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1 The advantages of rotary heat exchangers

A combination of engineering proposals, end user requirements, and civil authority regulations has resulted in an increasing use of energy recovery equipment. Investment in energy recovery equipment significantly reduces operating costs and investments in humidifiers and air conditioning.

1.1 General principle of rotary heat exchangers

Rotary heat exchangers (RHE) belong to the group regenerative heat exchangers. Rotor movement means that exhaust air and supply air pass the rotor medium alternately. A major proportion of the energy in the exhaust air is transferred to the supply air via the rotor medium. Thanks to the alternating airflow direction, the rotor is self-cleaning and frost proof to a large extent.

The ability to recover both thermal (sensible) and humidity (latent) energy makes rotary heat exchangers very efficient. Efficiency between 70 – 90 % with a pressure drop under 200 Pa is normal for rotary heat exchangers. And efficiency is easily adjusted by regulating motor rpm.

1.2 Certification programme and standards

Hoval Enventus rotary heat exchangers and the CASER selection program are Eurovent and TÜV certified. Certification is issued when test rotor values correspond to the results reported in the supplier's selection program. Eurovent certificates are renewed each year following new tests.

Hoval Enventus sorption rotor HM1 (Muonio) is certified by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI), an American trade association.

Please visit our website at www.hoval-enventus.com for copies of these certificates.

The Eurovent programme applies primarily to Europe. The regenerative heat exchanger range is based on EN 308 and AHRI 1060 standards and our own certification procedures. www.eurovent-certification.com

Hoval Enventus sorption rotor HM1 (Muonio) is AHRI certified (see CASER software printout for certified types). AHRI is an American trade association that applies the AHRI 1060 standard for certification. www.ahridirectory.org

TÜV Süd certifies the Hoval Enventus product selection program (Hoval Enventus CASER) and verifies program changes and algorithms. www.tuev-sued.de

Hoval Enventus business operations are certified to ISO 9001 standards.
2 Product description

Hoval Enventus supplies rotary heat exchangers to producers of air handling units worldwide. Rotary heat exchangers can be used in most types of applications. The 3 principal areas are:

- Comfort ventilation (e.g. homes, offices, hotels)
- Industrial ventilation (e.g. automotive industry)
- Marine ventilation (cruise liners and coastal environments)

The Hoval Enventus production line allows flexible manufacturing according to the customer’s requirements. We can provide customized rotor diameters, casing dimensions and foils for different applications and performance ranges, all with short, reliable delivery times.

1.3 Thermal wheels

The storage mass is made for laminar airflow using alternating layers of smooth and corrugated foil to provide a structure comprising small, sinusoidal channels. The storage mass allows cleaning with compressed air, steam, hot water or special cleaning agents.

The rotors are either 1-piece or segmented. Segmented rotors are divided into segments that are assembled when the rotor is installed.

<table>
<thead>
<tr>
<th>Rotor ∅</th>
<th>Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>950 – 1699</td>
<td>4</td>
</tr>
<tr>
<td>1700 – 2699</td>
<td>6</td>
</tr>
<tr>
<td>2700 – 3549</td>
<td>8</td>
</tr>
<tr>
<td>3550 – 4599</td>
<td>8 + 8</td>
</tr>
<tr>
<td>4600 – 5000</td>
<td>8 + 8 + 8</td>
</tr>
</tbody>
</table>

Table 1: Number of segments

Air velocity should be kept low for best efficiency. The design of Hoval Enventus rotary heat exchangers is very stable. However, high pressure drops are not recommended as high air speeds result in lower efficiency and higher fan energy consumption.

The rotors can be installed vertically or horizontally.

Rotors are made in 200 mm depth as standard and can also be produced in 250 mm depths.

<table>
<thead>
<tr>
<th>Installation</th>
<th>Vertical</th>
<th>Horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotor depth</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Construction</td>
<td>300 – 2600</td>
<td>300 – 2600</td>
</tr>
<tr>
<td>1-piece</td>
<td>300 – 2000</td>
<td>300 – 1800</td>
</tr>
<tr>
<td>Segmented</td>
<td>950 – 5000</td>
<td>950 – 3200</td>
</tr>
</tbody>
</table>

Table 2: Available wheel models (dimensions in mm)

6 different wave heights are available to enable optimisation of efficiency and pressure drop.

<table>
<thead>
<tr>
<th>Wheel type</th>
<th>Wave height</th>
<th>Wave length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra low (X)</td>
<td>1.50 mm</td>
<td>3.0 mm</td>
</tr>
<tr>
<td>Special low (S)</td>
<td>1.65 mm</td>
<td>3.0 mm</td>
</tr>
<tr>
<td>Low (L)</td>
<td>1.70 mm</td>
<td>4.0 mm</td>
</tr>
<tr>
<td>Medium (M)</td>
<td>1.80 mm</td>
<td>4.0 mm</td>
</tr>
<tr>
<td>Normal (N)</td>
<td>2.00 mm</td>
<td>4.0 mm</td>
</tr>
<tr>
<td>High (H)</td>
<td>2.70 mm</td>
<td>5.5 mm</td>
</tr>
</tbody>
</table>

Table 3: Wave heights and wave lengths
Rotors have maintenance-free hubs with life-time lubricated ball or roller bearings in a protected location in the hub. All bearings are sealed to prevent dirt and humidity from entering the bearing. Bearing lifetime is at least 200 000 h for 1-piece rotors and at least 60 000 h for segmented rotors with vertical installation and continuous operation at a maximum speed of 20 rpm (L10h as per ISO 281).

1.4 Foil types

According to the application and performance range different foil types are used. Depending on the foil type rotary heat exchangers are classified into 3 different groups:
- Condensation rotors
- Enthalpy / Hygroscopic rotors
- Enthalpy / Sorption rotors

**Condensation rotors (ST1, ST2, SC1)**

The condensation rotor ST1 is a cost-efficient solution to recover heat and is suitable for standard applications in comfort ventilation. Humidity is only transferred in cases when the dew point of one of the air streams is reached. Epoxy-coated foil (SC1) should be used in environments that entail a major risk of corrosion such as in industrial ventilation.

Seawater resistant foil (ST2) is available for marine applications (e.g. for use in cruise liners and coastal environments).

**Enthalpy / Hygroscopic rotor (SE3)**

The hygroscopic rotor SE3 has a molecular sieve 3 Å coating on the smooth foil of the storage mass. Therefore, it transfers sensible energy (temperature) as well as latent energy (humidity).

**Enthalpy / Sorption rotor Hybrid (SH1) and Muonio (HM1)**

The sorption rotor SH1 has a molecular sieve 3 Å coating on the corrugated foil of the storage mass. It transfers more humidity than the hygroscopic rotor.

The sorption rotor HM1 is the high-performance model. The storage mass is fully coated to provide a maximum humidity transfer. The high humidity efficiency is nearly constant throughout all climate conditions.

Sorption rotors are especially designed for summer season cooling recovery and dehumidification of supply air. Therewith, it should always be used in humid and hot climates, with dry cooling systems (chilled beams) and when in winter time humidifiers are used. This substantially reduces the cooling and humidification demand of the HVAC system.

<table>
<thead>
<tr>
<th>Type</th>
<th>Condensation</th>
<th>Enthalpy / Hygroscopic</th>
<th>Enthalpy / Sorption</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1</td>
<td>●</td>
<td></td>
<td></td>
<td>Untreated aluminium</td>
</tr>
<tr>
<td>ST2</td>
<td>●</td>
<td></td>
<td></td>
<td>Aluminium with 2.5% magnesium content (seawater resistant)</td>
</tr>
<tr>
<td>SC1</td>
<td>●</td>
<td></td>
<td></td>
<td>Epoxy-coated aluminium (corrosion-protected)</td>
</tr>
<tr>
<td>SE3</td>
<td>●</td>
<td></td>
<td></td>
<td>Corrugated foil: untreated aluminium Smooth foil: Aluminium coated with molecular sieve 3 Å</td>
</tr>
<tr>
<td>SH1</td>
<td>●</td>
<td></td>
<td></td>
<td>Corrugated foil: Aluminium coated with molecular sieve 3 Å Smooth foil: untreated aluminium</td>
</tr>
<tr>
<td>HM1</td>
<td>●</td>
<td></td>
<td></td>
<td>Aluminium coated with molecular sieve 3 Å</td>
</tr>
</tbody>
</table>

Table 4: Available foil types
1.5 Casings

Casings are available for the entire product range. They are characterized by flexible, modifiable dimensions suitable for air handling units. The robust design prevents rotor movements that can cause leaks.

Purge sectors can be supplied for all casings in optional sizes of $0^\circ - 10^\circ$. $0^\circ$ means without purge sector.

All casings have adjustable brush sealing around the rotor periphery and along the middle beam. Additional seals can be provided for high pressure differentials.

Standard casings are intended for vertical installation, smaller models can be ordered for horizontal installation.

The rotor has an adjustable suspension. To facilitate adjustment also in the installed state, pay attention to good accessibility. For more detailed information please contact Hoval Enventus customer service.

There are 2 different casing types:
- Slide-in casing
- Modular unit

**Slide-in casings (CS, SD, DS)**

Slide-in casings fit into air handling units (AHU’s) thus making a uniform AHU appearance possible. Furthermore, slide-in casings have a large rotor surface in relation to casing size and are normally supplied without additional insulation.

**CS type casing**
- Slide-in casing for 1-piece rotors
  The casing is made from non-corrosive Aluzinc. The stable middle beam is made of pressed sheet steel or a coated steel profile on larger units. For units from Ø 2451 mm, the casing is made from steel profile frame.
  The casings are delivered fully assembled.

![CS type casing](Image 8)

**SD type casing**
- Slide-in casing for segmented rotors (small)
  The casing is made from non-corrosive Aluzinc. The stable middle beam is made of coated steel profile. For units from Ø 2401 mm, the casing is made from steel profile frame.
  SD type casings are delivered in 2 parts. The rotor segments are delivered in separate packaging.

![SD type casing](Image 9)

**DS type casing**
- Slide-in casing for segmented rotors (large)
  The casing is made from non-corrosive sheet steel. The casing comprises an aluminium profile frame, or galvanized steel profile frame on units from Ø 4251 mm. The frame profiles are joined without corners to provide a play-free framework.
  DS type casings are delivered in 2 parts. The rotor segments are delivered in separate packaging.

![DS type casing](Image 10)
### Modular units (C, CD, D)
Complete units for connection to other parts of air handling units or directly to ducting. The unit is modified so that connection can be carried out using e.g. connection panels or corner connectors.

#### C type casing
- Modular unit for 1-piece rotors
  The casing is made from aluminium profiles and galvanized sheet. The units are delivered fully assembled.

![Fig. 11: Modular unit](image1)

#### CD type casing
- Modular unit for segmented rotors (small)
  The casing is made from aluminium profiles and galvanized sheet.
  CD type casings are delivered in 2 parts. The rotor segments are delivered in separate packaging.

![Fig. 13: CD type casing](image2)

#### D type casing
- Modular unit for segmented rotors (large)
  The casing is made from non-corrosive sheet steel. The casing comprises an aluminium profile frame, or galvanized steel profile frame on units from Ø 4251 mm. The frame profiles are joined without corners to provide a play-free framework.
  D type casings are delivered in 2 parts. The rotor segments are delivered in separate packaging.

![Fig. 14: D type casing](image3)

### Table 5: Available casing types (dimensions in mm)

<table>
<thead>
<tr>
<th>Casing type</th>
<th>Slide-in casing</th>
<th>Modular unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CS</td>
<td>SD</td>
</tr>
<tr>
<td>Rotor diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-piece casing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-piece rotor</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>2-piece casing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Segmented rotor</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Rotor depth</td>
<td>200</td>
<td>250</td>
</tr>
<tr>
<td>Casing depth</td>
<td>290,330</td>
<td>340</td>
</tr>
</tbody>
</table>
1.6 Dimensions

All casings are built according to customer specification. Height (H) and width (W) are dimensioned as required. All tables below show minimum sizes and refer to vertical installation with square casing.

### CS type slide-in casing for 1-piece rotors

<table>
<thead>
<tr>
<th>Rotor Ø</th>
<th>Casing W x H</th>
<th>X</th>
<th>L (200 rotor)</th>
<th>L (250 rotor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 – 399</td>
<td>Ø + 180</td>
<td>50</td>
<td>290</td>
<td>340</td>
</tr>
<tr>
<td>400 – 499</td>
<td>Ø + 160</td>
<td>50</td>
<td>290</td>
<td>340</td>
</tr>
<tr>
<td>500 – 599</td>
<td>Ø + 130</td>
<td>50</td>
<td>290</td>
<td>340</td>
</tr>
<tr>
<td>600 – 799</td>
<td>Ø + 100</td>
<td>50</td>
<td>290</td>
<td>340</td>
</tr>
<tr>
<td>800 – 1299</td>
<td>Ø + 100</td>
<td>80</td>
<td>290</td>
<td>340</td>
</tr>
<tr>
<td>1300 – 1800</td>
<td>Ø + 100</td>
<td>100</td>
<td>290</td>
<td>340</td>
</tr>
<tr>
<td>1801 – 2050</td>
<td>Ø + 100</td>
<td>125</td>
<td>290</td>
<td>340</td>
</tr>
<tr>
<td>2051 – 2450</td>
<td>Ø + 100</td>
<td>125</td>
<td>290</td>
<td>–</td>
</tr>
<tr>
<td>2451 – 2600</td>
<td>Ø + 120</td>
<td>125</td>
<td>330</td>
<td>–</td>
</tr>
</tbody>
</table>

Table 6: CS type casing (dimensions in mm)
### SD type slide-in casing for segmented rotors (small)

<table>
<thead>
<tr>
<th>Rotor Ø</th>
<th>Casing W x H</th>
<th>X</th>
<th>L (200 rotor)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>950 – 2400</td>
<td>Ø + 140</td>
<td>125</td>
<td>290</td>
<td></td>
</tr>
<tr>
<td>2401 – 2800</td>
<td>Ø + 170</td>
<td>125</td>
<td>330</td>
<td>Steel profile frame</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ø 950 – 2400</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Ø 2401 – 2800</th>
</tr>
</thead>
</table>

Table 7: SD type casing (dimensions in mm)

### DS type slide-in casing for segmented rotors (large)

<table>
<thead>
<tr>
<th>Rotor Ø</th>
<th>Casing W x H</th>
<th>H1</th>
<th>H2</th>
<th>X</th>
<th>Y</th>
<th>L (200 rotor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2451 – 5000</td>
<td>Ø + 200</td>
<td>H/2 + 40</td>
<td>H/2 – 40</td>
<td>160</td>
<td>80</td>
<td>430</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ø 2451 – 5000</th>
</tr>
</thead>
</table>

Table 8: DS type casing (dimensions in mm)
### C type modular unit for 1-piece rotors

<table>
<thead>
<tr>
<th>Rotor Ø</th>
<th>Casing W x H</th>
<th>Y</th>
<th>L (200 rotor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 – 1999</td>
<td>∅ + 200</td>
<td>50</td>
<td>430</td>
</tr>
<tr>
<td>2000 – 2600</td>
<td>∅ + 220</td>
<td>70</td>
<td>470</td>
</tr>
</tbody>
</table>

Table 9: C type casing (dimensions in mm)

### CD type modular unit for segmented rotors (small)

<table>
<thead>
<tr>
<th>Rotor Ø</th>
<th>Casing W x H</th>
<th>H1</th>
<th>H2</th>
<th>Y</th>
<th>L (200 rotor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>950 – 1999</td>
<td>∅ + 200</td>
<td>H/2 + 25</td>
<td>H/2 – 25</td>
<td>50</td>
<td>430</td>
</tr>
<tr>
<td>2000 – 2450</td>
<td>∅ + 200</td>
<td>H/2 + 35</td>
<td>H/2 – 35</td>
<td>70</td>
<td>470</td>
</tr>
</tbody>
</table>

Table 10: CD type casing (dimensions in mm)

### D type modular unit for segmented rotors (large)

<table>
<thead>
<tr>
<th>Rotor Ø</th>
<th>Casing W x H</th>
<th>H1</th>
<th>H2</th>
<th>Y</th>
<th>L (200 rotor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2451 – 5000</td>
<td>∅ + 230</td>
<td>H/2 + 40</td>
<td>H/2 – 40</td>
<td>80</td>
<td>430</td>
</tr>
</tbody>
</table>

Table 11: D type casing (dimensions in mm)
1.7 Drive equipment

Hoval Enventus provides easy, operationally reliable drive equipment for both constant and variable speed operation.

The drive motor is mounted on a bracket inside the casing and drives the rotor via a pulley and a V-belt to the rotor periphery. Belt pulley size and/or gearing are dimensioned to achieve optimum rotor speed:
- approx. 12 rpm for heat recovery
- approx. 20 rpm for moisture recovery

Constant drive
Rotary heat exchangers with constant drive work in on/off operating mode. Rotor speed is not controlled. Various motor types are available with different power levels. The motor type used in a specific exchanger depends on the type and diameter of the rotor. Select the desired parameters (1-phase/3-phase, voltage, frequency) in the CASER selection program. The motor type used in the specific case is shown in the data sheet.

Variable drive
Rotary heat exchangers with variable drive allow continuous rotor speed adjustment, i.e. the performance of energy recovery is controllable. All variable drive systems consist of a motor and the corresponding control unit. This controls rotor speed in relation to an input signal and also fulfills further functions depending on the model. Control units and motors are perfectly matched to one another.
A selection of different control units is available depending on the rotor diameter and the desired functionality. Select the desired type in the CASER selection program. The drive system used in the specific case is shown in the data sheet.

Components

Induction motors
Induction motors with reduction gearing are mainly used in small units. The motors have ISO class B insulation and IP54 protection ratings. The reduction gear is life-time lubricated and maintenance-free.

Asynchronous motors
Asynchronous motors with worm gears are used in larger units. The motors have class F insulation and IP55 protection ratings. The gearbox is life-time lubricated and maintenance-free.

Reluctance motors
Reluctance motors without gearbox are used in EMX-R drive systems.

MicroMax
MicroMax is part of a range of control units adapted, with the necessary additional functions, for optimum control of rotating heat exchangers in 3 different sizes: MicroMax180, MicroMax370 and MicroMax750. The systems use 3-phase motors. The control units fulfill the following functions:
- Continuous control of the rotor speed, proportionate to the input signal 0-10 V
- Cleaning function: After 30 minutes standstill the wheel rotates for 10 s.
- Rotation monitor using a magnet mounted on the wheel
- Monitoring of operation and alarms in case of faults
- Starts automatically following voltage drop-out, and resets all alarms on restart.
- Manual operation at low or high speed by means of a DIP switch

MiniMax
MiniMax is a modern, vector-modulated frequency converter, with the additional functions necessary for optimum control of rotating heat exchangers that uses a 3-phase motor.
The control unit fulfils the following functions:
- Continuous control of the rotor speed, proportionate to the input signal (all input signals currently used in the market)
- Cleaning function: After 30 minutes standstill the wheel rotates for 10 s.
- Rotation monitor using a magnet mounted on the wheel
- Monitoring of operation and alarms in case of faults
- Manual operation at minimum or maximum speed by means of a DIP switch

**Emotron**

Emotron drive systems provide full control across a broad range of rpm and ensure reliable operation. Rotor speed control is linear, i.e. the command signal is proportionate to rotor efficiency, which provides precise control.

**EMX-P**

EMX-P10 is a drive system for smaller rotary heat exchangers that uses a 1-phase induction motor. The control unit fulfills the following functions:
- Control of rotor efficiency proportionate to the input signal
- Full control of speed with tachometer feedback
- Cleaning function: 30 degrees rotation every 10 minutes
- Rotation monitor using a magnet mounted on the wheel
- Monitoring of operation and alarms in case of faults

![Fig. 19: EMX-P10 control unit](image)

**EMX-R**

EMX-R is a range of drive systems in different sizes and designs: EMX-R-15, EMX-R-25 and EMX-R-35. The control units are available in 2 versions:
- Version S (Standard)
- Version E (with increased functionality)

The systems are based on the switched reluctance (SR) motor technology. This allows the motor to drive heat exchanger wheels without any need for a gearbox. The motors are particularly robust and have a permanently attached motor cable. The direction of rotation is freely selectable via DIP switch. EMX-R is an integrated system, meaning EMX-R motor it is only working with an EMX-R control unit.

The control units in standard version fulfil the following functions:
- Control of rotor efficiency proportionate to the input signal
- Cleaning function: 30 degrees rotation every 10 minutes

- Rotation monitoring: with an integrated electronic rotation sensor or an external sensor, as desired
- Monitoring of operation and alarms in case of faults (red LED)
- Manual operation at maximum speed by means of a test switch
- Priority switch for preselected speed of rotation (e.g. during cleaning or defrosting)
- Cooling recovery with external differential thermostat

**EMX-R control units in E version fulfil the following additional functions:**
- Display with figures showing alarms in case of faults
- Possibility to connect external rotation sensor
- Display shows rpm of the rotor speed if an external rotation sensor is connected
- Analogue output signal proportionate to the speed of the motor
- Cooling recovery with external temperature sensor
- Manual operation by means of a potentiometer
- Prepared for serial communication

![Fig. 20: EMX-R drive systems](image)

**EMX-D**

EMX-D is a drive system for very large rotary heat exchangers that uses a 3-phase asynchronous motor. The control unit offers the same functions as EMX-R. It is equipped with a user-friendly display for control of settings and operation.

![Fig. 21: EMX-D control unit](image)
### Table 12: Drive motors

<table>
<thead>
<tr>
<th>Drive motors</th>
<th>Induction motors</th>
<th>Asynchronous motors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1~230 50 Hz Motor</strong></td>
<td>SPG6-1K</td>
<td>SPG25-1K</td>
</tr>
<tr>
<td>Voltage (V)</td>
<td>1 x 220-240</td>
<td>1 x 220-240</td>
</tr>
<tr>
<td>Frequency (Hz)</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Motor power (W)</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Electricity (A)</td>
<td>0.09</td>
<td>0.25</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>1.0</td>
<td>2.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>3~230 50 Hz Motor</strong></th>
<th>–</th>
<th>–</th>
<th>SPG40-3V</th>
<th>N56-3</th>
<th>N63-3</th>
<th>N71-3</th>
<th>N80-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (V)</td>
<td>–</td>
<td>–</td>
<td>3 x 220-240</td>
<td>3 x 220-240</td>
<td>3 x 220-240</td>
<td>3 x 220-240</td>
<td>3 x 220-240</td>
</tr>
<tr>
<td>Frequency (Hz)</td>
<td>–</td>
<td>–</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Motor power (W)</td>
<td>–</td>
<td>–</td>
<td>40</td>
<td>90</td>
<td>180</td>
<td>370</td>
<td>750</td>
</tr>
<tr>
<td>Electricity (A)</td>
<td>–</td>
<td>–</td>
<td>0.39</td>
<td>0.8</td>
<td>1.3</td>
<td>1.8</td>
<td>3.6</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>–</td>
<td>–</td>
<td>3.4</td>
<td>4.5</td>
<td>5.4</td>
<td>8.6</td>
<td>14.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>3~400 50 Hz Motor</strong></th>
<th>–</th>
<th>–</th>
<th>SPG40-3K</th>
<th>N56-3-60</th>
<th>N63-3-60</th>
<th>N71-3-60</th>
<th>N80-3-60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (V)</td>
<td>–</td>
<td>–</td>
<td>3 x 380-440</td>
<td>3 x 400</td>
<td>3 x 400</td>
<td>3 x 400</td>
<td>3 x 400</td>
</tr>
<tr>
<td>Frequency (Hz)</td>
<td>–</td>
<td>–</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Motor power (W)</td>
<td>–</td>
<td>–</td>
<td>40</td>
<td>90</td>
<td>180</td>
<td>370</td>
<td>750</td>
</tr>
<tr>
<td>Electricity (A)</td>
<td>–</td>
<td>–</td>
<td>0.19</td>
<td>0.4</td>
<td>0.7</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>–</td>
<td>–</td>
<td>3.4</td>
<td>4.5</td>
<td>5.4</td>
<td>8.6</td>
<td>14.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>3~400 60 Hz Motor</strong></th>
<th>–</th>
<th>–</th>
<th>SPG40-3K</th>
<th>N56-3-60</th>
<th>N63-3-60</th>
<th>N71-3-60</th>
<th>N80-3-60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (V)</td>
<td>–</td>
<td>–</td>
<td>3 x 380-440</td>
<td>3 x 400</td>
<td>3 x 400</td>
<td>3 x 400</td>
<td>3 x 400</td>
</tr>
<tr>
<td>Frequency (Hz)</td>
<td>–</td>
<td>–</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Motor power (W)</td>
<td>–</td>
<td>–</td>
<td>40</td>
<td>90</td>
<td>180</td>
<td>370</td>
<td>750</td>
</tr>
<tr>
<td>Electricity (A)</td>
<td>–</td>
<td>–</td>
<td>0.19</td>
<td>0.4</td>
<td>0.7</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>–</td>
<td>–</td>
<td>3.4</td>
<td>4.5</td>
<td>5.4</td>
<td>8.6</td>
<td>14.3</td>
</tr>
</tbody>
</table>

### Fig. 22: Drive systems
1.8 Options

**Lifting lugs (LL)**
Lifting lugs are available for safe lifting of the unit. These are delivered in a separate box inside the rotor casing.

![Fig. 23: Lifting lugs](image)

**Triangle inspection (IB)**
If motor and belt are not accessible from the side for inspection the casing can be fitted with triangle inspection hatches. These allow inspection of the rotor inside the air handling unit from both sides.

![Fig. 24: Triangle inspection](image)

**Casing painted (CPPST)**
Casings in powder-coated design are available for enhanced corrosion protection. The standard colour is white aluminium (RAL 9006).

**Loose del. control (CRL)**
The selected controller is supplied loose in a cardboard box.

![Fig. 25: Loose del. control](image)

**Matrix edge painted (EDG)**
For enhanced corrosion protection the face area of the storage mass can be treated with an anti-corrosion coating.

**Closed side panels - 4 sides (CCP)**
Slide-in casings can be fitted with side panels on all sides. The surface of the panels corresponds to the selected casing surface.

![Fig. 26: Closed side panels - 4 sides](image)

**Extra spare sealing (SX)**
An extra sealing is supplied loose. The type is the same as the installed sealing.

**Extra spare belt (BX)**
An extra belt is supplied loose. The type is the same as the installed belt.

**Condensate tray (DT)**
All casings can be fitted with a condensate tray and pipe fittings.

![Fig. 27: Condensate tray](image)

**Light in casing (LI)**
A lamp can be installed inside the casing beside the motor (e.g. in combination with an inspection window).

**E-Clean (EC)**
E-Clean is an pneumatic cleaning device for the rotor surface. It is made to measure and consists of a pneumatically controlled cylinder with sled, nozzle and control box.

![Fig. 28: E-Clean](image)
Cable bushing (CB)
Cable bushings are installed for the protection of power and signal cables. They ensure tight cable connection with the casing and provide strain-relief.

Double brush sealing (DBS)
An extra brush sealing is installed around the rotor periphery and along the middle beam. This is recommended for high pressure differentials between extract air and supply air.

Inspection window (IW)
If desired, modular units can be fitted with an inspection window for visual inspection of the drive.

Fig. 29: Inspection window

Cover plates (CP)
Modular units can optionally be fitted with cover plates on the face sides. These facilitate the connection of large rotor casings to smaller AHU’s. Define the width of the opening in the face side in the selection program.

Fig. 30: Cover plates

Insulation cover plates (ICP50)
Modular units with cover plates (CP) can optionally be fitted with insulated side panels. Top and bottom panels are not insulated. The insulation consists of mineral wool 50 kg/m².

Insulation complete casing (ICS50)
Modular units are optionally available in insulated design. The side panels as well as the top and bottom panels are insulated (mineral wool 50 kg/m²).

Rotor half mounted (SHM)
On request, segmented rotors can be delivered half-mounted. Half of the storage mass as well as the motor are installed in the lower part of the casing in the factory. The upper half of the casing, the remaining segments of the storage mass as well as belt, seals and, if applicable, the controller are delivered separately for assembly on site.

Fig. 31: Rotor half mounted

Rotor fully mounted (SFM)
On request, segmented rotors can be delivered fully mounted.

Handles (HDK)
Modular units can be fitted with side panels that are detachable with handles. A square socket key is required for opening (supplied). Unauthorized opening of the casing is not possible.

Fig. 32: Handles
1.9 Air flow and motor position

Hoval Enventus rotary heat exchangers are equipped with a purge sector as standard. In order to locate the purge sector correctly, it is necessary to define the installation position of the unit with regard to air flow and motor position (inspection side).

<table>
<thead>
<tr>
<th>Code</th>
<th>Air flow and motor position</th>
</tr>
</thead>
<tbody>
<tr>
<td>DU</td>
<td><img src="image" alt="Diagram A" /></td>
</tr>
<tr>
<td>BF</td>
<td><img src="image" alt="Diagram E" /></td>
</tr>
<tr>
<td>LR</td>
<td><img src="image" alt="Diagram I" /></td>
</tr>
<tr>
<td>FR</td>
<td><img src="image" alt="Diagram M" /></td>
</tr>
</tbody>
</table>

**Legend**
- Outdoor air/supply air
- Extract air/exhaust air
- Inspection side
- Purge sector

**Notice**
The purge sector is always installed on the supply air side, i.e. on the side of the rotor facing the room (see also section 4.6).

*Fig. 33: Air flow and motor position*
### Product description

#### 1.10 Type key

<table>
<thead>
<tr>
<th>Type &amp; Foil coating</th>
<th>ST1</th>
<th>L L - W V - 0750</th>
<th>CS</th>
<th>V1</th>
<th>DU</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensation rotor (untreated aluminium)</td>
<td>ST1</td>
<td>Condensation rotor (seawater resistant)</td>
<td>ST2</td>
<td>Condensation rotor (epoxy-coated)</td>
<td>SC1</td>
<td>Condensation rotor (condensation rotor (untreated aluminium))</td>
</tr>
<tr>
<td>Wave height</td>
<td>X</td>
<td>1.50 mm</td>
<td>S</td>
<td>1.65 mm</td>
<td>L</td>
<td>1.70 mm</td>
</tr>
<tr>
<td>Rotor depth</td>
<td>L</td>
<td>200 mm</td>
<td>N</td>
<td>250 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotor construction</td>
<td>W</td>
<td>1-piece</td>
<td>S</td>
<td>Segmented</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotor orientation</td>
<td>V</td>
<td>Vertical</td>
<td>H</td>
<td>Horizontal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotor diameter</td>
<td>0300 – 5000 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Casing type</td>
<td>CS</td>
<td>Slide-in casing for 1-piece rotors 300 – 2600 mm</td>
<td>SD</td>
<td>Slide-in casing for segmented rotors 950 – 2800 mm</td>
<td>DS</td>
<td>Slide-in casing for segmented rotors 2451 – 5000 mm</td>
</tr>
<tr>
<td>D</td>
<td>Modular unit for 1-piece rotors 300 – 2600 mm</td>
<td>C</td>
<td>Modular unit for segmented rotors 950 – 2450 mm</td>
<td>D</td>
<td>Modular unit for segmented rotors 2451 – 5000 mm</td>
<td></td>
</tr>
<tr>
<td>Drive and control system</td>
<td>V1</td>
<td>MicroMax 1~ 230 V 50/60 Hz</td>
<td>V2</td>
<td>MiniMax 1~ 230 V 50/60 Hz</td>
<td>V3</td>
<td>Emotron S 1~ 230 V 50/60 Hz</td>
</tr>
<tr>
<td>Air flow and motor position</td>
<td>A1-P4</td>
<td>Code for air flow and motor position</td>
<td>DU</td>
<td>Vertical installation: Horizontally divided air flow w/o motor position</td>
<td>BF</td>
<td>Vertical installation: Vertically divided air flow w/o motor position</td>
</tr>
<tr>
<td>Purge sector</td>
<td>0</td>
<td>Without purge sector</td>
<td>3</td>
<td>2.5°</td>
<td>5</td>
<td>5°</td>
</tr>
</tbody>
</table>
Table 13: Availability of options

<table>
<thead>
<tr>
<th>Code</th>
<th>Option</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wnnnn</td>
<td>Casing width (n = dimension in mm)</td>
<td>All casings</td>
</tr>
<tr>
<td>Hnnnn</td>
<td>Casing height (n = dimension in mm)</td>
<td>All casings</td>
</tr>
<tr>
<td>LL</td>
<td>Lifting lugs</td>
<td>All casings</td>
</tr>
<tr>
<td>IB</td>
<td>Triangle inspection</td>
<td>All casings / Ø ≥ 1350 mm</td>
</tr>
<tr>
<td>CPPST</td>
<td>Casing painted</td>
<td>All casings</td>
</tr>
<tr>
<td>CRL</td>
<td>Loose del. control</td>
<td>All casings</td>
</tr>
<tr>
<td>EDG</td>
<td>Matrix edge painted</td>
<td>All rotors</td>
</tr>
<tr>
<td>CCP</td>
<td>Closed side panels - 4 sides</td>
<td>All casings / Ø ≥ 800 mm</td>
</tr>
<tr>
<td>SX</td>
<td>Extra spare sealing</td>
<td>All casings</td>
</tr>
<tr>
<td>BX</td>
<td>Extra spare belt</td>
<td>All casings</td>
</tr>
<tr>
<td>DT</td>
<td>Condensate drip tray</td>
<td>All casings</td>
</tr>
<tr>
<td>LI</td>
<td>Light in casing</td>
<td>All casings</td>
</tr>
<tr>
<td>EC</td>
<td>E-Clean</td>
<td>All casings</td>
</tr>
<tr>
<td>CB</td>
<td>Cable bushing</td>
<td>All casings</td>
</tr>
<tr>
<td>DBS</td>
<td>Double brush sealing</td>
<td>All casings</td>
</tr>
<tr>
<td>IW</td>
<td>Inspection window</td>
<td>Modular units C, CD, D</td>
</tr>
<tr>
<td>CPnnnn</td>
<td>Cover plates (n = opening width in mm)</td>
<td>Modular units C, CD, D</td>
</tr>
<tr>
<td>ICP50</td>
<td>Insulation cover plates</td>
<td>Modular units C, CD, D with cover plates</td>
</tr>
<tr>
<td>ICS50</td>
<td>Insulation complete casing</td>
<td>Modular units C, CD, D</td>
</tr>
<tr>
<td>SHM</td>
<td>Rotor half mounted</td>
<td>2-piece casings SD, DS, CD, D</td>
</tr>
<tr>
<td>SFM</td>
<td>Rotor fully mounted</td>
<td>2-piece casings SD, DS, CD, D / Ø ≤ 2500 mm</td>
</tr>
<tr>
<td>HDK</td>
<td>Handles</td>
<td>Modular units C, CD, D</td>
</tr>
</tbody>
</table>

Table 14: Application limits

<table>
<thead>
<tr>
<th>Application limits</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature without control unit</td>
<td>-20...50°C</td>
</tr>
<tr>
<td>with MicroMax / MiniMax control unit</td>
<td>-20...45°C</td>
</tr>
<tr>
<td>with Emotron control unit</td>
<td>-30...40°C</td>
</tr>
<tr>
<td>Pressure difference between air streams</td>
<td>max. 1000 Pa</td>
</tr>
<tr>
<td>Pressure difference to outside</td>
<td>max. 1000 Pa</td>
</tr>
<tr>
<td>Pressure drop 1-piece rotors</td>
<td>max. 300 Pa</td>
</tr>
<tr>
<td>Pressure drop segmented rotors</td>
<td>max. 400 Pa</td>
</tr>
</tbody>
</table>

Table 14: Application limits of Hoval Enventus rotary heat exchangers
3 Product selection and performance calculations

1.12 Hoval Enventus CASER selection program

Hoval Enventus CASER

The Hoval Enventus CASER selection program is available for fast and accurate design of rotary heat exchangers (= Computer Aided Selection of Energy Recovery). It runs under Microsoft® Windows and offers the following applications:

- Secure planning with Eurovent and TÜV certified data
- Accurate calculation of a specific rotary heat exchanger
- Calculation of all appropriate rotary heat exchangers for a specific project
- Calculation of the efficiency class in accordance with EN 13053
- Calculation of leakage in accordance with Eurovent
- Price calculation for the selected rotary heat exchangers

Notice
You can download the Hoval Enventus CASER selection program free of charge from our homepage (www.hoval-enventus.com).

Notice
Hoval Enventus CASER is also available as a Windows DLL file and can therefore be integrated into other spreadsheet programs (on request).

1.13 Replacement rotors

Hoval Enventus rotary heat exchangers can be used to replace most makes on the market.

When replacing a rotor it is often possible to use the existing rotor casing. Bearings on all Hoval Enventus rotors are installed in the hub, and this solution is very beneficial.

If the rotor does not run properly it is necessary to find the cause. Was the initial choice of material wrong, or has the operation in the environment changed? The new rotor may possibly need a different specification compared to the original. If there is a lack of space, a 1-piece rotor can be replaced by a segmented rotor.

A rotary heat exchanger can also replace other heat recovery system types. It is important to consider the following:

- What are the maximum dimensions?
- Can a slide-in casing be used?
- What kind of environment is it; is a rotor suitable?

For more detailed information about replacing rotors, please contact Hoval Enventus customer service.
4 Technical function

Hoval Enventus rotary heat exchangers transfer sensible energy (temperature) and latent energy (humidity) between 2 air flows. Rotary heat exchangers are very important for energy conservation in air handling units that treat outdoor air to ensure good indoor climate and air quality.

1.14 Description of function

The regenerative system consists mainly of the following components:
- Storage mass (hub, bearings and foil)
- Drive equipment (motor, control unit and belt)
- Casing (purge sector and seals)

![Fig. 34: Description of function](image)

**1** Storage mass
**2** Drive equipment
**3** Casings

250 mm deep; 200 mm is suitable for most installations. Regenerative systems are very attractive due to their high continuous recovery rates and minimal installation depths.

![Fig. 35: Storage mass](image)

Untreated aluminium foil is used for sensible heat recovery. Epoxy-coated aluminium or seawater resistant foil with higher magnesium content is best suited in installations in aggressive environments such as industrial or maritime locations.

Condensation rotors only transfer humidity during the winter when extract air condenses in the storage mass and is taken up by the supply air stream.

Hygroscopic or sorption-treated rotors transfer airborne humidity (latent energy) year round. Sorption rotor foil is permanently coated with sorption material of the type 3 Å molecular sieve, which has an extremely high humidity transfer capacity. The storage mass of hygroscopic rotors is partly coated to create a surface that transfers humidity.

The rotary heat exchanger is connected on the exhaust side to the outdoor air and exhaust air ducts and on the supply side to the supply air and extract air ducts. In this way the air streams pass the storage mass in opposite directions. Both air streams pass the rotor simultaneously and continuously, and the rotor is heated and cooled within one revolution. Energy from extract air is transferred to the storage mass and then from the storage mass to the outdoor air.

The storage mass consists of many small, sinusoidal channels made from thin aluminium foil. Depending on the desired level of recovery, wave height varies between 1.5 mm and 2.7 mm. The storage mass is 200 mm or
1.15 Heat and humidity recovery

Heat recovery
According to the fundamental laws of thermodynamics, heat energy is transported from the warmer to the cooler substance. Similarly, during the winter, sensible heat energy in extract air is transferred to the storage mass and from the storage mass to the cooler outdoor air. The amount of heat transfer is generally specified by the temperature efficiency.

The temperature efficiency of rotary heat exchangers in counterflow operations is usually between 70% and 90% and for the supply air side is calculated according to the following equation:

\[ \eta_h = \frac{(t_{22} - t_{21})}{(t_{11} - t_{21})} \]

Temperature efficiency can be determined relatively easily in terms of both measurement and theory. It is largely dependent on the size of the heat transfer surface area, rotor material, air speed through the storage mass channels and rotor speed.

An important parameter that affects temperature efficiency is the face velocity on the rotor surface. The Reynold number inside the storage mass is very low, which results in laminar airflow. The larger the supply air flow is in relation to the extract airflow, the lower the temperature efficiency. Rotor speed should be around 12 rpm for optimal heat recovery. If rpm is reduced, temperature efficiency drops. Furthermore, temperature efficiency is not dependent on the relationship of air temperature, which makes it easier to calculate the recovery rate for varying air temperatures.

Humidity recovery
Humidity efficiency depends on temperature and humidity content in outdoor air and extract air; it is defined by the following equation:

\[ \eta_x = \frac{(x_{22} - x_{21})}{(x_{11} - x_{21})} \]

In general, there are 2 humidity transfer principles:
- Humidity transfer via condensation and evaporation (condensation rotors)
- Humidity transfer via physical adsorption and desorption (hygroscopic or sorption rotors)

The following table provides an overview of general rotor types and their humidity recovery capabilities:

<table>
<thead>
<tr>
<th>Rotor type</th>
<th>Condensation rotor (ST1)</th>
<th>Hygroscopic rotor hybrid (SE3)</th>
<th>Sorption rotor hybrid (SH1)</th>
<th>Sorption rotor (HM1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage mass</td>
<td>Untreated aluminium</td>
<td>Smooth foil with sorption</td>
<td>Corrugated foil with</td>
<td>Complete surface</td>
</tr>
<tr>
<td></td>
<td>surface</td>
<td>coating (molecular sieve 3 Å)</td>
<td>sorption coating (molecular</td>
<td>foil with sorption</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>sieve 3 Å)</td>
<td>coating (molecular</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>sieve 3 Å)</td>
</tr>
<tr>
<td>Humidity transfer</td>
<td>Humidity transfer when</td>
<td>Small humidity transfer via</td>
<td>Medium humidity transfer</td>
<td>High humidity</td>
</tr>
<tr>
<td>principle</td>
<td>condensation is present</td>
<td>evaporation and additionally</td>
<td>via adsorption and</td>
<td>transfer via</td>
</tr>
<tr>
<td></td>
<td></td>
<td>condensation, if present</td>
<td>additionally condensation,</td>
<td>adsorption</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>if present</td>
<td></td>
</tr>
<tr>
<td>Eurowent classification</td>
<td>No humidity efficiency</td>
<td>Humidity efficiency &lt; 70%</td>
<td>Humidity efficiency ≥ 70%</td>
<td></td>
</tr>
<tr>
<td>(without condensate)</td>
<td></td>
<td>of temperature efficiency</td>
<td>of temperature efficiency</td>
<td></td>
</tr>
</tbody>
</table>

Table 15: Humidity recovery depending on rotor type

Heat transfer surface area is in turn a function of the structure's wave height and design. A simple rule of thumb is that reducing wave height increases the heat transfer surface area and thus temperature efficiency.

![Wave height and wave length](image)

Fig. 37: Wave height and wave length
Humidity transfer by condensation rotors

Condensation rotors transfer humidity only when condensation occurs on the extract air side which is taken up through evaporation by the supply side. Thus, humidity efficiency is directly dependent on the amount of condensation on the extract air side and the amount of humidity taken up on the supply side.

The maximum humidity transfer potential is the difference between extract air humidity content and the outdoor air temperature dew point, also known as condensation potential $\kappa$. The condensation potential is independent of air temperature and is a direct measurement of humidity transfer due to condensation. The greater the condensation potential, the larger the amount of condensate on the extract air side, and thus the larger the humidity efficiency. If the condensation potential is 0, no humidity transfer via condensation can take place. Negative condensation potential describes the summer case and humidity transfer only takes place via physical adsorption.
**Humidity transfer by hygroscopic rotors**
The storage mass of a hygroscopic rotor has a partly capillary surface structure with adsorption properties. Up until the 1990s it was thought that hygroscopic rotors transfer humidity solely via adsorption and desorption, and therefore humidity efficiency was almost constant and not dependent on condensation potential. Today it is known that hygroscopic rotors reach their best humidity efficiency at low outdoor air temperatures where humidity is also transferred via condensation.
When the outdoor air temperature increases, the humidity efficiency is reduced. Compared to condensation rotors, hygroscopic rotors transfer a smaller proportion of humidity without condensation occurring.

**Humidity transfer by sorption rotors**
Sorption rotors have a special coating that consists of a 3 Å molecular sieve. Humidity transfer takes place solely through adsorption and desorption. Humidity efficiency depends on sorption layer coating thickness, adsorption capacity, polarity and air temperature differential. Adsorption kinetics, which is the speed of the adsorption and desorption process as well as absorbed and released sorption energy, also play an important part.
Because humidity transfer depends solely on sorption, the condensation potential does not affect the humidity efficiency. The humidity efficiency graph for sorption rotors shows a slight reduction with reduced temperature differential between outdoor air and extract air. This is because temperature differential forms an important part of the parameters behind the adsorption and desorption process.

1.16 Process in Mollier diagram

**Condensation rotor**
Condensation rotors only transfer sensible energy and no airborne humidity if no condensation is present. In the Mollier diagram the process graphs are vertical as air temperature alone is changed through the rotor.

**Hygroscopic and sorption rotors**
Hygroscopic and sorption rotors transfer sensible and latent energy. The process graphs run at an angle through the diagram as temperature and humidity content change. Humidity efficiency for sorption rotors is larger than that of hygroscopic rotors.

1.17 Pressure drop

Airflow through the storage mass channels causes a pressure drop, which is the static pressure difference between air flowing in and out. The magnitude of the pressure drop depends on face velocity, wave height and depth of the storage mass. Pressure drop increases with lower wave height or increasing air flow.
Depending on the fan arrangement, air can be drawn or blown through the storage mass.

---

**Fig. 41:** Process of sorption rotor

**Fig. 42:** Pressure drop depending on face velocity
1.18 Performance control

The amount of energy recovered by a rotary heat exchanger depends on the condition of outdoor air and extract air. Outdoor air temperature and humidity content change daily, and over a year the differences can be very large.

Air temperature is expressed over a full year by means of the duration graph. Areas 1 and 2 show heat exchange by the rotor. Areas 3 and 4 show necessary external heat and cooling requirement to reach the required supply air temperature.

Time period A shows winter and time interval C describes summer. During these periods, the rotor is driven at maximum rpm for maximum energy recovery. Time period B shows the intermediate months during spring and autumn. During these periods rotor speed is adjusted downwards, which means maximum efficiency is not exploited to reach the required supply air temperature.

When rotor rpm decreases in relation to maximum rpm, temperature efficiency and humidity efficiency are reduced. Temperature efficiency is reduced significantly from 5 rpm and lower. Humidity efficiency is reduced more constantly than temperature efficiency as a function of rpm.
1.19 Purge sector

**Carry over**
The heat exchanger matrix rotates between two counter-flowing air streams. When the rotor passes the separating floor between the air streams, the air trapped in the matrix is transferred from one duct to the other. This phenomenon is called carry over.

If no action is taken, trapped air will be constantly transferred between the air streams. In this way, a small part of the extract air can get mixed with the supply air. Installation of a purge sector is recommended.

The degree of transfer is proportional to rotation speed and matrix thickness.

\[ c = \frac{r^2 \cdot \pi \cdot l \cdot f \cdot n}{120 \cdot q} \cdot 100\% \]

- *c* = Carry over [%]
- *r* = Radius of rotor [m]
- *l* = Depth of rotor [m]
- *f* = Rotor porosity = 0.95 [-]
- *n* = Rotational speed [min⁻¹]
- *q* = Air flow rate [m³/s]

**Purge sector**
To prevent extract air mixing with supply air by carry over, a purge sector can be installed. Its function is to flush the storage mass with outdoor air before it rotates into the supply air duct. In this way only outdoor air is present in the matrix and no carry over of extract air to supply air is possible. The purge sector is located on the supply air / extract air side. No purge sector is installed on the opposite side, where the matrix leaves the supply air duct, as transfer of outdoor air to extract air does not impair supply air quality.

The purge process is ensured by allowing sufficient air to flow through the storage mass as it passes the purge sector, so that all trapped air is replaced by outdoor air. 3 different purge sector angles are available as standard: 2.5° / 5.0° / 10.0°. The size of the purge sector angle depends on air speed in the sector and rotational speed.

\[ a = \frac{(l \cdot n \cdot 6)}{v} \]

- *a* = Purge sector angle
- *l* = Depth of rotor [m]
- *n* = Rotational speed [min⁻¹]
- *v* = Air velocity through purge sector [m/s]

The most important parameter is the air speed through the purge sector, which in turn is dependent on static pressure conditions around the rotor.

The table below provides guidelines for purge angles, which should be chosen depending on static pressure conditions on the supply air side P_{22-11} (pressure differential between supply air and extract air).

**1.20 Effect of the purge flow**

The size of the volume flow through the purge sector (purge flow) depends on the rotor diameter, the purge sector angle and the static pressure conditions. In theory, purge flow affects the temperature efficiency and humidity efficiency only marginally and has no practical relevance. Air leakage rates can be calculated with Hoval Enventus CASER selection program.
### Technical function

**Fig. 48: Purge sector recommendation**

<table>
<thead>
<tr>
<th>Pressure difference $p_{22} - p_{11}$</th>
<th>$&lt; 0 \text{ Pa}$</th>
<th>$0 - 250 \text{ Pa}$</th>
<th>$250 - 500 \text{ Pa}$</th>
<th>$&gt; 500 \text{ Pa}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Diagram" /></td>
<td>No purge sector recommended</td>
<td>5° angle</td>
<td>2.5° angle</td>
<td>No purge sector recommended</td>
</tr>
<tr>
<td><img src="image" alt="Diagram" /></td>
<td>No purge sector recommended</td>
<td>5° angle</td>
<td>2.5° angle</td>
<td>No purge sector recommended</td>
</tr>
<tr>
<td><img src="image" alt="Diagram" /></td>
<td>No purge sector recommended</td>
<td>5° angle</td>
<td>2.5° angle</td>
<td>No purge sector recommended</td>
</tr>
<tr>
<td><img src="image" alt="Diagram" /></td>
<td>No purge sector recommended</td>
<td>5° angle</td>
<td>2.5° angle</td>
<td>No purge sector recommended</td>
</tr>
</tbody>
</table>

Legend:  
- $p_{22}$ = Static pressure of supply air  
- $p_{12}$ = Static pressure of exhaust air  
- $p_{21}$ = Static pressure of outdoor air  
- $p_{11}$ = Static pressure of extract air

*No purge sector (wrong airflow direction through the purge zone)*
1.21 Air leakage

A sealing system is installed between the storage mass and casing parts. Because the storage mass is movable, a small amount of leakage between the air ducts may occur. The magnitude and direction of leakage flow depends on the static pressure relationship between the supply and extract ducts and on the rotor size (total length of seals). The larger the pressure differential between extract air and supply air, the larger the leakage. It is preferable for the air pressure on the supply side to be a little larger than the extract side in order that air leakage is directed toward extract air to avoid contaminating supply air. Leakage in smaller rotors is proportionally larger than in large rotors, as leakage flow is related to supply airflow. For pressure differentials larger than 300 Pa double sealing is recommended.

Leakage rate and average pressure

Air leakage can be calculated in Hoval Enventus CASER. The leakage flow rate is expressed as a percentage of supply airflow.

The average pressure differential is the difference between outdoor air and exhaust air pressure differential, and that of supply and extract air. An increase in average pressure differential will result in increased leakage flow.

1.22 Frost limit

At low outdoor air temperatures the humidity of the extract air can condensate inside the storage mass. When outdoor air temperature decreases, condensate remains inside the storage mass. The condensate is drained from the rotor with the airflow, given that average surface temperature of the storage mass during one round is above 0°C. If the average surface temperature of the storage mass during one round is below 0°C, a layer of frost will form. However, this occurs very rarely as extract air humidity content during the winter is often very low, and outdoor air temperature varies over 24 hours which is the reason why condensate evaporates and is taken up by supply air or drained away in most applications.

The frost limit depends on rotor type, extract air temperature and humidity content and outdoor air temperature. The following diagram shows the general frost limit for condensation rotors and sorption rotors. A sorption rotor transfers humidity through the entire matrix sorption layer. This principle constantly reduces extract air humidity content. Thus, a sorption rotor can operate at around 10 °C lower outdoor air temperature compared to a condensation rotor, without the occurrence of frosting.

Defrosting

An effective way to prevent frosting or to defrost a rotor is to pre-heat the outdoor air to -8 °C. Another method is to reduce rotor speed to 0.5 min⁻¹ which results in a reduction of temperature efficiency and humidity efficiency to a minimum allowing extract air to thaw the layer of frost on the rotor.

It is also possible to change the mass flow ratio and lower the outdoor air flow rate. This can be achieved by installing bypass dampers or speed-controlled fans.
1.23 Contamination of supply air with extract air

Supply air can be contaminated with extract air in 3 different ways:
- Air leakage through sealing due to unfavourable pressure set-ups
- Carry over in the absence of a purge sector
- Through a hygroscopic or sorption coating (matrix borne carry over)

**Carry over and leakage flow**
When the supply air duct has a larger static pressure than the extract air duct, leakage from extract air to supply air is excluded. Furthermore, proper purge sector function is ensured, preventing supply air contamination by extract air through carry over (refer to previous section).

**Matrix Borne Carry Over (MBCO)**
Sorption rotors with conventional sorption technology transfer volatile organic compounds (VOCs). The degree of carry over is defined by MBCO and depends on the type of sorption coating.

\[
MBCO = T_{VOC,BA} - T_{VOC,OA} / T_{VOC,RA} - T_{VOC,OA}
\]

Hoval Enventus uses a 3 Å molecular sieve as a sorption coating, which in comparison to conventional sorption coatings has a selective adsorption capability ≤ 3 Å, i.e. airborne humidity (H₂O = water molecule = 2.7 Å). Installations and tests show that a 3 Å molecular sieve is the best choice for reducing the risk of odour transfer via the sorption coating. The MBCO rate for HM1 3 Å molecular sieves is very low. Many conventional sorption coatings do not only transfer humidity, but also organic gases in the extract air, which are then transferred to supply air. Measurements show that MBCO from conventional sorption coatings can reach 30%. As a result, air quality is impaired and there are often odour problems, e.g. when the air has great concentrations of cooking smells from kitchens.

A high MBCO rate can increase VOC concentration in room air through constant recirculation. To counteract this effect, an increased ventilation rate would be required which requires larger fan energy consumption.
1.24 Project planning advice

**Recommended installation**
The best flow conditions are achieved when supply and extract air fans are installed on the suction side of the regenerative heat recovery unit. A reasonable pressure difference between the supply air and extract air ducts $p_{22-11}$ is obtained in almost all installations. Alternatively, the supply air can be located in the direction of flow upstream of the rotor. This variation is often found in hospital installations where the entire supply air section is run at overpressure. The risk of supply air contamination is thus eliminated.

**Constant pressure and recirculated air**
Blow through extract air fans and draw through supply air fans are typical in installations with a recirculating air function, or in installations where constant duct pressure is necessary. The system leads to a negative pressure differential between $p_{22-11}$ and because a purge sector is unable to function correctly, it should not be installed. Therefore, blow through extract air fans should only be used in systems where recirculating air is allowed.

**Inspection**
It is important when installing rotors to consider service, maintenance and cleaning. Hatches are necessary on the inspection side to allow access to control equipment, motors, drive belts and brush sealings.

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**Airflow disturbance**
Rotor performance calculations are based on undisturbed airflows in and out. Because very uneven airflow speed profiles have a negative effect on rotor performance, component location should be carefully planned in a ventilation installation. If the rotor is e.g. installed in direct connection to a right-angle duct, guides should be installed in the duct so that air speed is evened out as far as possible.

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**Air containing particulates**
Experience shows that the rotor can be run with a moderate amount of particulates in the air. Due to the laminar airflow inside the storage mass a self-cleaning effect is achieved when the rotor switches airflow directions between outdoor and extract air. If particulates do remain on the outer surface of the rotor these can be vacuum cleaned or washed away. It is always recommended to install an air filter in the direction of airflow upstream of the rotor in order to protect the rotor from contamination. It is advisable to install an extract air oil filter in installations with kitchen extract air.

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**1.25 Energy recovery**

**Sorption rotor – Muonio**
Hoval Enventus molecular sieve 3 Å HM1 rotors provide exceptionally high humidity efficiency up to 85%. Sorption rotors provide an excellent method of cooling and de-humidifying outdoor air before it reaches the air handling unit cooling coil.

- Direct investment pay off
- Lower investment cost in cooling capacity
- Lower energy consumption in cooling period
- Better indoor air quality
- Minimum carry over
- Increased humidity in winter season
- Lower investment and running costs for humidification
- Better performance for dry cooling systems
- Increased cooling capacity in existing systems
- 5 – 10 °C lower freezing temperature
Performance

Smaller

Cooling

The

Supply

Minimized

Lower

Better indoor air quality during winter

Advantages of 3 Å molecular sieves
The Hoval Enventus HM1 molecular sieve 3 Å provides high selectivity for water molecule absorption (2.7 Å size).
- Performance of 3 Å technology is proven in several international and independent studies.
- Minimized carry over of VOC’s from extract air to supply air.

Lower investment costs in cooling capacity both in AHU’s and cooling systems
- The cooling capacity saving is 20 – 50 %.
- The required cooling capacity will decrease by 10 – 25 kW/m³/s air flow compared to sensible energy recovery systems.
- Smaller compressors
- Smaller electrical connection costs and power consumption in cooling system
- Lower water flows to cooling coils and smaller pipe works and valves
- Savings in cooling equipment investments are higher than additional cost of sorption treatment of the rotor.

Lower investment cost in supply air humidification
- Supply air humidification equipment will be smaller, due to high rate of humidity recovery from the extract air.

Lower running costs of ventilation and cooling
- Cooling recovery in summer time
- Humidity recovery in winter time

Better working conditions for dry cooling systems (chilled ceilings or beams)
- Almost constant humidity efficiency provides effective dehumidification of outdoor air in extreme summer conditions
- Smaller requirement for raised water temperature to unit

Better indoor air quality during winter
- High humidity recovery from extract air during winter season

Double Wheel Concept
In regions with high air temperature and humidity or buildings with dry cooling systems (chilled beams, chilled ceilings), the supply air needs to be cooled and dehumidified. Traditionally air dehumidification has been done by cooling the air to condense the humidity from the air and reheating it to the requested air temperature.

Compared to traditional systems the Hoval Enventus Double Wheel Concept is cooling, dehumidifying and reheating the supply air in a more energy effective way.

Components and functions:
1. Muonio – HM1 sorption rotor: The HM1 rotor dehumidifies and cools warm outdoor air very efficiently.
2. Cooling coil: Outdoor air is further dehumidified by the cooling coil until the preferred temperature is reached.
3. ST1 condensation rotor: The condensation rotor warms the air to the required supply air temperature.
4. At the same time, extract air is cooled which means the HM1 rotor works more efficiently.

The Hoval Enventus Double Wheel Concept saves up to 60 % of the total cooling capacity and requires lower investment and running costs compared to traditional systems. As rule of thumb, the additional cost of the sensible wheel can be saved in the lower investment compared to traditional system components, coils, chillers, cold and hot water piping installation, pumps, valves, controls and electric power supply costs. Accurate total investment costs analysis of the complete installation will show major savings in initial costs. Both cooling and heating energy savings will be additional profit of the investment.
1.26 Materials selection

Different environments demand different materials. Hoval Enventus offers materials that are suitable for most environments.

**Low to normal corrosion risk**
Galvanized or Aluzinc coated sheet metal is usually used in areas with low to normal corrosion risk. Frames are made from aluminium. All of our rotor materials are ideally suited for their purposes. All bearings are life-time lubricated and sealed for extended life.

**High corrosion risk**
Great care should be taken when choosing materials in areas where there is a high risk of corrosion such as industrial use. All casing parts can be powder-coated to enhance corrosion resistance (option). All bearings are life-time lubricated and extra sealed for extended life. Vital parts such as shaft are coated with tectyl for enhanced corrosion resistance. Epoxy-coated foil (SC1) should be selected. It provides extremely effective protection against corrosion.

**Marine ventilation**
In maritime environments all sheet metal parts should be powder-coated (option). All bearings are life-time lubricated and extra sealed for extended life. Vital parts such as bearings are coated with tectyl for enhanced corrosion resistance. Seawater resistant foil ST2 is recommended for use in maritime environments. The alloy has a 2.5% magnesium content, which provides good corrosion protection.

1.27 Sound attenuation

The following values can be used as standards for sound attenuation of the rotor:

<table>
<thead>
<tr>
<th>Insertion attenuation △Lw [dB]</th>
<th>Frequency [Hz]</th>
<th>63</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
<th>8000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensation rotor</td>
<td></td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Hygroscopic rotor</td>
<td></td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Sorption rotor</td>
<td></td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 16: Standard values for sound attenuation

5 Transport

Hoval Enventus delivers goods worldwide by land, sea and air. Our packaging is ideally suited for the transportation of heat exchangers by land, sea (including containers) or air. We pack onto pallets or in wooden crates or boxes depending on the type of product, the destination and requirements. All packaging is heat treated and stamped ISPM 15 (in accordance with UN FAO international standards). Packaging is made with 2-way or 4-way pallet bases and can be handled by fork lift.

We recommend that goods be inspected on arrival to ensure no damage occurred during transport. If they are to be stored, the goods should be kept in their original packaging and stored on a flat surface and in a dry place.

We can also provide lifting eyes on some casing types to facilitate installation.

Contact us for further information.

Fig. 59: Packing materials
6 Commissioning and maintenance

Correct installation and maintenance is important for ensuring product performance. Hoval Enventus provides various aids to ensure efficient, hassle-free commissioning and long product service life.

1.28 Commissioning

In order to ensure effective, hassle-free commissioning, it should be performed according to the commissioning protocol (BL036) included in delivery. This protocol is also available for download at the Hoval Enventus website. The Hoval Enventus product warranty is conditional upon presentation of a completed commissioning record.

For other manuals, and installation instructions, refer to our website www.hoval-enventus.com.

1.29 Maintenance

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotor</td>
<td>The rotor surface must be inspected regularly. Rotor fouling is affected by air quality, filter type, filter condition and air leakage etc. Base inspection frequency on the above factors. Hoval Enventus recommends that inspections be carried out at least once per year.</td>
</tr>
<tr>
<td>Cleaning rotor surfaces</td>
<td>See section 6.3.</td>
</tr>
</tbody>
</table>
| Segmented rotors | - Check all periphery plate fasteners. Re-tighten fasteners. Tightening torque 50 Nm.  
- Check that the periphery plates overlap correctly; see illustration.  
- Hoval Enventus recommends that inspections be carried out at least once per year. |
| Other rotor checks | Check:  
- that the rotor sits square in the casing. Adjust vertical and horizontal alignment as necessary.  
- that the rotor spins freely. Adjust brush sealing to ensure contact with the rotor or side plates.  
Hoval Enventus recommends that inspections be carried out at least once per year. |
| Wear parts | Seals and drive belts are classed as wear parts and should be checked regularly. Hoval Enventus recommends that inspections be carried out at least once per year. |
| Seals | Check that sealing strips seal against the rotor and side plates. Adjust as necessary. This should be done for the first time 2-3 weeks after commissioning. Replace the seals when needed, normally in 2-5 years intervals. |
| Drive belt, hanging motor bracket | Check:  
- that the motor bracket is suspended at a 20-45° angle to the horizontal. Adjust drive belt length as necessary.  
- belt lock and drive belt condition. |
| Drive belt, fixed motor bracket | Check:  
- that the belt does not slip.  
- belt lock and drive belt condition. |
1.30 Cleaning

If the rotor is dirty, clean it using:
- a vacuum cleaner, if fouling is light
- compressed air if fouling is heavy but not too sticky
- hot water and mild degreasing cleanser if fouling is heavy and also sticky (applies to spoked rotors)
- Wash glued rotors with hot water.

In cases when rotors must be cleaned often, an automatic pneumatic device may be integrated, e.g. the optional E-Clean compressed air cleaning equipment, 6 – 8 bar (without high-pressure water).

1.31 Spare parts

Hoval Enventus provides a large range of spare parts and accessories such as drive equipment (motors and control units), drive belts and brush sealing, independent of the type or manufacture or rotating heat exchangers.

We recommend the use of our original parts when replacing heat exchangers that come originally from us.

Most spare parts are in stock for immediate delivery.

Our spare parts price list can be found on our website at www.hoval-enventus.com.

Please contact us if you have any questions. Our experience will help you make the right choice.
Responsibility for energy and environment

Hoval Enventus is one of the world’s leading providers of plate and rotary heat exchangers with 70 years of experience in the industry. We are today already manufacturing and developing components and solutions for the demands of the future. Hoval Enventus is your reliable partner for technically superior energy-recovery solutions to meet the demands of today and tomorrow.

Plate heat exchangers

Hoval Enventus plate heat exchangers are air-to-air heat exchangers made from high-quality aluminium. They are used to recover energy in air handling systems and process engineering. The performance for every desired application may be adapted by modifying sizes and plate spacing.

Rotary heat exchangers

Hoval Enventus is able to deliver the appropriate rotary heat exchanger for all applications – from small aluminium rotors for comfort ventilation systems to large segmented rotary heat exchangers for industrial use.

Innovative solutions for all applications

Do you need to fulfill specific requirements? Hoval Enventus will tailor the solution for you. Our specialists will, for example, implement special applications for regions with high outdoor air temperatures and humidity. The Hoval Enventus CASER designing program is also available for efficiently dimensioning heat exchangers to meet your own specifications.