosting in the rotor at very low outdoor temperatures and high humidity of the exhaust air. For particulars of when frosting is likely to occur, see chart 3 on page 7. If the pressure drop across the rotor exceeds the value preset on differential pressure switch ②, the rotor speed will be reduced if the heat exchanger is running at variable speed.

Constant speed: In the case of a constant-speed heat exchanger, the rotor is defrosted by the supply air being by-passed across the rotor via a damper or by the supply air fan being stopped. The differential pressure switch indicates when the damper should be opened or when the fan should be stopped.

Caution. No frosting is permissible in a composite rotor.

① Speed controller
② Billman type LGW3,
Stäfa type AFS 293,
TAAFS 293,
SAAS AFS 293
differential pressure switch.
③ Control signal

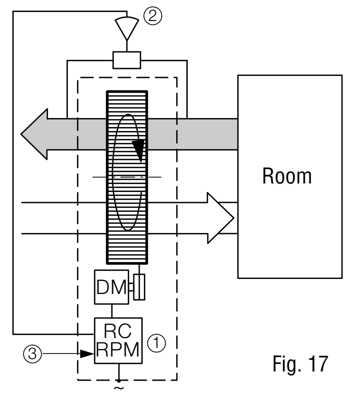
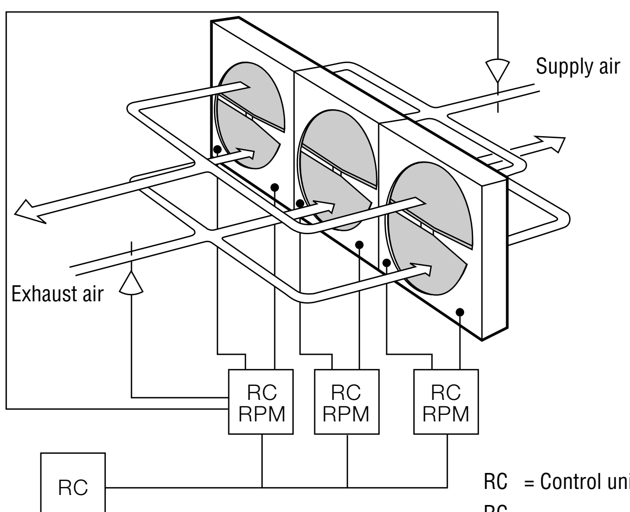


Fig. 17

Example 6. Parallel operation

If several rotary heat exchangers are included in a given air handling system and are thus to be controlled simultaneously, each heat exchanger must have its own speed controller and sensor for the speed detector. On the other hand, the control signals from the control unit (RC) and summer case sensors can be connected to only one speed controller, from which the others are supplied.



RC = Control unit
RC RPM = Speed controller

Fig. 18

Control

Example 7. Purging operation

Purging operation should be employed when the heat exchanger rotor is stationary for an extended period of time in an environment in which the supply or exhaust air contains dust that may cause clogging.

For the ECONOVENT with variable speed, no timeswitch need be employed. Purging operation is integrated into the speed controller. The function is switched in automatically when the rotor is stationary. A timeswitch (SU) with 24-hour dial is used for the ECONOVENT for constant speed, and this starts the rotor and runs it at maximum speed for 0.5–1 hour per 24 hours. Any dust that may have settled in the rotor passages will then be blown away by the air flow which is continually reversed through the rotor. A filter should always be installed in systems in which the dust is likely to cause deposits (see page 18).

Temperature limit for the drive motor

To ensure effective cooling of the drive motor located inside the casing, the temperature in the motor compartment should always be lower than +40 °C.

In systems in which the supply or exhaust air is at a higher temperature than +40 °C, the heat exchanger should be installed so that the leakage flow is from the cooler air stream to the warmer air stream. This is achieved by $p_1 > p_2$ and $p_2 > p_4$ as shown in Fig. 20 below. If the supply and exhaust air are both at temperatures above +40 °C, the motor compartment should be cooled by means of a separate fan.

As an alternative, the heat exchanger can be supplied with the drive motor located outside the casing.

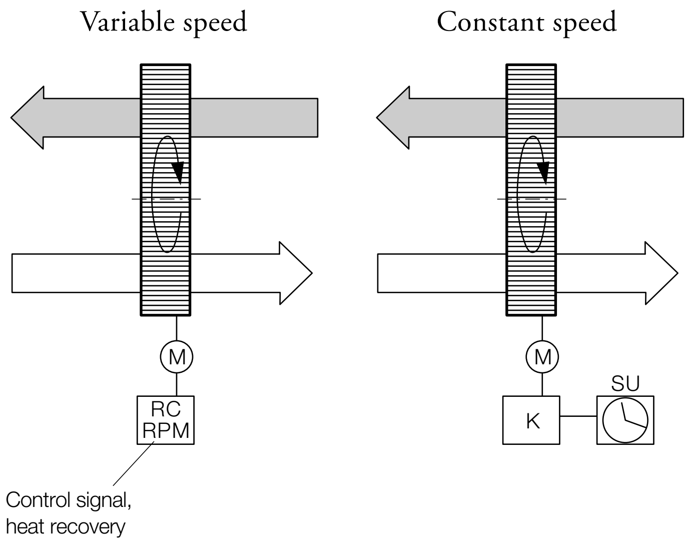


Fig. 19

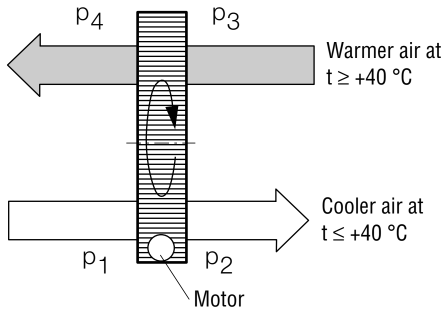
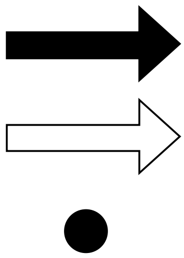
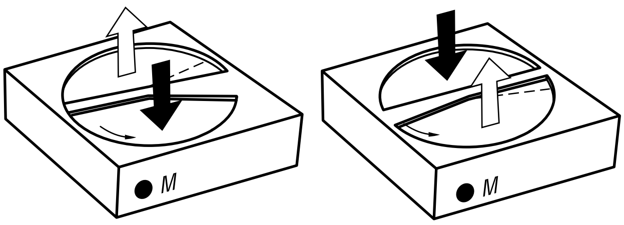


Fig. 20

Installation

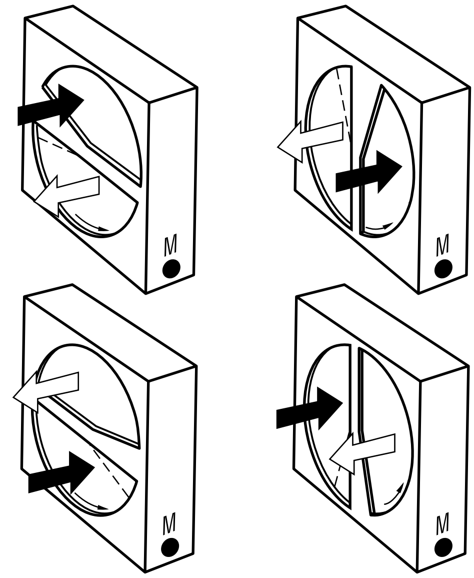
Rotary heat exchangers can be supplied for installation in air handling units, in the ducting or in a plant room. All variants and sizes can be installed either horizontally or vertically.





1. Horizontal installation

Fig. 21



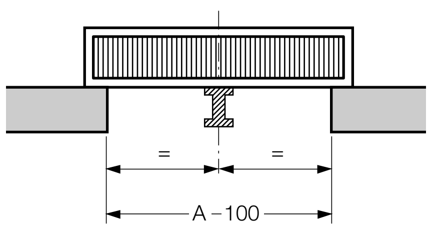
2. Vertical installation - horizontally split

3. Vertical installation - vertically split

Fig. 22

The heat exchanger should rest on a flat supporting surface. If other components, such as a duct or unit section, are connected to the top of the heat exchanger, their weight must not be applied to the exchanger.

A supporting centre beam must be provided for size 200 and larger units. The maximum permissible deflection of the load-bearing centre beam when supporting the weight of the heat exchanger and any other components is 1 mm.



For dimension A, see page 24.

Fig. 24

Installing the speed controller

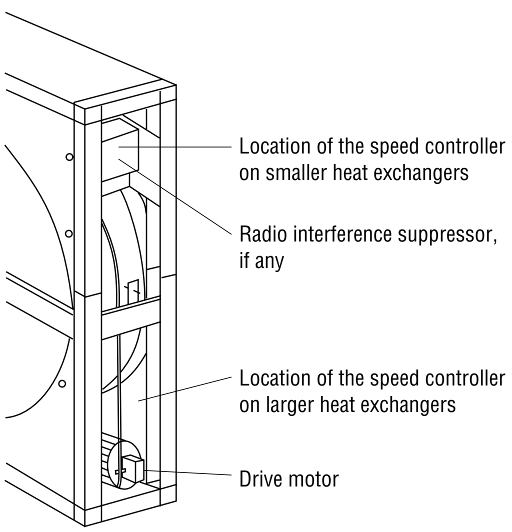


Fig. 23

Installation

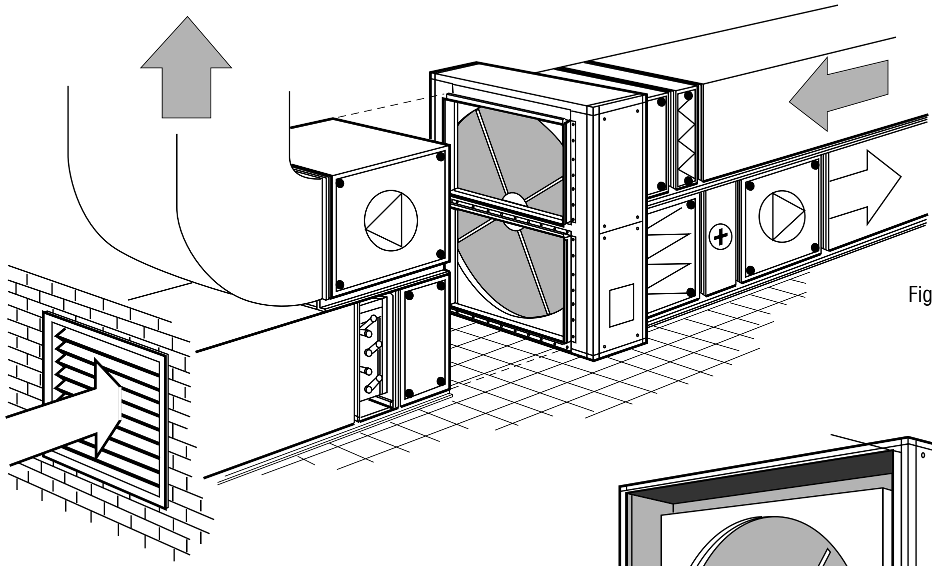


Fig. 25

Connection to other unit sections

A rotary heat exchanger with casing is best connected to the air handling unit or the ducting by means of slip clamps. The slip-clamp system should be fitted by the unit manufacturer or installation contractor to suit the connection openings on the unit or ducts.

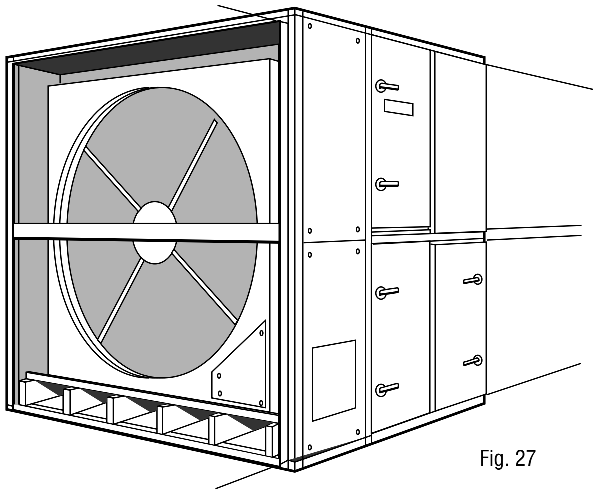


Fig. 27

Installation in a modular unit

The rotary heat exchanger with casing is mounted inside a unit casing or is connected by means of connection frames.

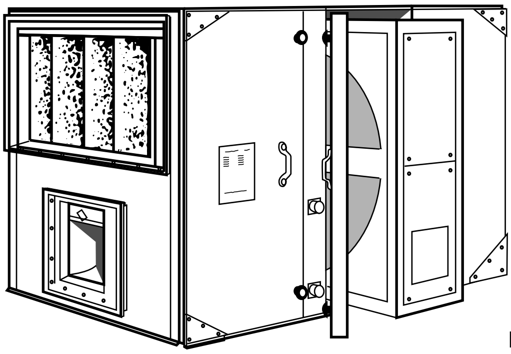


Fig. 26

Installation in compact units

The rotary heat exchanger with casing is pushed into the unit which is provided with seals designed to avoid

air leakage.

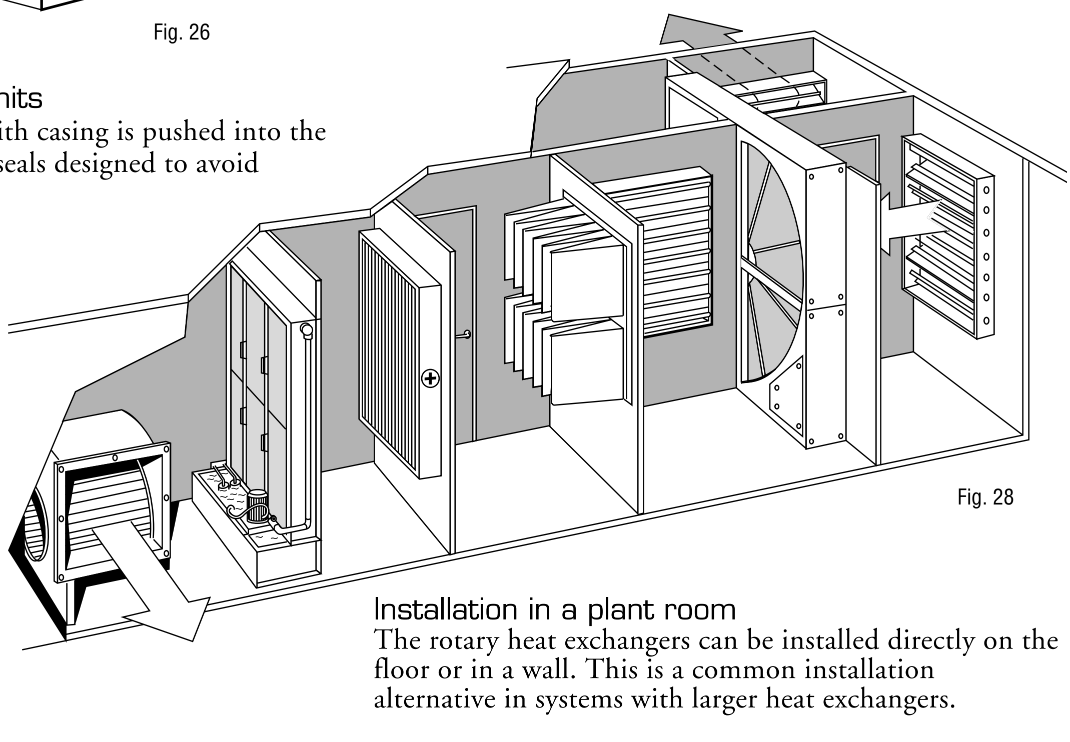


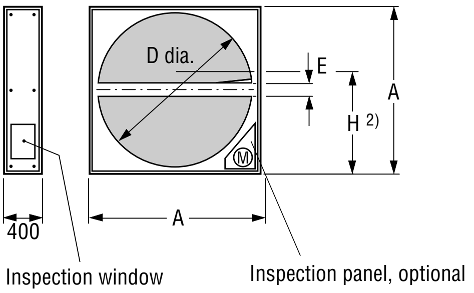
Fig. 28

Installation in a plant room

The rotary heat exchangers can be installed directly on the floor or in a wall. This is a common installation alternative in systems with larger heat exchangers.

Dimensions and weights – All dimensions in mm

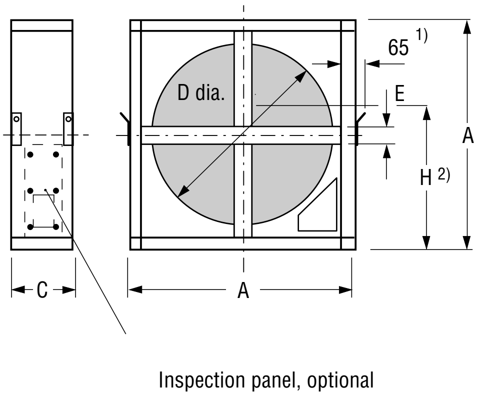
Size 060 - 240



2) Height H is the dimension for a split heat exchanger.

Size	A	D	E	H	Weight, kg Standard foil spacing	 Wider foil spacing	 Standard foil spacing industrial version
060	960	600	60	–	95	90	–
080	1100	800	60	–	130	125	–
095	1200	950	60	–	145	140	200
110	1400	1100	104	–	165	160	240
120	1500	1200	104	–	210	195	270
135	1600	1350	104	–	215	200	290
150	1700	1500	104	990	265	245	350
170	1900	1700	104	1090	305	275	395
190	2100	1900	104	1190	360	335	500
200	2200	2000	104	1240	415	355	550
215	2400	2150	104	1340	430	395	600
240	2640	2400	104	1460	530	480	740

Size 265–500

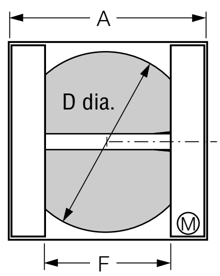


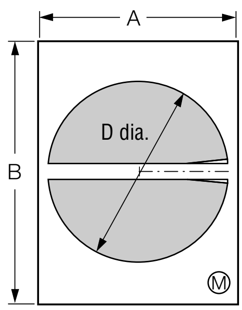
Size	A	C	D	E	H	Weight, kg Standard foil spacing	 Wider foil spacing	 Standard foil spacing Industrial version composite rotor
265	2900	430	2650	120	1800	870	770	970
290	3100	430	2900	120	1900	970	870	1100
320	3400	430	3200	120	2050	1200	1050	1350
350	3660	430	3460	120	2180	1300	1120	1450
380	4000	430	3800	120	2350	1500	1350	1700
420	4500	430	4200	120	2600	1800	1600	2000
460	4900	470	4600	185	2800	2900	2700	3500
500	5400	470	5000	185	2050	3500	3200	3800

1) Removable lifting lugs for sizes 265 to 500 inclusive.
2) Height H is the dimension for a split heat exchanger.

Rectangular casing and baffle plates

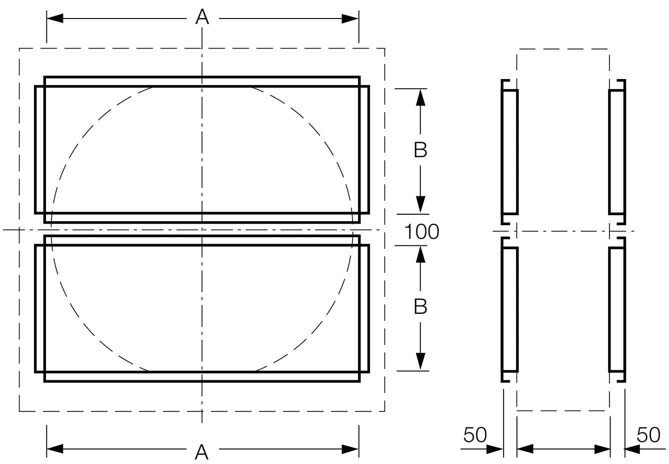
A rectangular heat exchanger casing can be produced, and the heat exchanger can be provided with baffle plates as shown in the figure below. In such cases, always specify the required dimensions A, B and F.





Dimensions and weights - Accessories All dimensions in mm

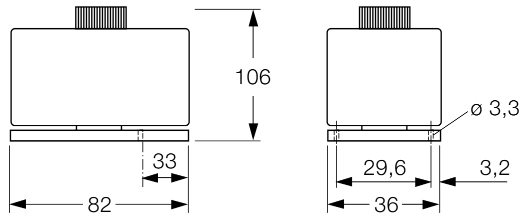
Duct connection frame PUMZ-17-bbb-2-0
Type for PG joint



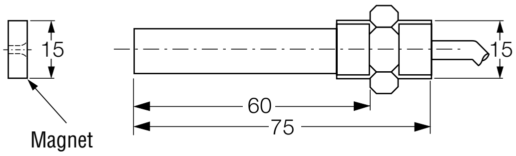
Size	PG / joint	
-bbb-	A	B
060	600	300
080	800	400
095	1000	500
110	1200	500
120	1200	600
135	1400	600
150	1400	700
170	1600	800
190	1800	900
200	2000	1000
215	2200	1000
240	2400	1200
265	2780	1340
290	2980	1440
320	3280	1590
350	3540	1720
380	3880	1890

Speed detector
An alarm relay and speed detector are needed for a constant speed heat exchanger, and only a speed detector for a variable speed heat exchanger (EMS).

Alarm relay PUMZ-20-2-1



Speed detector PUMZ-20-b-c

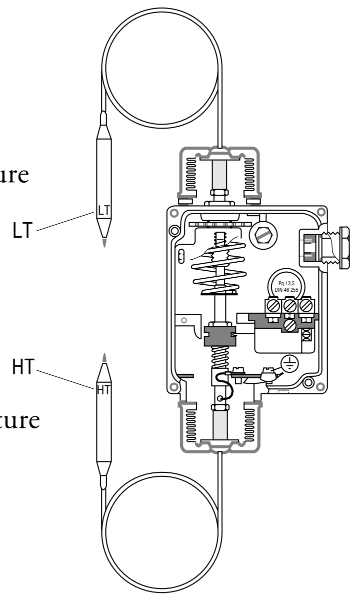


Differential thermostat PUMZ-21

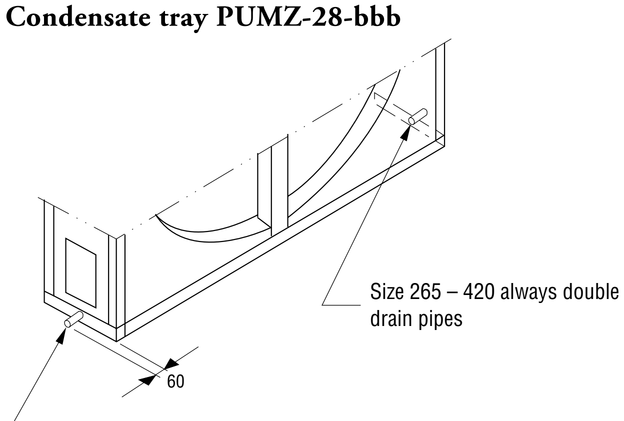
Danfoss type RT 270
2 m length of capillary tube

LT bulb
= For the lower air temperature

HT bulb
= For the higher air temperature



Condensate tray PUMZ-28-bbb



Ordering key

ECONOVENT **PUM(A-F)-a-bbb-c-d-e-1**
Rotary heat exchanger

Rotor material
A = non-hygroscopic aluminium
B = hygroscopic aluminium
C = edge-reinforced, non-hygroscopic aluminium
D = edge-reinforced, hygroscopic aluminium
E = epoxy-coated aluminium (for a = 1, 2, 5 och 6)
F = composite (for a = 2 and bbb ≤ 420)

Rotor **(a)**
1 = wound, with standard foil spacing
2 = sectorized, with standard foil spacing
3 = wound, with standard foil spacing, industrial grade, aluminium
4 = sectorized, with standard foil spacing, industrial grade, aluminium
5 = wound, with wider foil spacing
6 = sectorized, with wider foil spacing
7 = wound, with wider foil spacing, industrial grade, aluminium
8 = sectorized, with wider foil spacing, industrial grade, aluminium

Size **(bbb)**
060[1)], 080[1)], 095, 110, 120, 135, 150, 170, 190, 200, 215, 240, 265, 290, 320, 350, 380, 420, 460, 500

1) Only wound rotor

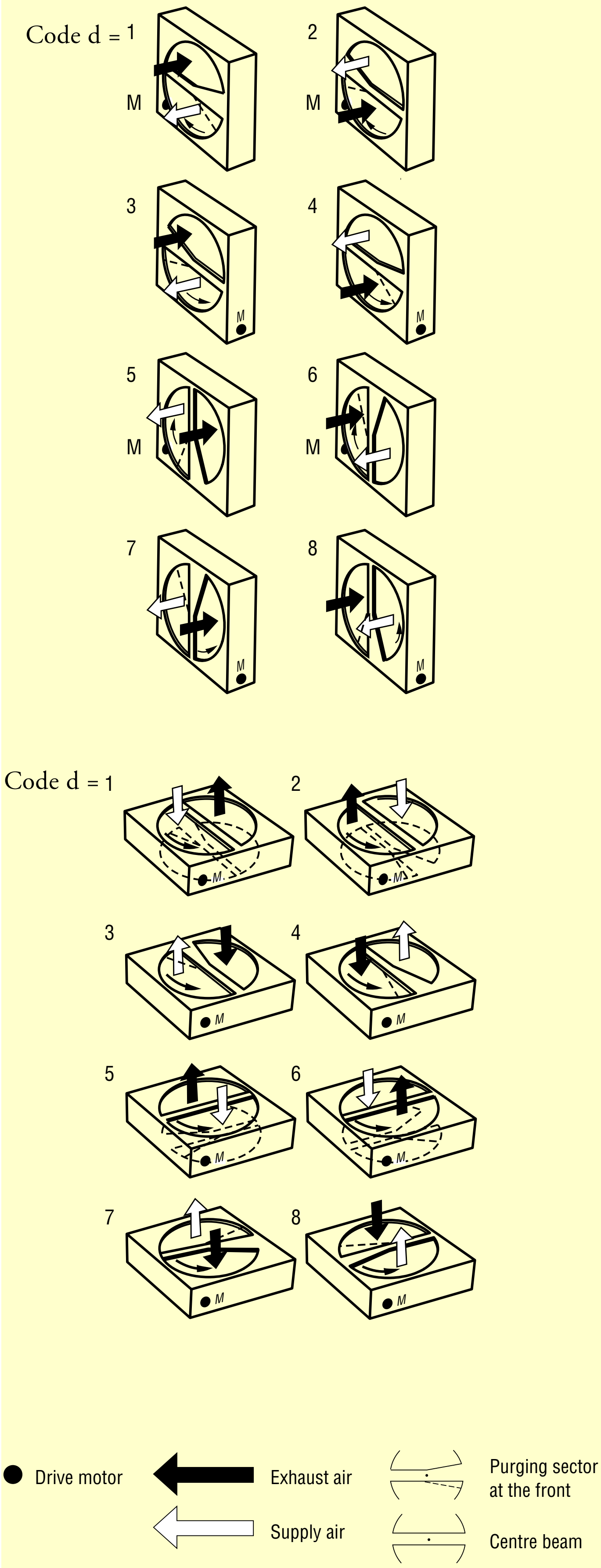
Drive equipment **(c)**
00 = without drive equipment
01 = with constant speed drive equipment (ABM), heat recovery
04 = with variable speed drive equipment (EMS MASTER), size 350-500
07 = with variable speed equipment (EMS standard), size 060-320
08 = with variable speed equipment (EMS with display), size 060-320
11 = with constant speed equipment (ABM), cool recovery

Installation alternative **(d)**
1–8 as shown in figure

Delivery form **(e)**
1 = factory-assembled unit with purging sector, sizes 060–240
2 = dismantled casing, two units, with purging sector, sizes 150–500
3 = factory-assembled unit, split casing with purging sector, sizes 150–290
4 = factory-assembled unit without purging sector, sizes 060–240
5 = dismantled casing, two units, without purging sector, sizes 150–500
6 = factory-assembled unit, split casing, without purging sector, sizes 150–290

Design figure

Installation alternatives



Ordering key - Accessories

Duct connection frame **PUMZ-17-bbb-2-d**

Size
060 215
080 240
095 265
110 290
120 320
135 350
150 380
170 420
190 460
200 500

Version **2**

Connection type **(d)**
0 = PG joint
1 = flanged connections

Alarm relay for constant speed **PUMZ-19**

Speed detector for constant and variable speeds **PUMZ-20-b-c-d**

Make **(b)**
4 = for sizes 095 - 240
5 = for sizes 265 - 500

Delivery condition **(c)**
1 = delivered in unmounted condition
2 = factory-mounted

Material **(d)**
1 = galvanized
2 = stainless

Differential thermostat **PUMZ-21**

Cleaning equipment **PUMZ-27-bbb-1**
(ECONOMATIC 95)

Size **(bbb)**
060 170 320
080 190 350
095 200 380
110 215 420
120 240 460
135 265 500
150 290

Version **(c)**
1 = for compressed air

Condensate tray **PUMZ-28-bbb-c**

Size **(bbb)**
060 170 320
080 190 350
095 200 380
110 215 420
120 240 460
135 265 500
150 290

Material **(c)**
1 = galvanized
2 = stainless

Descriptive text

			Page	
Code (AMA)	Item	Text	Quantity	Unit

AIR-TO-AIR HEAT EXCHANGER
Regenerative heat recovery unit
ECONOVENT type PUM rotary heat exchanger

Rotor type

Type A: ☐ Non-hygroscopic aluminium rotor for recovering sensible heat.

Type B: ☐ Hygroscopic aluminium rotor for recovering sensible heat and latent heat.

Type C: ☐ Edge-reinforced non-hygroscopic aluminium rotor for recovering sensible heat.

Type D: ☐ Edge-reinforced hygroscopic aluminium rotor for recovering sensible heat and latent heat.

Type E: ☐ Epoxy-treated aluminium rotor for recovering sensible heat.

Type F: ☐ Hygroscopic composite rotor with high resistance to corrosion for recovering sensible heat and latent heat.

Casing
Sturdy casing with purging sector of galvanized sheet steel.

Max. operating temperature: 75°C

☐ Without drive equipment
☐ Variable speed control
☐ Single-speed motor

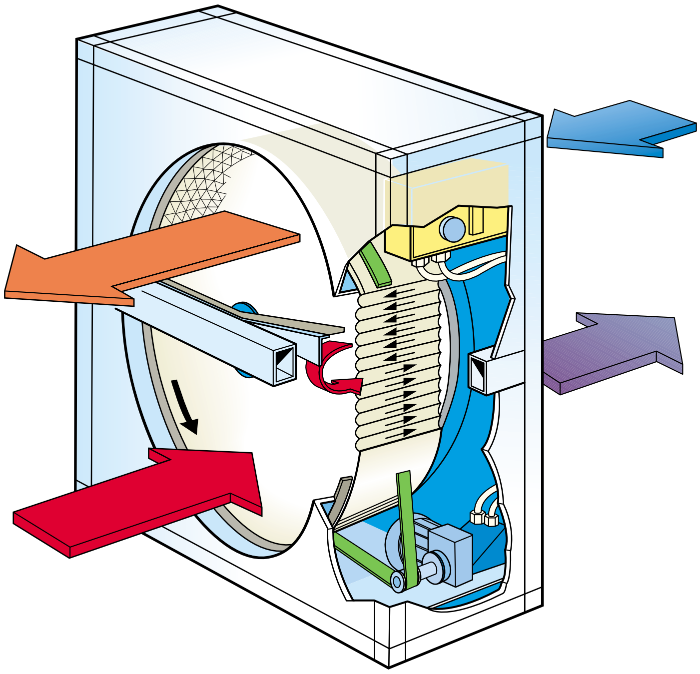
Operating data:

Supply air:

Air flow rate.......................................m^3/s (20°C)
Temperature upstream of the heat recovery unit..........°C
Relative humidity upstream of the heat recovery unit..........%
Supply air temperature efficiency, η_t = min. ....%
Supply air moisture efficiency, η_x = min. ....%
Temperature downstream of the heat recovery unit..........°C
Max. pressure drop across the heat recovery unit..........Pa

Exhaust air

Air flow rate.......................................m^3/s (20°C)
Temperature upstream of the heat recovery unit..........°C
Relative humidity upstream of the heat recovery unit..........%
Max. pressure drop across the heat recovery unit..........Pa



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