ZENCO INDUSTRIES

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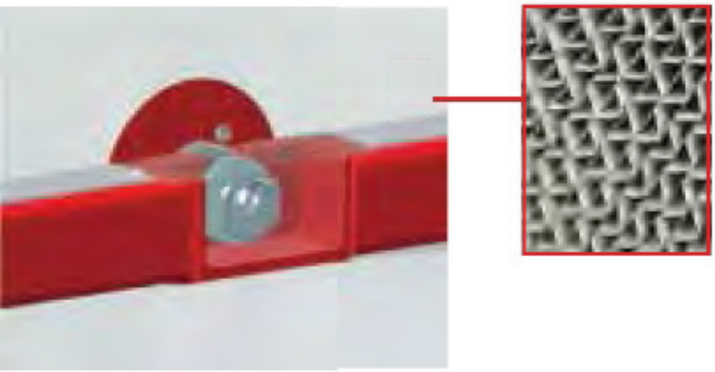
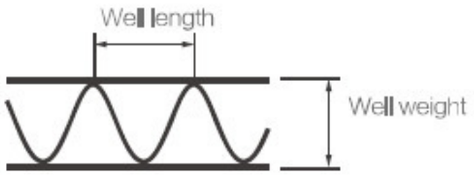
2.1 Rotor Matrix

The rotor matrix is made for laminar airflow using alternating layers of flat and corrugated foil to provide a structure comprising small, triangular channels.

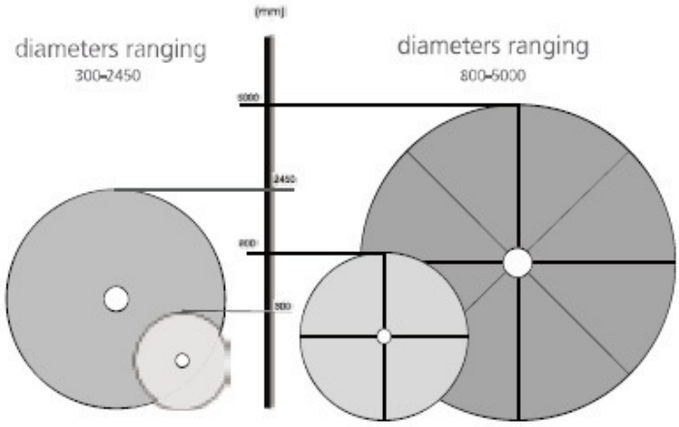


Five different well heights are available to enable optimization of efficiency and pressure drop

Rotor type	Well height
Extra Low (XL)	1,5 mm
Special Low (SL)	1.65mm
Low (L)	1,7 mm
Normal (N)	2,0 mm
High (H)	2,7 mm

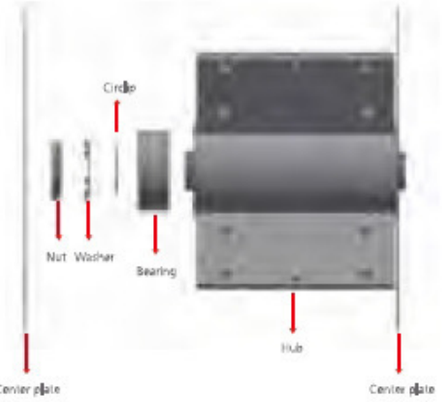


The rotor are either in one piece or sectorized. One piece rotor are made in diameters ranging between Ø300-2450 mm, while sectorized rotor have diameters ranging of Ø801-5000 mm. Sectorized rotor are divided into segments that are assembled when the rotor is installed.



The illustration above shows the number of segments for sectorized rotors of different dimensions.

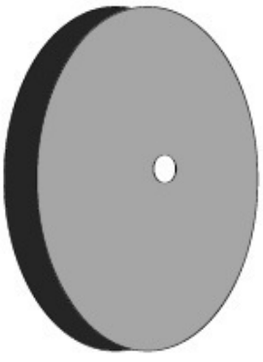
Rotors are available in widths of 100, 150, 200 or 250 mm. in all type of foil. For large OEM customer a customized width can be provided.



Sectorized Standard Hub, Shaft and Bearing

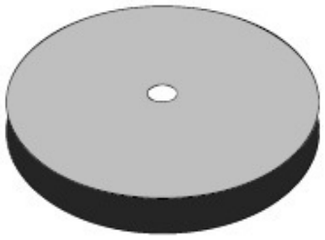
The rotor are as standard manufactured for vertical installation, horizontal installation is an option and must be notified at ordering. One piece rotor up to Ø2100 mm may be installed horizontally, and sectorized up to Ø3200 mm.

Vertical installation

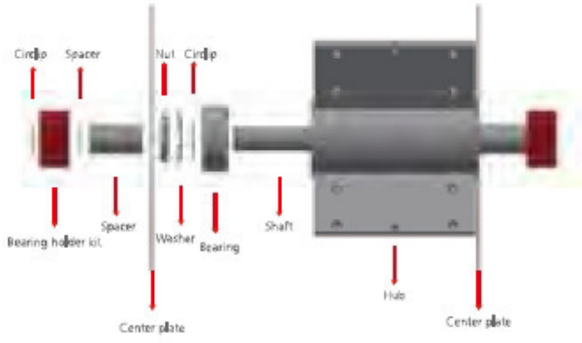


Applicable to all diameter rotors

Horizontal installation

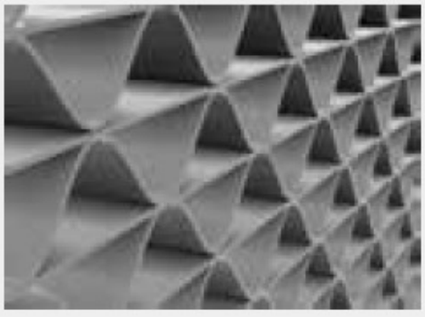


Applicable to diameter : D<2100mm one piece rotor
D<3200mm sectorized



Sectorized Special Hub, Shaft and Pillow block

2.1.1 Foil/Media



Condensation rotors (Sensible), non-hygroscopic rotors (OT, OC, OK)

The condensation rotor 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.

Hybrid rotors (OH)

60% of the media in this rotor is coated with molecular sieve 3Å the remaining 40% is standard sensible media. The mix of sensible and Sorption rotor gives a HYBRID with extended support for humidity transfer. The OH have a performance slightly lower than OM, used for standard applications in comfort ventilation systems where extended need of humidity transfer is requested.

Sorption rotor (OM)

100% of the media in this rotor is coated with molecular sieve 3Å which provide a MAXIMUM of humidity transfer capacity for MINIMAL Carry Over. The high humidity efficiency is 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.
The OM rotor also provides an extended corrosion protection and is therefore also suitable for marine applications.

Increased corrosion protection (OC, OK)

In an environment with aggressive components in the air it is either recommended to use a rotor with epoxy coating (OC) or a sea water corrosion resistant foil (OK) for better corrosion protection. Such applications can be, e.g. dairy industry, on ships or for coastal areas. Other applications for additional corrosion protection are adiabatic cooling and cooling rotors of Direct Evaporative Cooling (DEC) units.

Type	Condensation	Hybrid	Sorption	Remarks
OT	x			Untreated aluminium foil
OC	x			Epoxy-coated foil
OK	x			Seawater resistant foil (AlMg), 100µm
OH		x		3Å Molecular sieve and untreated aluminium foil
OM			x	3Å Molecular sieve

Casing is consist of a frame structure, purge sector and seals.

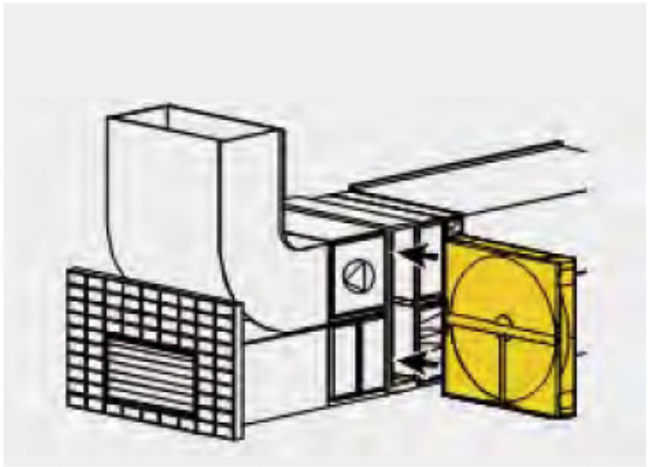
2.2.1 Structure

There are two different casing types; the slide-in model and the modular unit.

Slide-in model, (CS, OCS, DS)

Slide-in models fit into air handling units (AHU's) thus making a uniform AHU appearance possible. Slide-in casings are always uninsulated and have a large, exposed rotor surface in relation to casing size. Slide-in casings can be provided with one piece (max Ø2450 mm) or sectorized rotors (max Ø5000 mm).

CS type casing:
Slide-in casing light sheet metal casing for one piece rotor, Ø300-2450 mm.
OCS type casing:
Slide-in casing Heavy Duty casing for one piece rotor and sectorized rotors Ø 801 -3000 mm.
DS type casing:
Slide-in casing for sectorized rotors Ø3001-5000 mm.

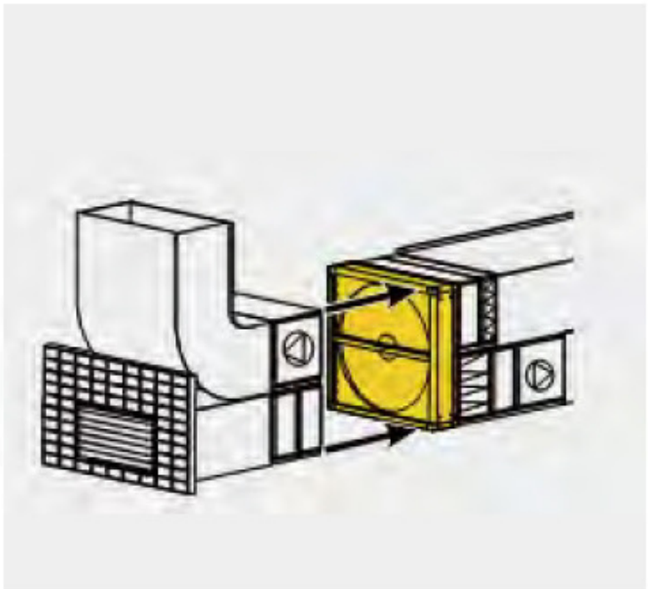


Modular units (OCS, D)

Complete units for connection to other parts of air handling unit or directly to ducting. The unit is modified so that connection can be carried out using e.g. connection panels or corner connectors. The modules are delivered with or without insulation. The modular unit can be made with a one piece casing (one piece rotors) up to Ø2450 mm and divided casings (sectorized rotors) up to Ø5000 mm. Accessories such as inspection window, ducted connection frame, lighting and condensate trays are available.

OCS type casing: Modular unit for sectorized rotors Ø801-3000 mm.

D type casing: Modular unit for sectorized rotors Ø3001-5000 mm.



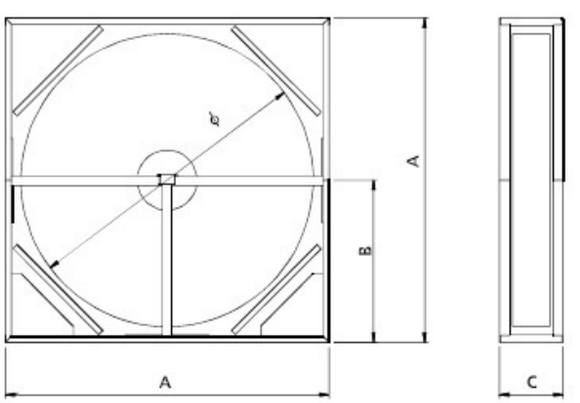
2.2.2 Standard dimensions:

Energy Recovery units can be ordered in standard sizes, with price competiveness and short delivery time. If the requested dimension is missing

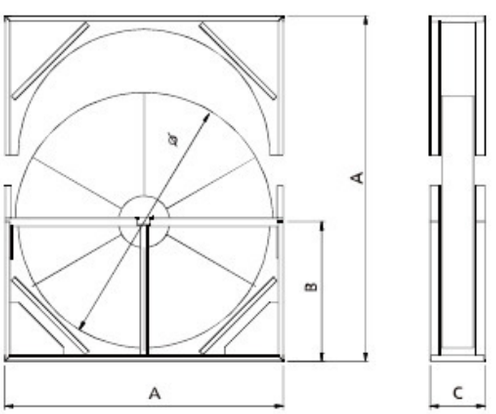
All casing are dimensioned as requested.
A: Height (mm)
B: Center Height (mm)
C: Casing Depth (mm)

Casing type OCS

Rotor depth / Casing dimension / Rotor ϕ	OCS - 250			OCS - 200			OCS - 150			OCS - 100		
	A(mm)	B(mm)	C(mm)	A(mm)	B(mm)	C(mm)	A(mm)	B(mm)	C(mm)	A(mm)	B(mm)	C(mm)
900	1030	515	390	1030	515	340	1030	515	290	1030	515	240
1000	1130	565	390	1130	565	340	1130	565	290	1130	565	240
1100	1230	615	390	1230	615	340	1230	615	290	1230	615	240
1200	1330	665	390	1330	665	340	1330	665	290	1330	665	240
1300	1430	715	390	1430	715	340	1430	715	290	1430	715	240
1400	1530	765	390	1530	765	340	1530	765	290	1530	765	240
1500	1630	815	390	1630	815	340	1630	815	290	1630	815	240
1600	1730	865	390	1730	865	340	x	x	x	x	x	x
1700	1830	915	390	1830	915	340	x	x	x	x	x	x
1800	1930	965	390	1930	965	340	x	x	x	x	x	x
1900	2030	1015	390	2030	1015	340	x	x	x	x	x	x
2000	2130	1065	390	2130	1065	340	x	x	x	x	x	x
2100	2230	1115	390	2230	1115	340	x	x	x	x	x	x
2200	2330	1165	390	2330	1165	340	x	x	x	x	x	x
2300	x	x	x	2470	1235	340	x	x	x	x	x	x
2400	x	x	x	2570	1285	340	x	x	x	x	x	x
2500	x	x	x	2670	1335	340	x	x	x	x	x	x



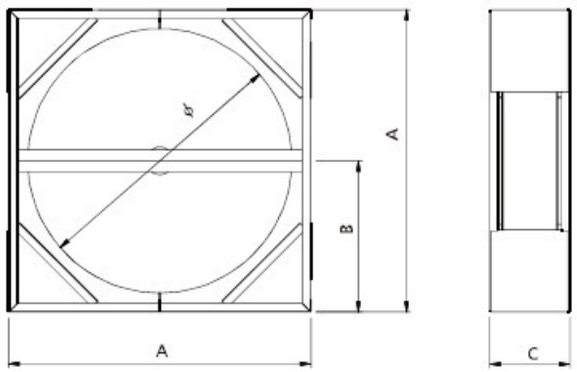
OCS Winded



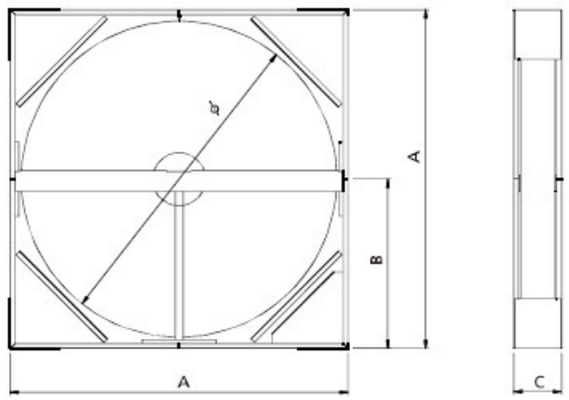
OCS Sectorized

Casing type CS

Rotor depth / Casing dimension / Rotor ϕ	CS - 200			CS - 150			CS - 100		
	A(mm)	B(mm)	C(mm)	A(mm)	B(mm)	C(mm)	A(mm)	B(mm)	C(mm)
300	470	235	290	470	235	240	470	235	190
400	550	275	290	550	275	240	550	275	190
500	620	310	290	620	310	240	620	310	190
600	700	350	290	700	350	240	700	350	190
700	800	400	290	800	400	240	800	400	190
800	900	450	290	900	450	240	900	450	190
900	1000	500	290	1000	500	240	1000	500	190
1000	1100	550	290	1100	550	240	1100	550	190
1100	1200	600	290	1200	600	240	1200	600	190
1200	1300	650	290	1300	650	240	1300	650	190
1300	1400	700	290	1400	700	240	1400	700	190
1400	1500	750	290	1500	750	240	1500	750	190
1500	1600	800	290	1600	800	240	1600	800	190
1600	1700	850	290	x	x	x	x	x	x
1700	1800	900	290	x	x	x	x	x	x
1800	1900	950	290	x	x	x	x	x	x
1900	2000	1000	290	x	x	x	x	x	x
2000	2100	1050	290	x	x	x	x	x	x
2100	2200	1100	290	x	x	x	x	x	x
2200	2300	1150	290	x	x	x	x	x	x
2300	2400	1200	290	x	x	x	x	x	x
2400	2500	1250	290	x	x	x	x	x	x
2450	2550	1275	290	x	x	x	x	x	x



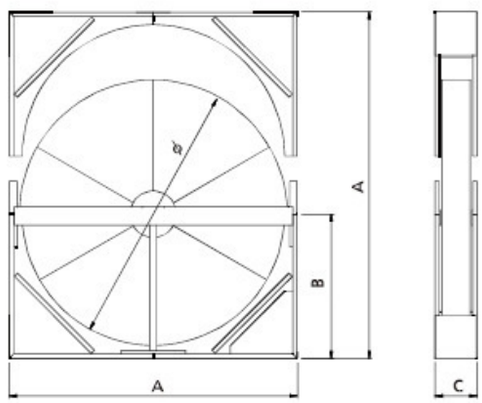
CS ≤1000mm



CS ≥1800mm

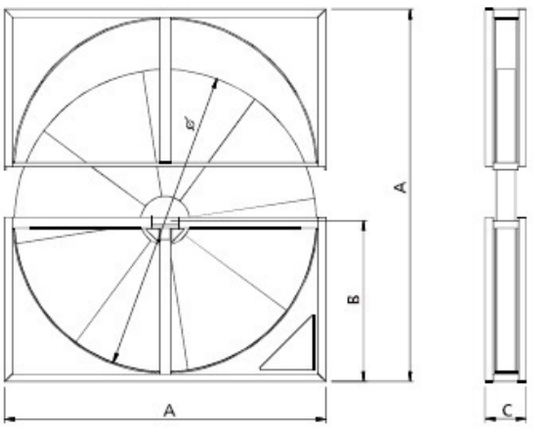
Casing type CSD

Rotor depth / Casing dimension / Rotor ϕ	CSD - 200		
	A(mm)	B(mm)	C(mm)
800	940	470	290
900	1040	520	290
1000	1140	570	290
1100	1240	620	290
1200	1340	670	290
1300	1440	720	290
1400	1540	770	290
1500	1640	820	290
1600	1740	870	290
1700	1840	920	290
1800	1940	970	290
1900	2040	1020	290
2000	2140	1070	290
2100	2240	1120	290
2200	2340	1170	290
2300	2440	1220	290
2400	2540	1270	290



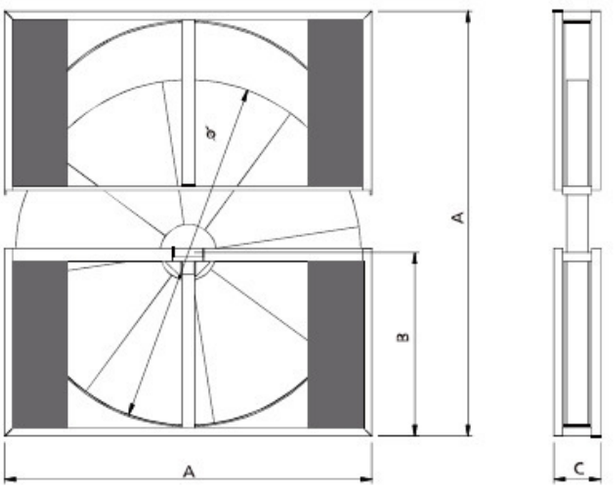
Casing type DS

Rotor depth / Casing dimension / Rotor ϕ	DS - 200		
	A(mm)	B(mm)	C(mm)
2500	2700	1350	430
2600	2800	1400	430
2700	2900	1450	430
2800	3000	1500	430
2900	3100	1550	430
3000	3200	1600	430
3100	3300	1650	430
3200	3400	1700	430
3300	3500	1750	430
3400	3600	1800	430
3500	3700	1850	430
3600	3800	1900	430
3700	3900	1950	430
3800	4000	2000	430
3900	4100	2050	430
4000	4200	2100	430
4100	4300	2150	430
4200	4400	2200	430
4300	4500	2250	430
4400	4600	2300	430
4500	4700	2350	430
4600	4800	2400	430
4700	4900	2450	430
4800	5000	2500	430
4900	5100	2550	430
5000	5200	2600	430



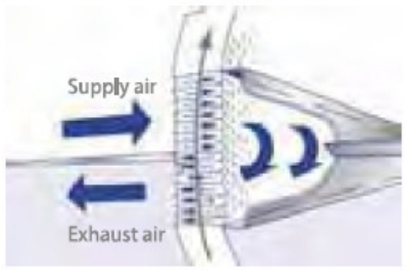
Casing type D

Rotor depth / Casing dimension / Rotor ϕ	D - 200		
	A(mm)	B(mm)	C(mm)
2500	2730	1365	430
2600	2830	1415	430
2700	2930	1465	430
2800	3030	1515	430
2900	3130	1565	430
3000	3230	1615	430
3100	3330	1665	430
3200	3430	1715	430
3300	3530	1765	430
3400	3630	1815	430
3500	3730	1865	430
3600	3830	1915	430
3700	3930	1965	430
3800	4030	2015	430
3900	4130	2065	430
4000	4230	2115	430
4100	4330	2165	430
4200	4430	2215	430
4300	4530	2265	430
4400	4630	2315	430
4500	4730	2365	430
4600	4830	2415	430
4700	4930	2465	430
4800	5030	2515	430
4900	5130	2565	430
5000	5230	2615	430



2.2.3 Purge sector

To prevent exhaust air mixing with supply air by carryover, most installations have a purge sector. Its function is to flush the rotor matrix with outside air before it rotates into the supply air duct. In this way only outside air is present in the matrix and no carryover of exhaust air to supply air is possible. The purge sector is located on the supply side of the supply air duct.



2.2.4 Seals

Drive equipment is consist of motor, control unit and drive belt.
Rotors are driven by a motor mounted on a bracket inside the casing. All rotors are driven by the motor via a belt to the rotor periphery.

2.3.1 Constant drive

Constant drive means that rotor speed remains constant during operation, or is switched off to remain stationary – so called on/off drive.

Induction motors with reduction gearing are available in three-phase and single-phase versions.

Asynchronous motors with worm gears are available in three-phase and single-phase versions.

2.3.2 Variable drive

Variable drive enables rotor speed regulation and thus optimal control throughout the year.
The drive unit consists of a motor and control unit that regulates motor rpm in relation to an input signal.

MicroMax

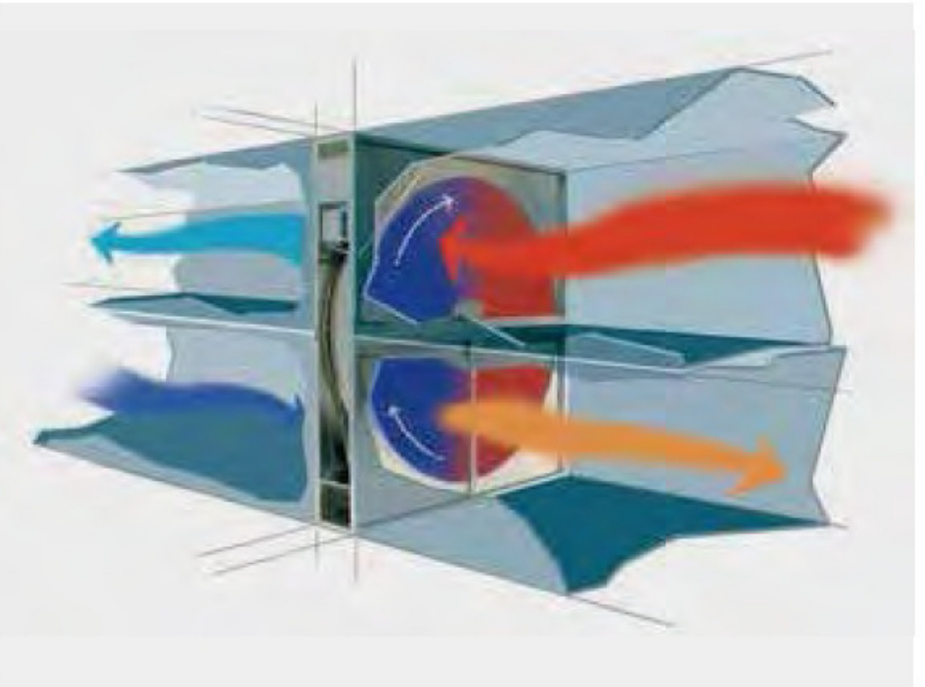
VariMax

3.1 Principle of rotary heat exchangers

rotary heat exchangers are classified as regenerative air-to-air energy recovery units.

Air-to-air energy exchangers can recycle more than 85% of the energy from conditioned building exhaust, or high temperature exhaust from industrial processes. Exhaust recovery ventilation utilizes energy from the exhaust air stream to precondition the outside air being introduced into the building. In the winter it provides free heating and in the summer free cooling.

Applying air-to-air energy recovery can help achieve a higher LEED® status, meet the requirements of ASHRAE 90.1, and save significantly on operating cost with a quick payback. Choose from stand-alone heat exchanges or pre-engineered, yet customizable modular units that incorporate heat recovery, humidity control, and other air treatment options.
Thanks to the alternating airflow direction, the rotor is self-cleaning and frost proof to a large extent.



3.2 Leakage

Definition of leakage: leakage is the percent of air that's transferred from one airstream to another airstream.

OACF: percentage leakage from outdoor air to exhaust air (from P1 to P4).
EATR: percentage leakage from return air to supply air (from P3 to P2).

Leakage:

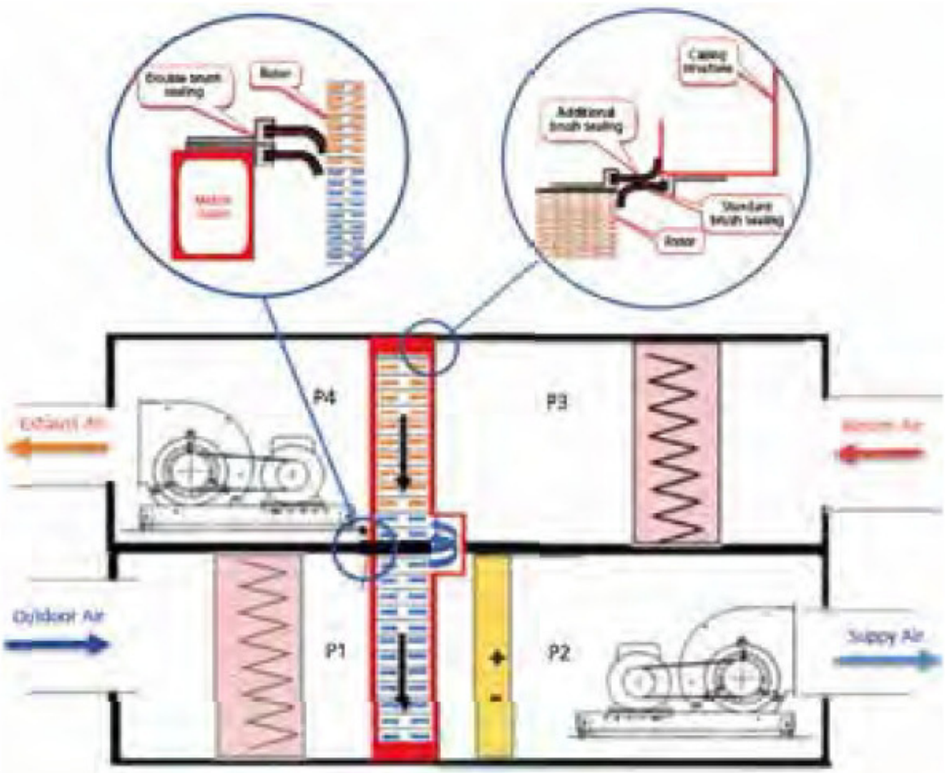
Leakage occurs either around the periphery of the rotor or via the middle beam dividing the airstreams. The positioning of the fans are vital for the percent of leakage, in a correct planned Air-handling Unit the fan positioning prevents the exhaust air to "leakage" over to supply air stream. The positioning of the fans is the responsivity of the designer of the ventilation system.

Periphery leakage:

The rotor is sealed- off from leakage around the periphery of the rotor. The standard application is a brush sealing attached to the casing that seals off the air toward the rotor surface.

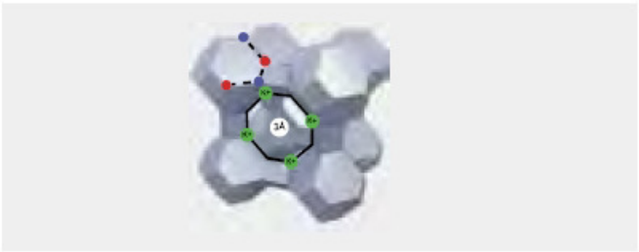
Middle beam leakage:

The rotor is sealed- off from lekagage at the middle beam using a brush sealing. This gives under normall application enougth sealing function. But if the Air handling unit have unfavrable pressure differences between the two airstreams an additional brushsealing can be applied to minimize leakage.



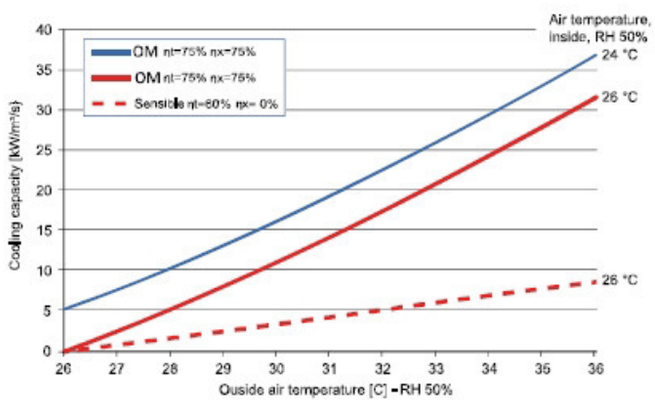
To ensure no leakage between the air-streams, pressure shall be higher in P1 (OA) than in P4 (EA) and higher in P2 (SA) than in P3 (RA).

3.3 Molecular Sieves 3Å



A molecular sieve is a material with uniform pores size (very small holes). The molecular sieve is measured in ångströms (Å). Molecular sieve 3Å do not adsorb compounds with diameters larger than 3Å. The water vapor (humidity) is smaller than 3Å and is therefore adsorbed by the Molecular sieve 3Å. Installations and tests show that a 3Å molecular sieve is the best choice for eliminate the risk of odor transfer via the sorption coating.

COOLING CAPACITY SAVINGS



Sorption rotors

Östberg Molecular Sieve 3Å OM rotors provide exceptionally high humidity efficiency more than 85%. Sorption rotors provide an excellent method of cooling and de-humidifying outside 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
- Increase cooling capacity in existing systems

3.3 Molecular Sieves 3Å

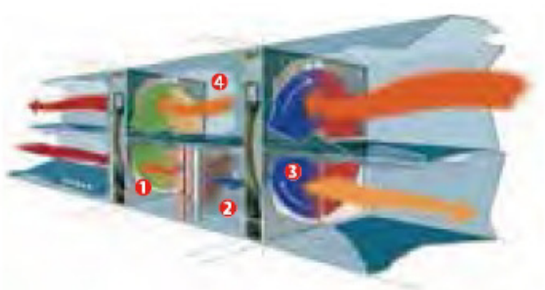
Advantages of 3Å molecular sieves

The Östberg OM Molecular Sieve 3Å provides high selectivity for water molecule absorption (2.7Å size).	• Performance of 3Å technology is proven in several international and independent studies • It is recommended in cases where cross contamination needs to be minimized • Minimized Carry Over of VOC's from extract air to supply air
Lower investment costs in cooling capacity both in AHU's and cooling system	• 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, condensers or cooling towers or higher evaporation and lower condensing temperatures • 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 exhaust air
Lower running costs of ventilation, cooling and humidification	• 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 outside air in extreme summer conditions • Smaller requirement for raised water temperature to unit
Better indoor air quality during winter	• High humidity recovery from exhaust air during winter season

3.4 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 Double Wheel Concept is cooling, dehumidifying and reheating the supply air more energy effective.



The Double Wheel Concept comprises the following components and functions:

1. OM sorption rotor: The OM rotor dehumidifies and cools warm outside air very efficiently.
2. Cooling coil: Outside air is further dehumidified by the cooling coil until the preferred temperature is reached.
3. OT Condensation rotor: The condensation rotors warms the air to the required supply air temperature.
4. At the same time, exhaust air is cooled which means the OM rotor works more efficiently.

The Östberg Double Wheel Concept saves up to 60% of the total cooling capacity, remove the need of reheating 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 analyze of the complete installation will show major savings in initial costs. Both cooling and heating energy savings will be additional profit of the investment.

DRIVE EQUIMENT - TABLE SUMMARY

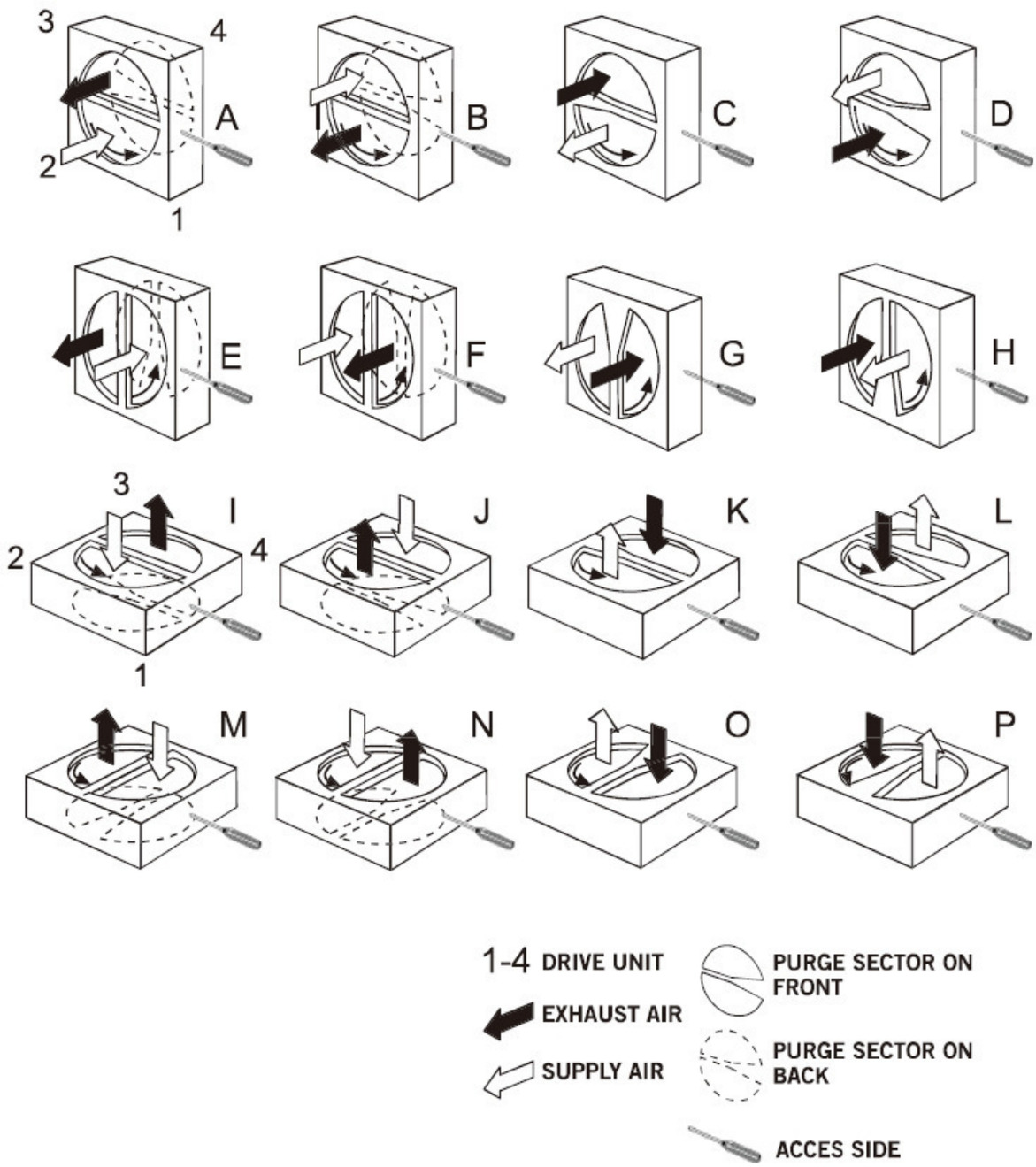
VARIABLE DRIVE EQUIPMENT - MICROMAX WITH MOTOR

DRIVE MOTOR		40V	AP56t	AP63t	AP71t	AP80t
Rotor diameter	mm	≤1000	<1500	1500-2399	2400-3549	3550-5000
Control unit		Micromax 180	Micromax 180	Micromax 180	Micromax 370	Micromax 750
Input voltage	V	3x230	3x230	3x230	3x230	3x230
Frequency	Hz	50/60	50/60	50/60	50/60	50/60
Motor power	KW	0,04	0,09	0,18	0,37	0,75
Rated current	A	0,39	0,74	1,10	1,92	3,34
Protection class		IP54	IP55	IP55	IP55	IP55
Weight (motor/control unit)	KG	3,4/<2,0	4,4/<2,0	5,4/<2,0	8,1/<2,0	12,6/<2,0

CONSTANT DRIVE EQUIPMENT

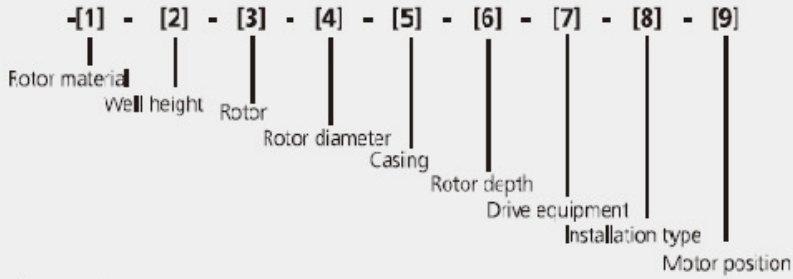
DRIVE MOTOR		40K	AP56	AP63	AP71	AP80
Rotor diameter	mm	≤1000	<1200	1200 - 1699	1700-2449	2450-5000
Input voltage	V	3x400	3x230/400	3x230/400	3x230/400	3x230/400
Frequency	Hz	50/60	50/60	50/60	50/60	50/60
Motor power	KW	0,04	0,09	0,18	0,37	0,75
Rated current	A	0,21	0,73/0,43	1,10/0,63	1,92/1,11	3,34/1,93
Weight	KG	3,4	4,4	5,4	8,1	12,6

INSTALLATION TYPE MOTOR POSITION



SPECIFICATION

HOW TO READ THE ORDER KEY



Example: Ostberg OM-N-W-1500-OCS-200-K-A-1

SYMBOLS

[1] Rotor material	OT	- Untreated aluminium foil
	OC	- Epoxy-coated foil
	OK	- Seawater corrosion resistant alumiuium alloy (5052) foil
	OH	- 3A molecular sieve and untreated aluminium foil
	OM	- 3A molecular sieve
[2] Well height	XL	- Extra Low
	SL	- Special Low
	L	- Low
	N	- Normal
	H	- High
[3] Rotor	W	- Winded rotor
	S	- Sectorized rotor
[4] Rotor diameter in mm		see "Dimensions"
[5] Casing	OCS	- In accordance with "Dimensions"
	CS / CSD	- In accordance with "Dimensions"
	D / DS	- In accordance with "Dimensions"
[6] Rotor depth in mm	250	250 mm
	200	200 mm (Standard)
	150	150 mm
	100	100 mm
[7] Drive equipment	V	- Variable drive, MicroMax
	K	- Constant drive
[8] Installation type	A,B,C,D,E,F...P ("Installation type and motor position")	
[9] Motor position	1,2,3,4 ("Installation type and motor position")	

Accessories

*Powder coated sheet metal, *Drain pan, *Insulation and *SST 304 complete casing