Regenerative heat recovery with rotary heat exchangers

KLINGENBURG

ENERGY RECOVERY

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Klingenburg
convincing technology and quality for 3 decades - worldwide

The company Klingenburg GmbH manufactures and sells regenerative and recuperative heat recovery systems.

This systems have been produced in Gladbeck/ Germany for 3 decades.

The products are as follows:

- Rotary heat exchangers (rotors)
- Desiccant / enthalpy regenerators (SECO)
- Cross-flow plate heat exchangers
- Counter-flow plate heat exchangers
- Humidifiers

This catalog describes the rotary heat exchangers that are in the normal climate range the product with the largest sales figures of the company Klingenburg GmbH.

The possibility to effect control, the self-cleaning effect, the limited spatial demand and the high degree of efficiency are the advantages no other system can offer.

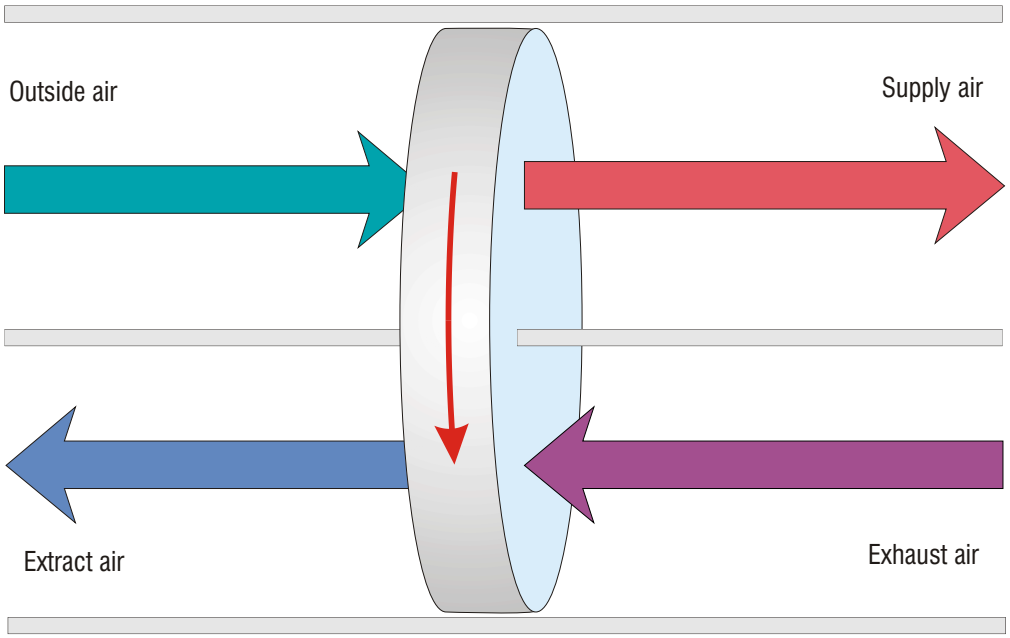
The principle of the rotor

Regenerative Heat Recovery Systems / Rotors

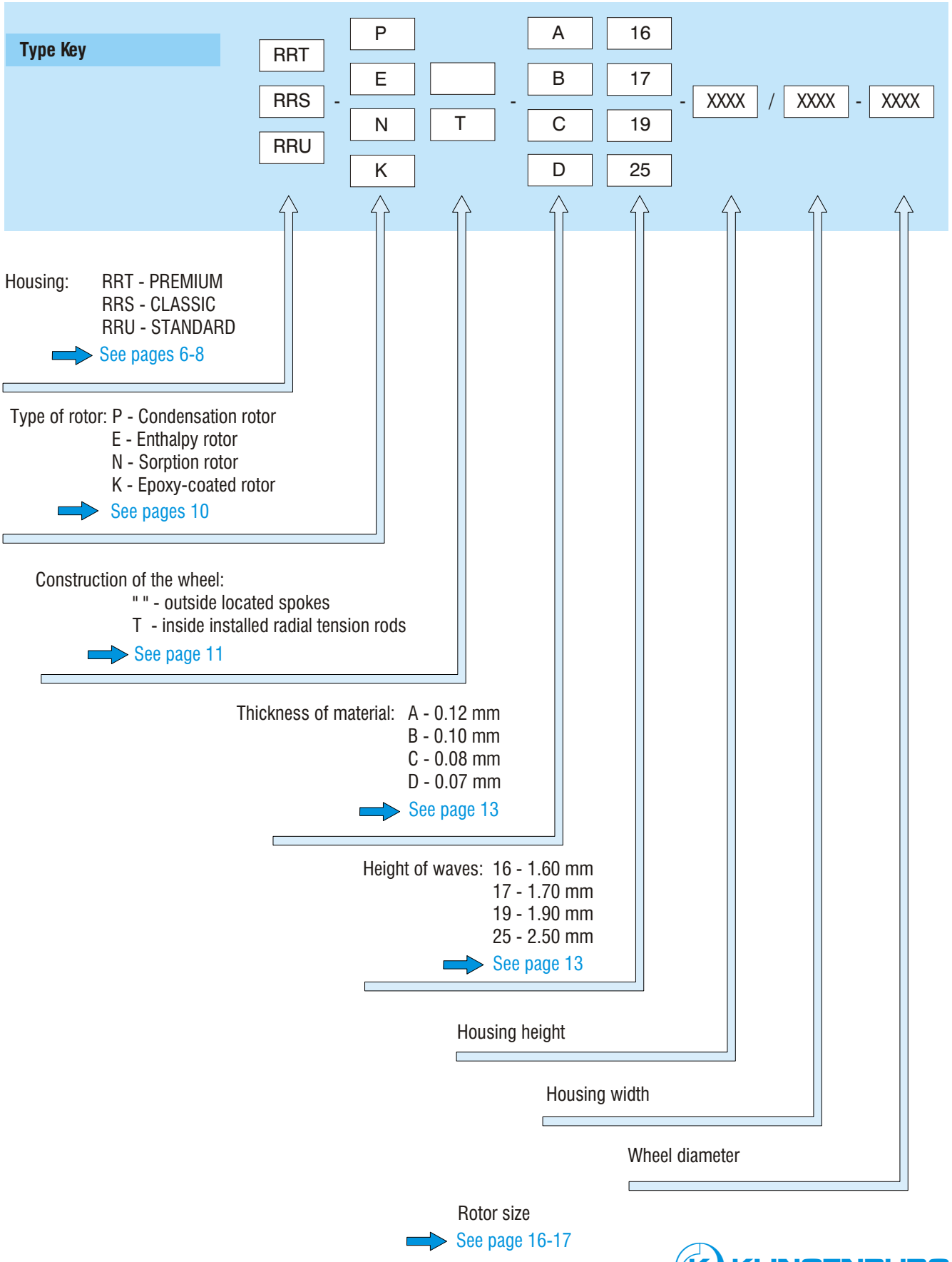
The rotor matrix consists of aluminium foil. A bond formed in waves is wrapped together with a straight bond on top of each other. In this way, depending on the height of the waves, flow-through channels are created of different size, the shape of which is a measure for the efficiency but also for the pressure drop and the application.

The rotor rotates ten times in a minute in the case of full efficiency. By reducing the number of rotations, a reduction of the transmission can be achieved.

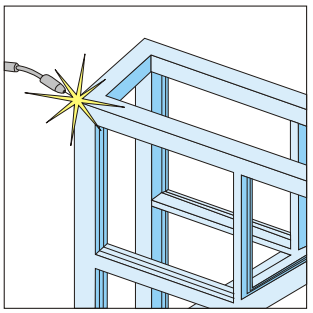
The air flows are in counter flower, as shown in the illustration below.



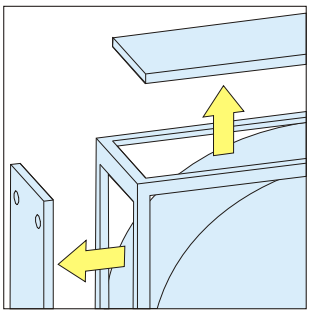
Type Keys


Type Key
RRT
RRS
RRU
-
P
E
N
K
T
A
B
C
D
16
17
19
25
XXXX
/
XXXX
-
XXXX
Housing: RRT - PREMIUM
RRS - CLASSIC
RRU - STANDARD
See pages 6-8
Type of rotor: P - Condensation rotor
E - Enthalpy rotor
N - Sorption rotor
K - Epoxy-coated rotor
See pages 10
Construction of the wheel:
" " - outside located spokes
T - inside installed radial tension rods
See page 11
Thickness of material: A - 0.12 mm
B - 0.10 mm
C - 0.08 mm
D - 0.07 mm
See page 13
Height of waves: 16 - 1.60 mm
17 - 1.70 mm
19 - 1.90 mm
25 - 2.50 mm
See page 13
Housing height
Housing width
Wheel diameter
Rotor size
See page 16-17

Housing RRT - Model PREMIUM

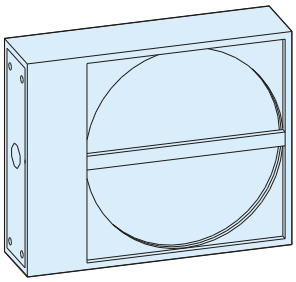


- Strong welded aluminium housing design, made of rectangular profiles
- Corrosion resistance and lightweight construction

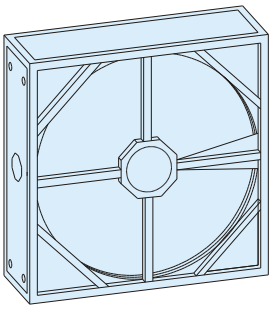


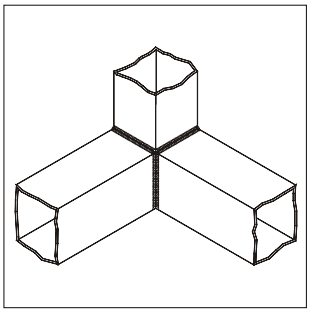
- The lateral covering sheets can be removed.
- The motor side is quickly accessible by quick snap locks.
- An alteration of the motor position into another rotor corner is possible without

RRT 600-800



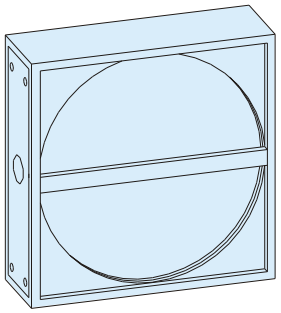
RRT 2000



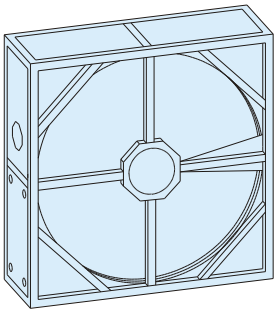


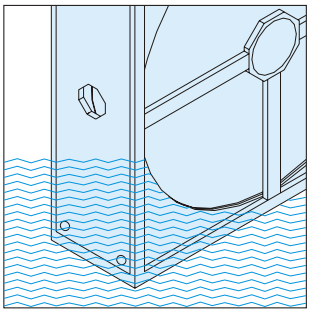
- As circumferential seals, adjustable seals are used, which are held in position by means of retaining rings and clamps. In this way, a maximum seal is achieved.
- When used in industrial installations, special seals are used.

RRT 1000



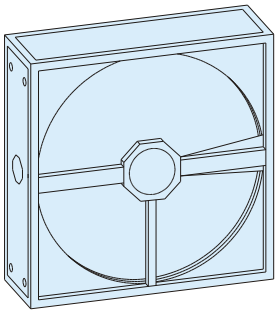
RRT 2250-2500 undivided



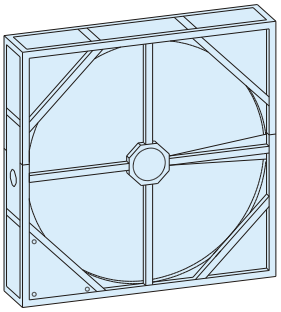


- The casing and the housing are made of seawater-resistant aluminium.

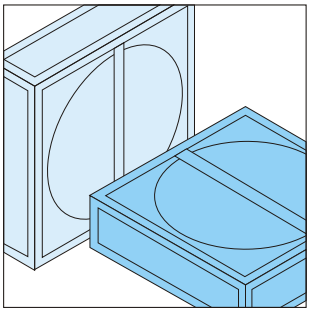
RRT 1250-1750



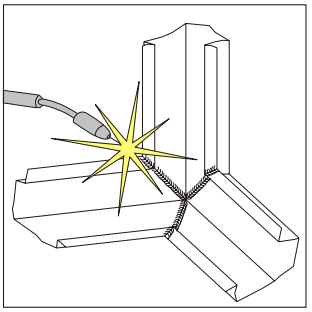
RRT 2500-5000 divided

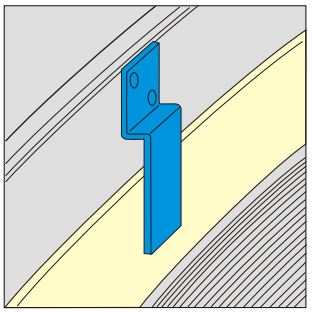


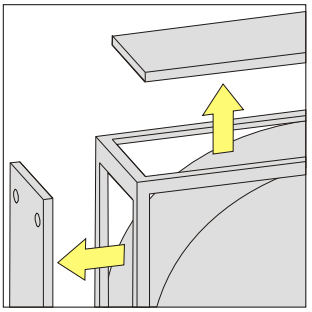
- Vertical and horizontal installation position possible for every size
- Applicable as flange or as fitting rotor
- Variable housing dimension for all construction sizes, maximal height or width up to 8000 mm



Housing RRS - Model CLASSIC



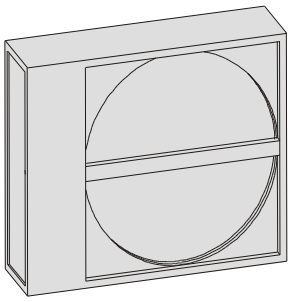




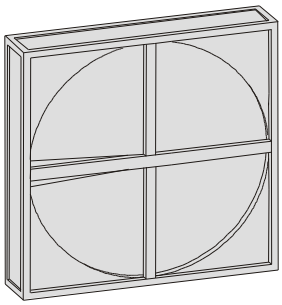
- Strong welded frame construction, made of galvanised steel
- The lateral covering sheets can be removed. The motor side is quickly accessible by quick snap locks.
- An alteration of the motor position into another rotor corner is possible without

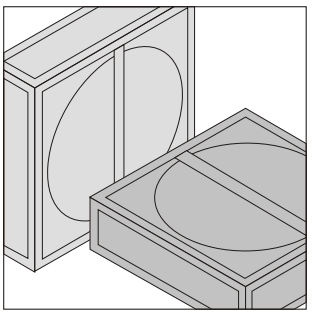
- As circumferential seals, adjustable seals are used, which are held in position by means of retaining rings and clamps. In this way, a maximum seal is achieved.
- When used in industrial installations, special seals are used.

RRS 600-800



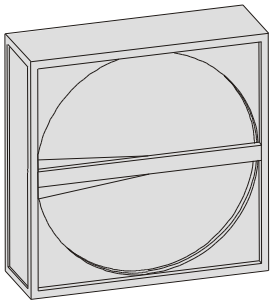
RRS 2000



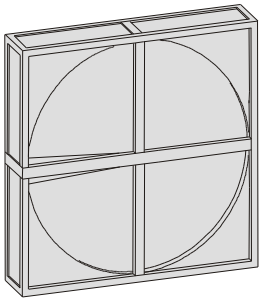


- Vertical and horizontal installation position possible for every size
- Applicable as flange or as fitting rotor
- Variable housing dimension for all construction sizes, maximal height or width up to 4250 mm

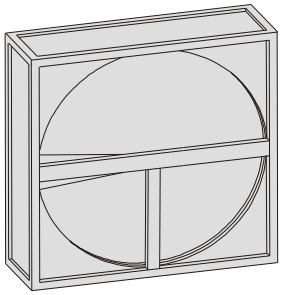
RRS 1000-1250



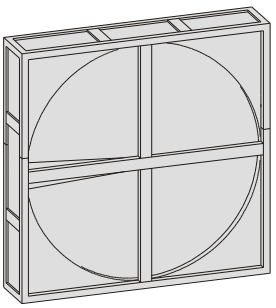
RRS 2250-2500 undivided



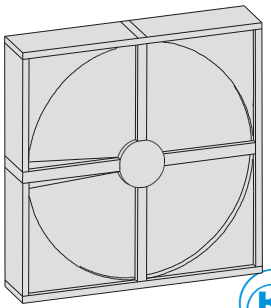
RRS 1500-1750



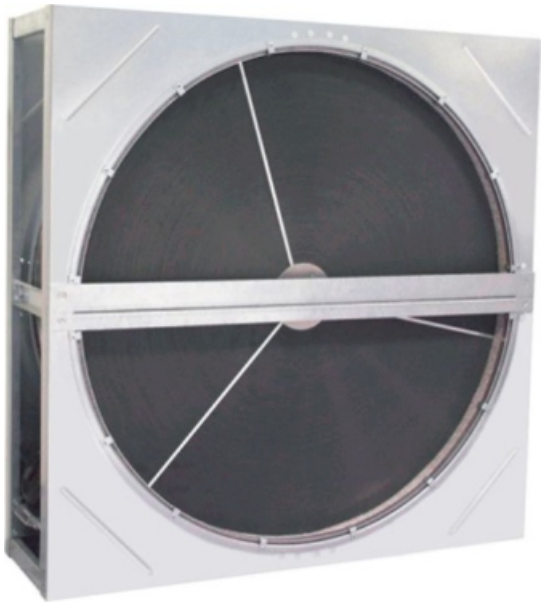
RRS 2250-3000 divided

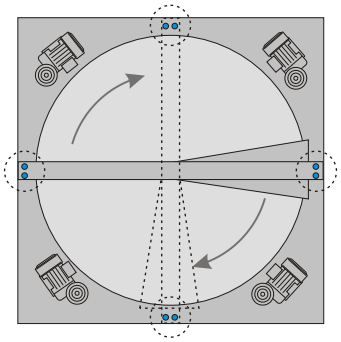


RRS 3001-4500 divided



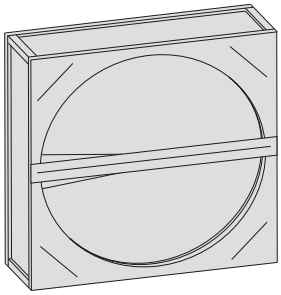
Housing RRU - Model STANDARD



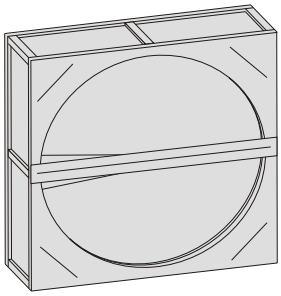


- Strong screwed housing design, made of galvanised steel
- Airflow can be altered from horizontal (over & under) to vertical (side by side).
- Cleaning sector position is moveable and different angles from 0° to 10° are applicable.
- Motor position is changeable to any corner.
- **thereby optimal use for direct and subsequent storage.**

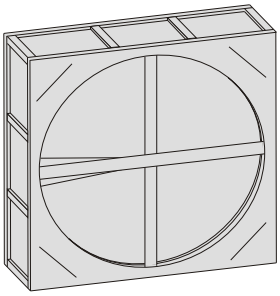
RRU 600

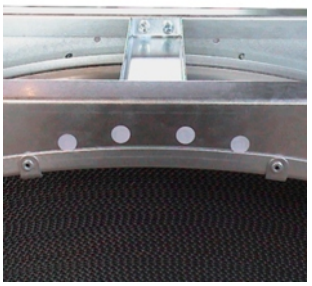


RRU 800-1375



RRU 1400-2500

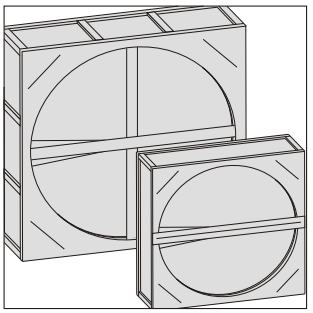




- Prefabricated holes and blind plugs make conversion a snap!

- Adjustable and wear resistant seals completely adjacent round the wheel.

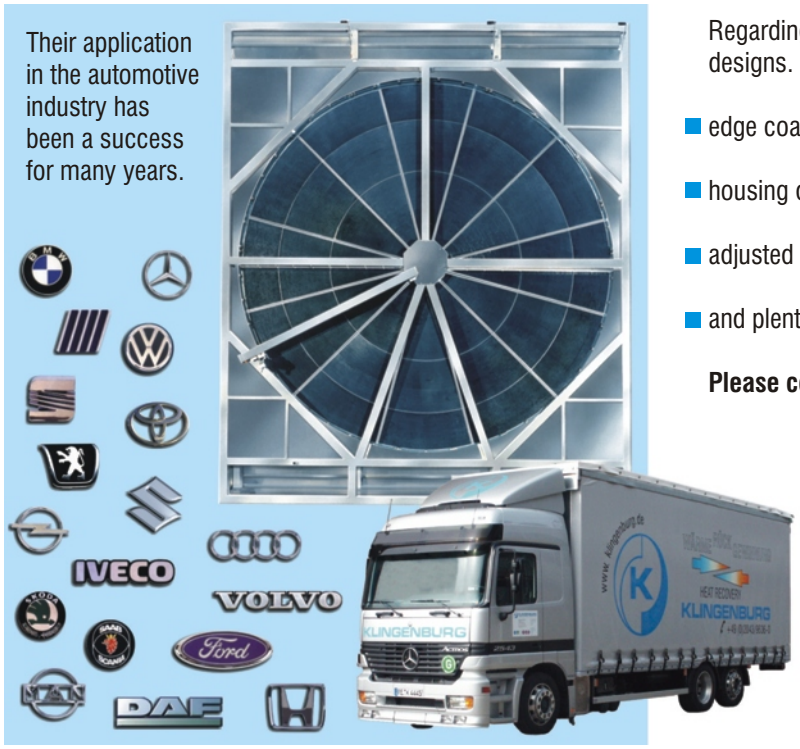
- Vertical installation for every size
- Preferred use as fitting rotor in air conditioner
- Square housing in many sizes up to max. 2500 mm in height and width.
- Variable housing dimension available on request



Special Rotary Heat Exchangers

Rotors for paint spraying plants

Their application in the automotive industry has been a success for many years.



These rotors are in most cases coiled of thick aluminum sheet - e.g. 0.12 mm - and have, depending on the degree of soil ingress, higher waves. For these rotors, various cleaning devices have been developed which are applied depending on the degree of soiling.

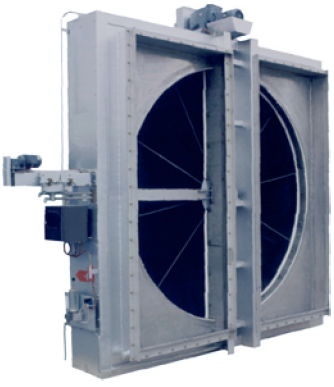
Further special designs

Regarding special application we can offer a variety of designs. For example:

- edge coated enthalpy rotors
- housing design in stainless steel
- adjusted housing measurements
- and plenty more…

Please contact us!

High temperature rotors



For the operation with high temperature in industrial and process applications Klingenburg offers heat recovery wheels for the preheating of boiler-air, catalytic oxidation, drier installation, or similar processes.

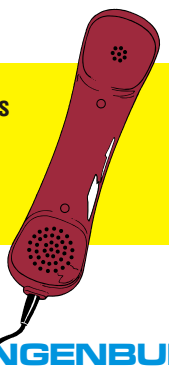
Depending on the process we offer rotors for operation temperatures of up to 650°C (570°F).

The rotor wheel is manufactured from chromium steel foil 0.10 mm thick with waves of different heights. Two different qualities of chromium steel foil can be used: material 1.4571 for normal specifications or material 1.4539 for more demanding specifications. The casing is of robust, welded sheet steel. It has a double-shell construction and thermal insulation. The inner shell can be made of stainless steel.

Medium temperature rotors

In the case of a design of the rotors with chain drives, special sealing and temperature-resistant bearings, a continuous operation temperature of 180°C (356°F) can be achieved.

In case you plan special rotor designs a consultation with our head office is necessary in any case. Just contact us!



The types of rotors

The heat storing matrix is made out of special seawater resistant Aluminium alloy, composed of waved and flat continuous wound layers to guarantee laminar air flow. Flat and wavy layer flush at front.

Condensation rotors type P/PT

Rotors of this type are preferrably used for sensible energy recovery. Humidity transfer by condensation is ensured as soon as the exhaust air in the heat wheel is cooled down below to the dew point.

Enthalpy rotors type E/ET

Rotors of this type have a hygroscopic surface which support to transmit moisture. This implicates a higher total energy transmission. The performance regarding moisture transmission do not comply with the features of moisture transmission of special sorption rotors (type N/NT or Seco).

Sorption rotors type HUgo N/NT

Rotors of this type are made of aluminium with a high hygroscopic coating which allows high sensible and latent efficiencies - all the year.

Epoxy coated rotors type K/KT

Rotors are also available with epoxy coated aluminium matrix in order to increase the corrosion resistance. The performance can be compared to the performance of condensation rotors. Also here humidity transfer is only ensured as soon as the exhaust air in the wheel is cooled down below the dew point temperature . These rotors are very applicative for adiabatic cooling.

SECO

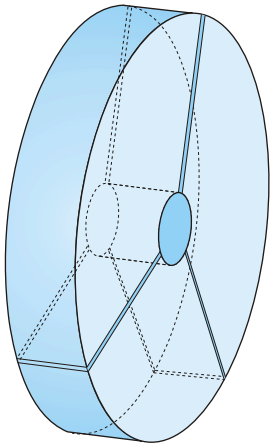
The matrix of the SECO is constructed of cellulose. It has a very high capacity for moisture absorption. SECO can be used both as total energy recovery rotor and as drying rotor for air dehumidification (see also the SECO catalogue).

The moisture transmission of rotary heat exchangers is a process depending on the temperature and humidity differences between outside air and extract air. The moisture transmisssion is affected markedly by operating conditions and environment influences (e.g. pollution). This should be taken into consideration in planning the following components.

Construction of the wheel

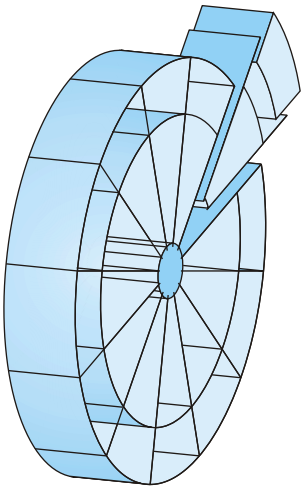
Rotor types P, E, K, N

undivided



- Mechanical fixed with opposite arranged welded internal and external double spoke system
- All models up to 2720 mm in diameter
- No non-ventilated zones
- No stall within the matrix
- Service life of up to 20 years

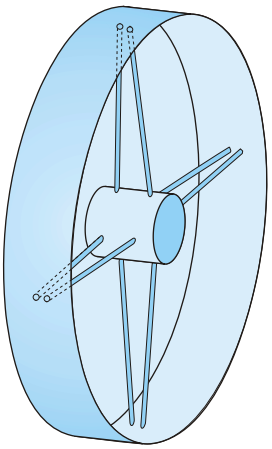
divided



- Divided rotors have firmly framed segments for simple assembly
- Rotors with a diameter of more than 2380 mm are divided up as standard. Smaller-sized models can also be divided up.
- No non-ventilated zones
- No stall within the matrix
- Service life of up to 20 years

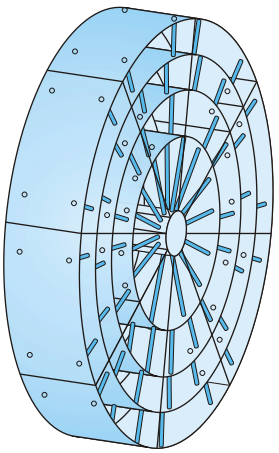
Rotor types PT, ET, KT, NT

undivided



- Construction principle dating back to 1960. The stability of the rotor wheel is achieved by tie rods inside. This creates non-ventilated zones within the rotor wheel.
- All models up to 2720 mm in diameter

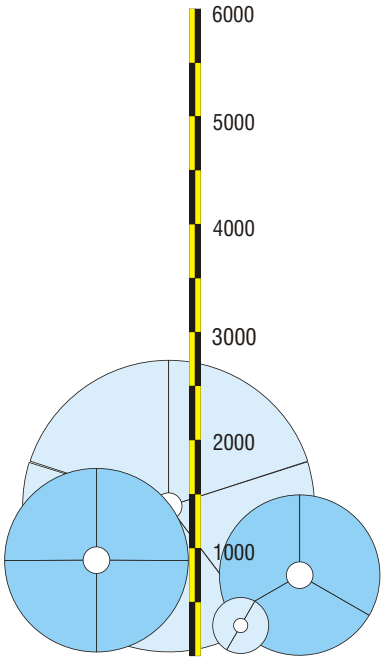
divided



- Rotors with a diameter of more than 2380 mm are divided up as standard. Smaller-sized models can also be divided up.

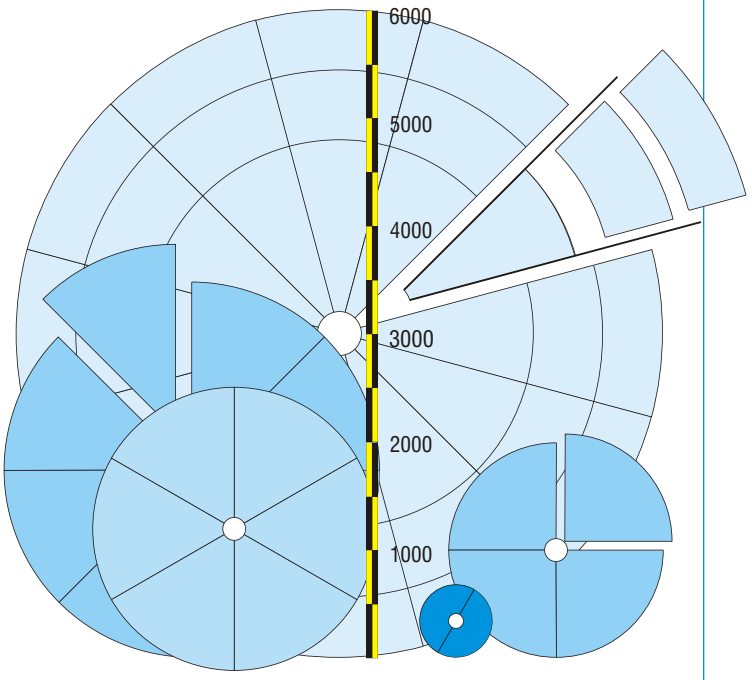
Divided matrix

Undivided matrix

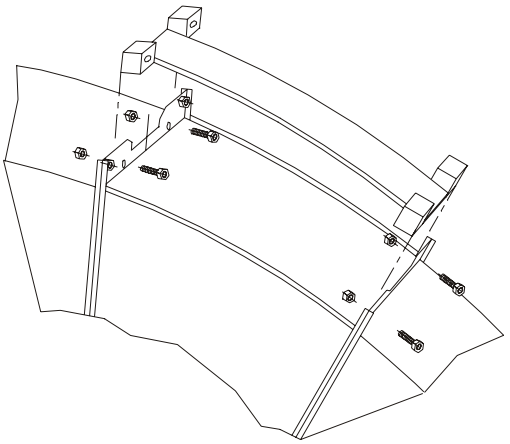


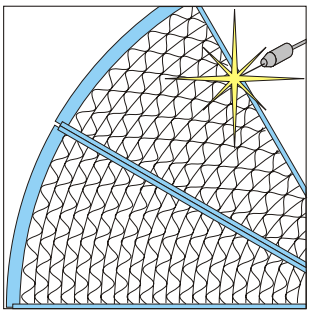
Up to a size of 2720 mm the rotors are undivided and, depending on their size, provided with different numbers of spokes.

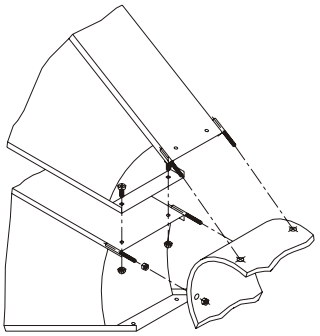
Divided matrix



For reasons of transportation, rotors are divided or segmented above a housing-size of 2500 mm. Smaller rotors can also be segmented on request.



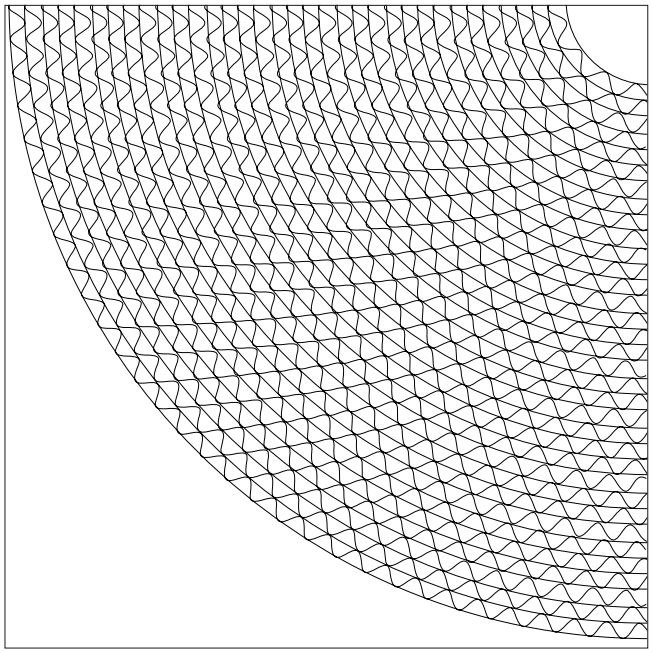




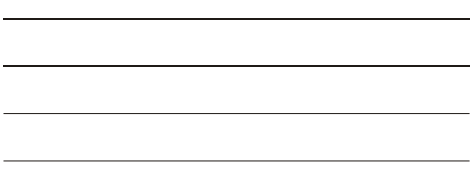
The rotors provided with spokes are welded on the inside at the hub and on the outside with a cross-strut. This design lends the matrix a firm seat and prevents dirt ingress or condensate being created in zones where no flow exists.

The matrix

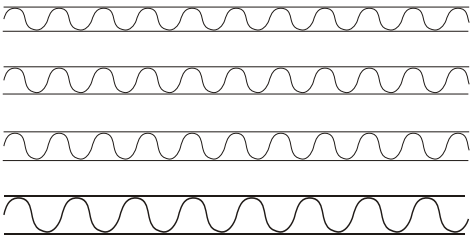
Wheel geometry



Thickness of material



Height of waves

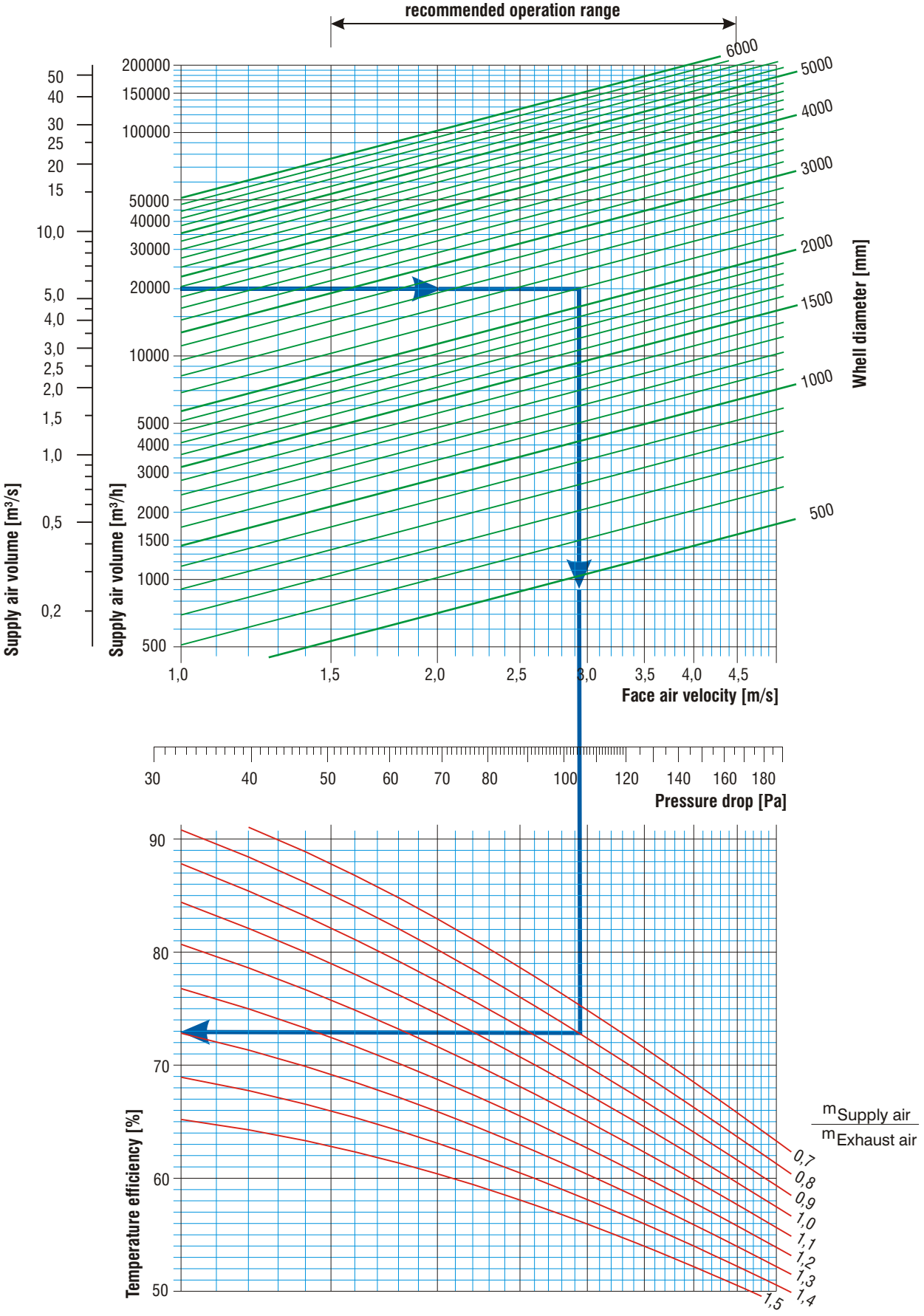


Range of application of several rotor profiles

- Material thickness:
  - A: Special rotary heat exchanger, for example in laquer plants
  - B: At frequent high pressure cleaning and special demand on durability
  - C: Standard: air handling systems with moderate polluted exhaust air, qualified for high pressure cleaning
  - D: Air handling systems with moderate polluted exhaust air
- Wave height:
  - 16, 17: High efficiency due to tight coiling, but also increased pressure drop
  - 19: Standard: air handling systems with moderate polluted exhaust air
  - 25: Special design for more polluted exhaust air

We offer further rotor profiles for special applications

Layout diagram



The design diagram refers to the most-used rotor profile C19.

Design programmes for our products are available, either as an independent computer programme or also to be integrated into your existing application. The performance data are based on measurements according to DIN EN 308 but carried out under practice conditions.

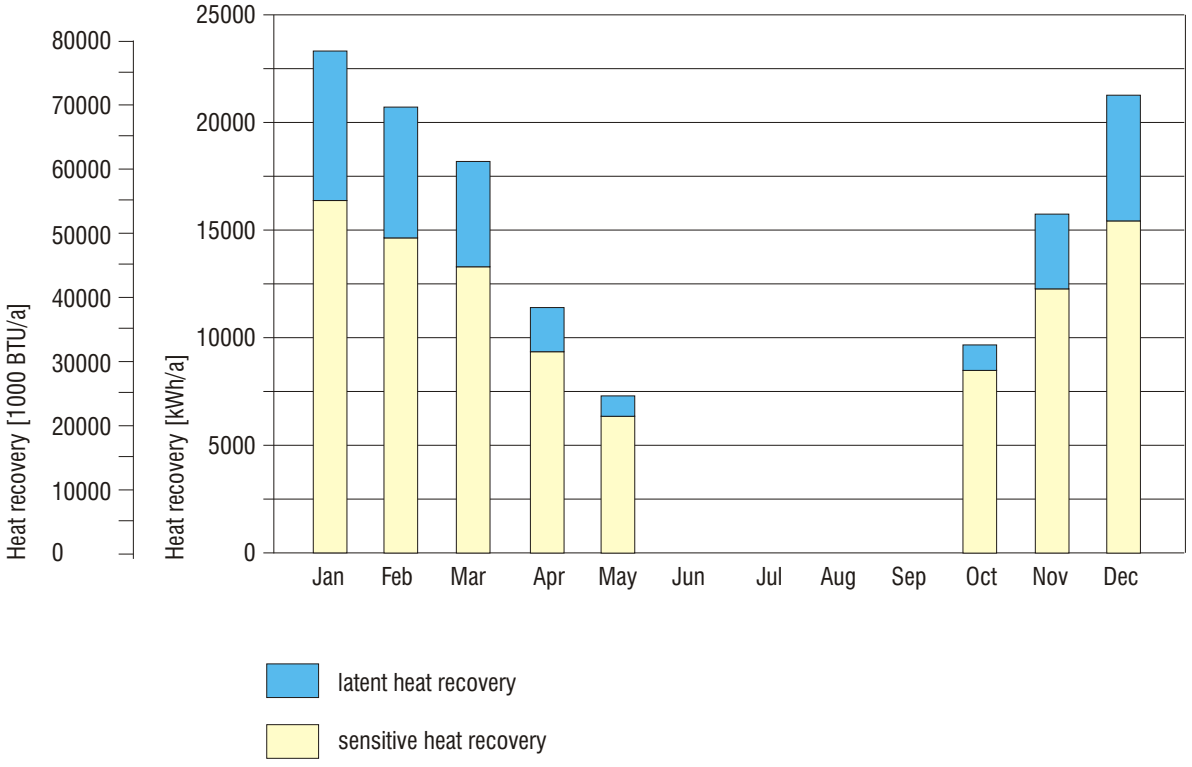
Calculation of economy

An important part of the total heat loss of a building is caused by ventilation. A constant air change is required to remove moisture and odours and to introduce fresh air, that means to maintain an agreeable climate in the rooms.

Heat losses through ventilation can be reduced when the heat is taken from the used up exhaust air and added to the unused supply air. The saving potential resulting from this arrangement can be determined by a calculation of economy according to VDI 2067.

Example of a calculation of economy

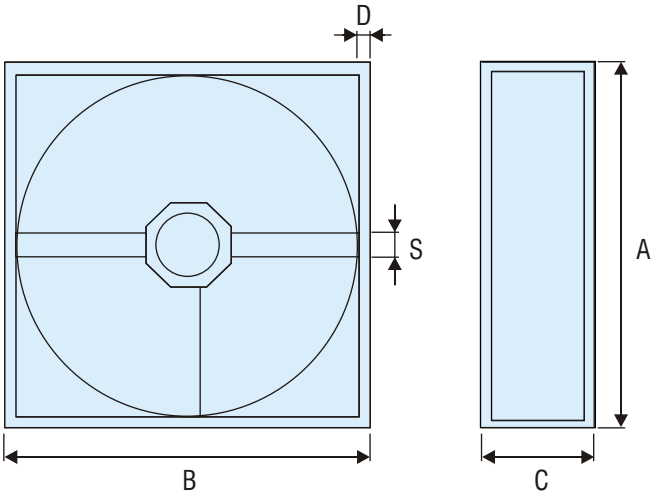
Rotortype	RRT-E-C19-Ø 2000	
Supply volume	10 000 m³/h	5880 cfm
Exhaust volume	10 000 m³/h	5880 cfm
Exhaust air temperature	22 °C	71.6 °F
Exhaust air moisture	50 %	40 %
Climate zone	2	2
Working time	07:00 a.m. - 06:00 p.m. at 6 days per week. Month with heating from October until may	



We would be pleased to carry out calculations of economy for heat recovery systems.

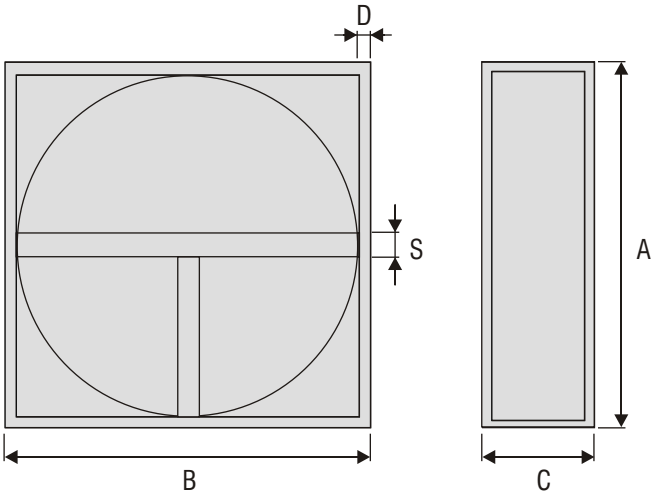
The rotor sizes RRT and RRS

Housing RRT - model PREMIUM



Rotor size	Dia-meter [mm]	Height A [mm]	Width B [mm]	Depth C [mm]	Profile D [mm]	Rib-profile S [mm]	Weight [kg]
600	505	600	700	400	sheet metal	80	35
800	705	800	900	400	sheet metal	80	50
1000	905	1000	1000	400	40	80	70
1250	1170	1250	1250	400	40	80	120
1500	1420	1500	1500	400	40	80	160
1750	1670	1750	1750	400	40	80	200
2000	1920	2000	2000	400	40	80	260
2250	2130	2250	2250	440	60	60	340
2500	2380	2500	2500	440	60	60	470
2750	2630	2750	2750	440	60	60	550
3000	2800	3000	3000	510	80	80	680
3250	3050	3250	3250	510	80	80	800
3500	3300	3500	3500	510	80	80	900
3750	3550	3750	3750	510	80	80	1000
4000	3760	4000	4000	550	100	100	1330
4250	4010	4250	4250	550	100	100	1460
4500	4260	4500	4500	550	100	100	1590
4750	4510	4750	4750	550	100	100	1730
5000	4760	5000	5000	550	100	100	1870
5250	5010	5250	5250	550	100	100	2010
5500	5100	5500	5500	550	100	100	2090
5750	5350	5750	5750	550	100	100	2230
6000	5600	6000	6000	550	100	100	2400
6250	5850	6250	6250	550	100	100	2570
6400	6000	6400	6000	550	100	100	2670

Housing RRS - model CLASSIC

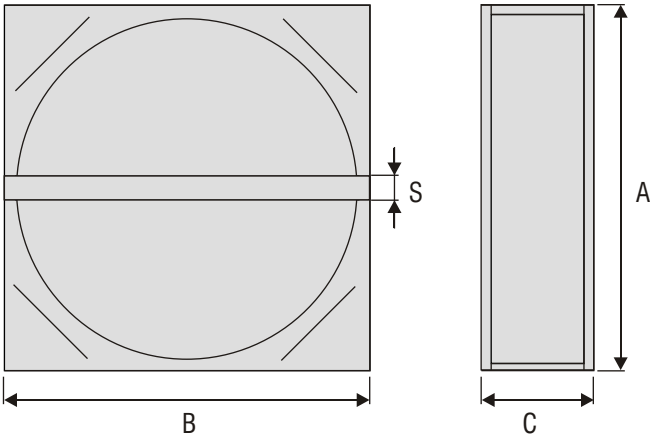


Rotor size	Dia-meter [mm]	Height A [mm]	Width B [mm]	Depth C [mm]	Profile D [mm]	Rib-profile S [mm]	Weight [kg]
600	505	600	700	400	sheet metal	60	70
800	705	800	900	400	sheet metal	60	90
1000	905	1000	1000	400	40	60	115
1250	1155	1250	1250	400	40	60	155
1500	1380	1500	1500	400	40	75	225
1750	1630	1750	1750	400	40	75	285
2000	1880	2000	2000	400	40	75	415
2250	2090	2250	2250	440	60	110	535
2500	2340	2500	2500	440	60	110	620
2750	2590	2750	2750	440	60	110	780
3000	2840	3000	3000	440	60	110	1000
3250	3010	3250	3250	550	100	120	1170
3500	3260	3500	3500	550	100	120	1320
3750	3510	3750	3750	550	100	120	1460
4000	3760	4000	4000	550	100	120	1940
4250	4010	4250	4250	550	100	120	2130

The sizes listed are standard sizes. They can readily be adjusted to the requirements of the customers.
Tailor-made rotors can be supplied on request.
The rotors can be supplied in a large variety of housing sizes which will be manufactured according to the requests of the customers. Please inquire!

The rotor sizes RRU

Housing RRU - model STANDARD

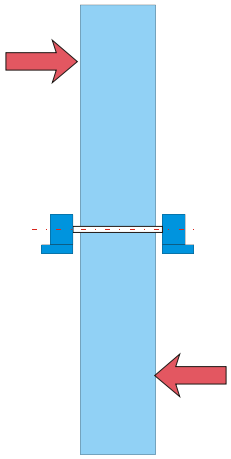


Rotor size	Dia-meter [mm]	Height [Mm]	Width [mm]	Depth [mm]	Rib [mm]	Weight [kg]
600	515	600	750	290	80	27
700	615	800	800	290	80	34
800	715	800	900	290	80	43
1000	915	1000	1000	290	80	61
1125	1040	1125	1125	290	80	76
1250	1165	1250	1250	290	80	93
1375	1290	1375	1375	290	80	111
1500	1415	1500	1500	330	80	135
1625	1540	1625	1625	330	80	156
1750	1625	1750	1750	330	80	175
1875	1750	1875	1875	330	80	199
2000	1875	2000	2000	330	75	225
2125	2000	2125	2125	330	75	269
2250	2125	2250	2250	330	75	299
2375	2250	2375	2375	330	75	331
2500	2375	2500	2500	330	75	364

The sizes listed are standard sizes. They can readily be adjusted to the requirements of the customers.
Tailor-made rotors can be supplied on request.
The rotors can be supplied in a large variety of housing sizes which will be manufactured according to the requests of the customers. Please inquire!

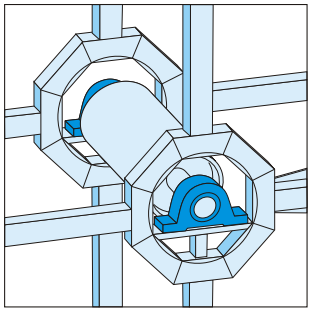
The bearings

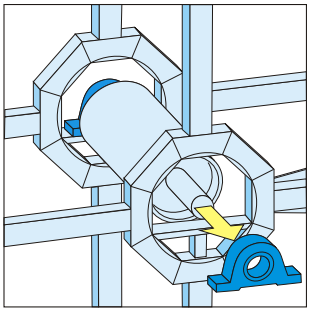
outside located bearings

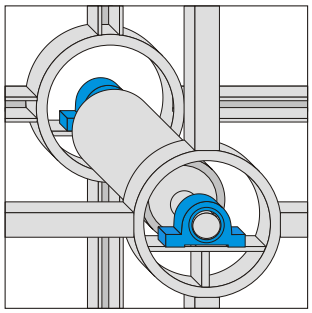


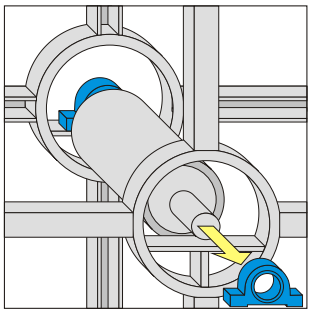
Rotors above a size of 1250 mm (RRT and RRS) or 2000 mm (RRU) are designed with external bearings.

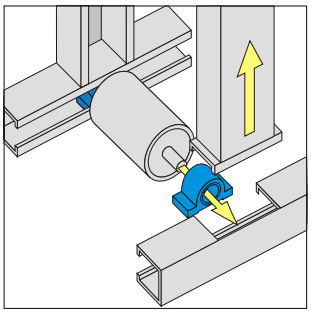
The bearings are located at the outside in the rotor, protected by a housing. On account of the outside arrangement, loads can be absorbed considerably better than in the case of bearings located at the inside. The external bearings offer, in addition, the advantage to be disassembled more easily.



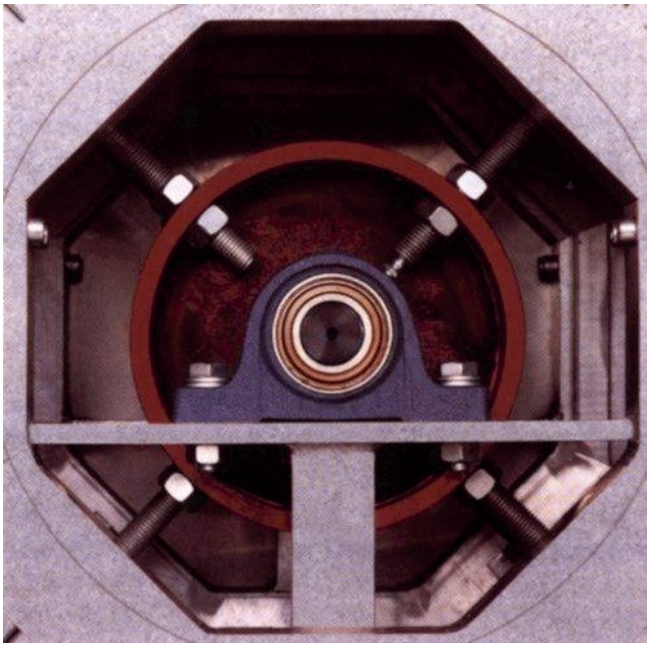




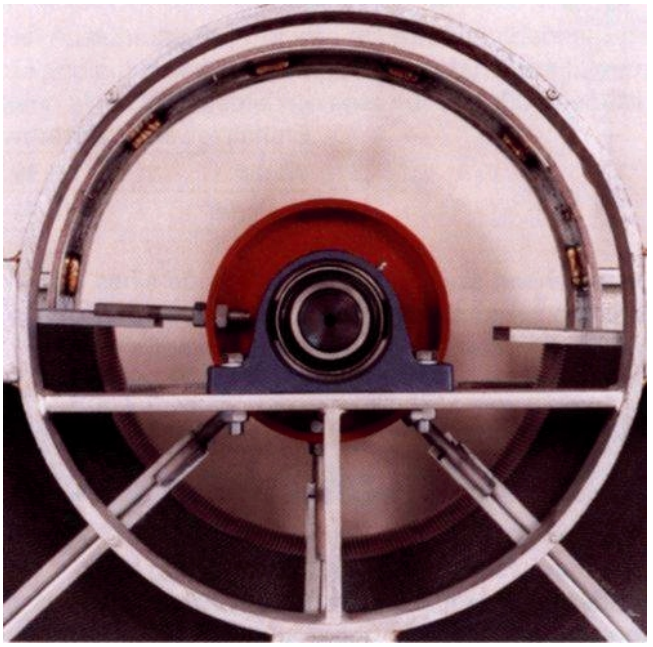




Bearings of rotor type RRS
up to rotor size 3000



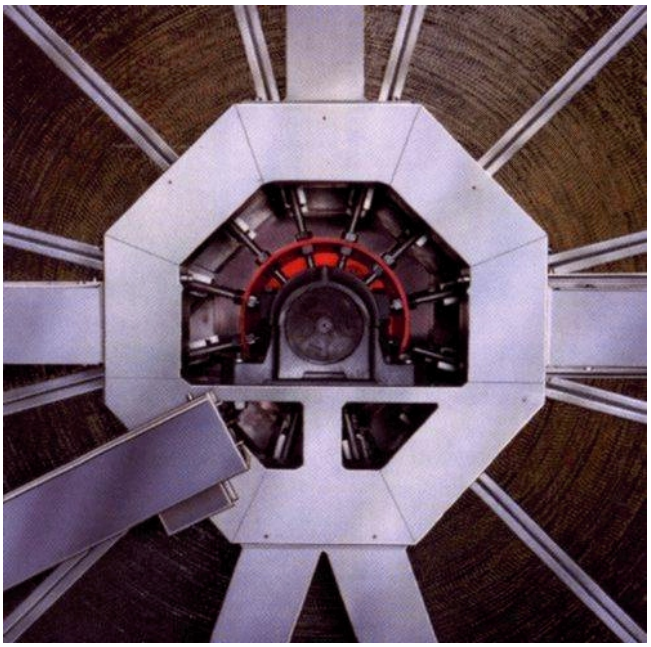
Bearings of rotor type RRT

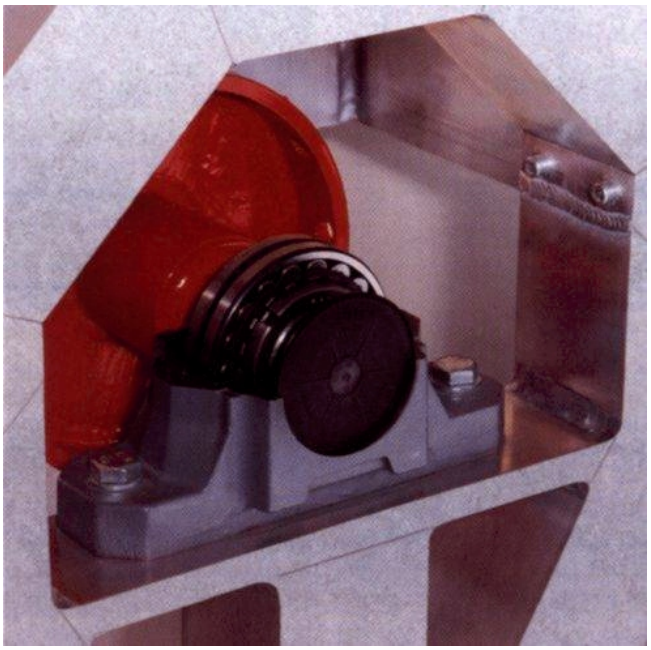


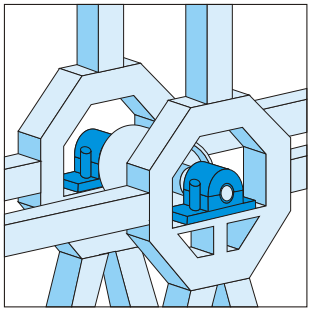
Bearings of rotor type RRS from rotor size 3001

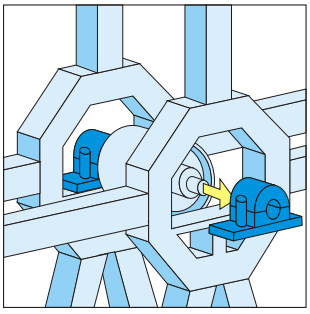
The bearings of lacquer rotors model RRT
The bearing of horizontal steel rotors model RRS

The bearings lacquer rotors Model RRT



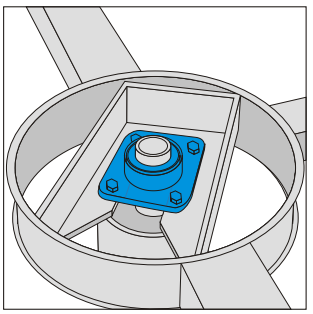


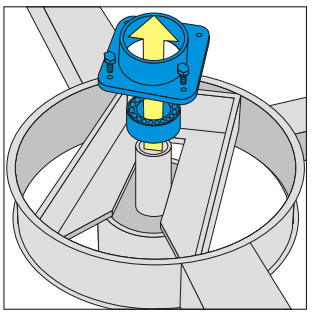




The bearings of horizontal steel rotors model RRS

above 3000mm diameter





Explosion drawing of divided rotors

A Frame

Above rotor size 2500,the housing is, as standard, divided into two halves. Other divisions, also in the case of smaller housing sizes, can be provided at any time. The fastening of the channels is usually effected by means of self-cutting screws. When installing it into a central device, casings can be adjusted to meet the required dimensions

B Lining

All rotors are lined with removable sheets. This is of special advantage for installation and during maintenance work. The floor sheets can be shaped in the form of a trough.

C Motor doors

The motor is accessible through the door at the front side. Above rotor size 2500 (as an option also in the case of smaller sizes), maintenance work for the motor can be carried out through a triangular front door.

D Mounting corner

Usually, the rotor segments are completely pre-assembled in the lower half of the frame, before the upper frame is installed. The upper segments are individually mounted at the site.

E Bearings

Easy access and improved disassembly through exterior bearings.

F Supporting strut for bearings

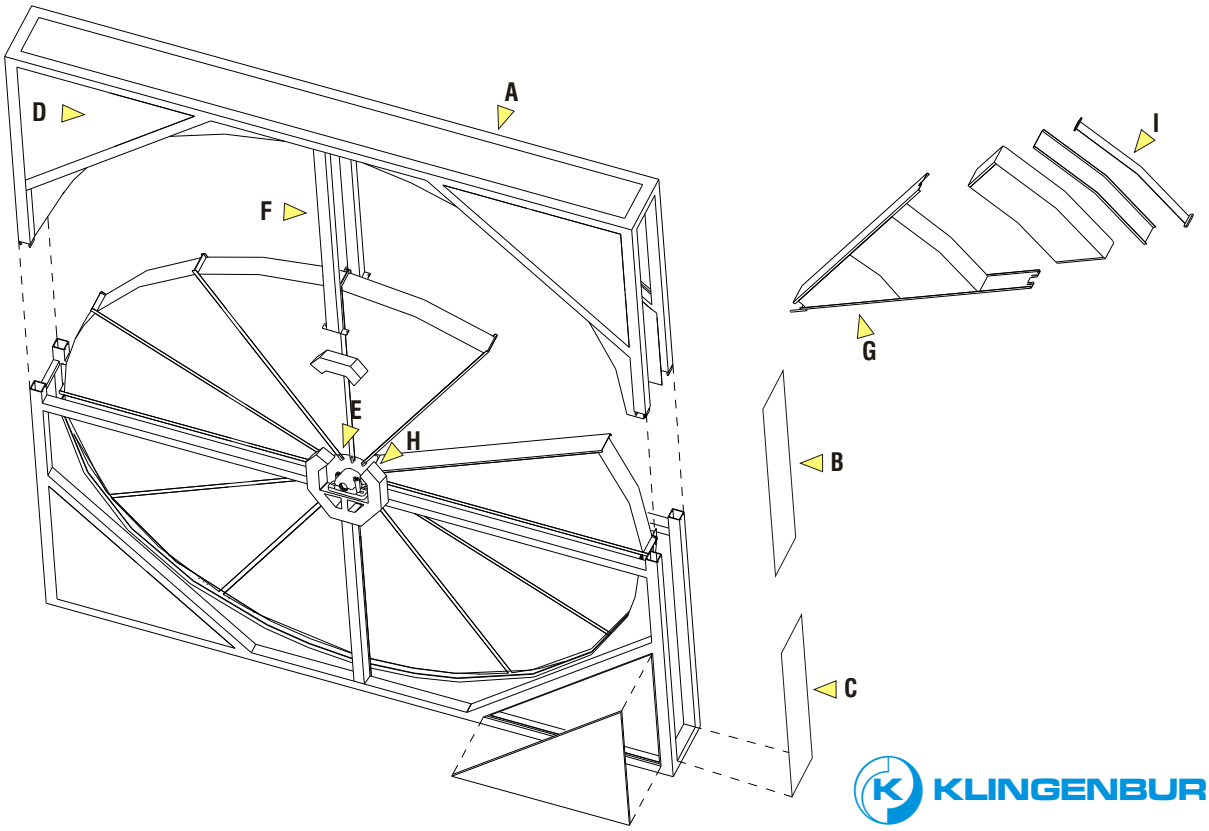
G Rotor Sector

The segments are mounted in special metal sheets. These metal sheets are bolted in the rotor center and at the outside. Mounting work is, as a consequence, exceedingly simple.

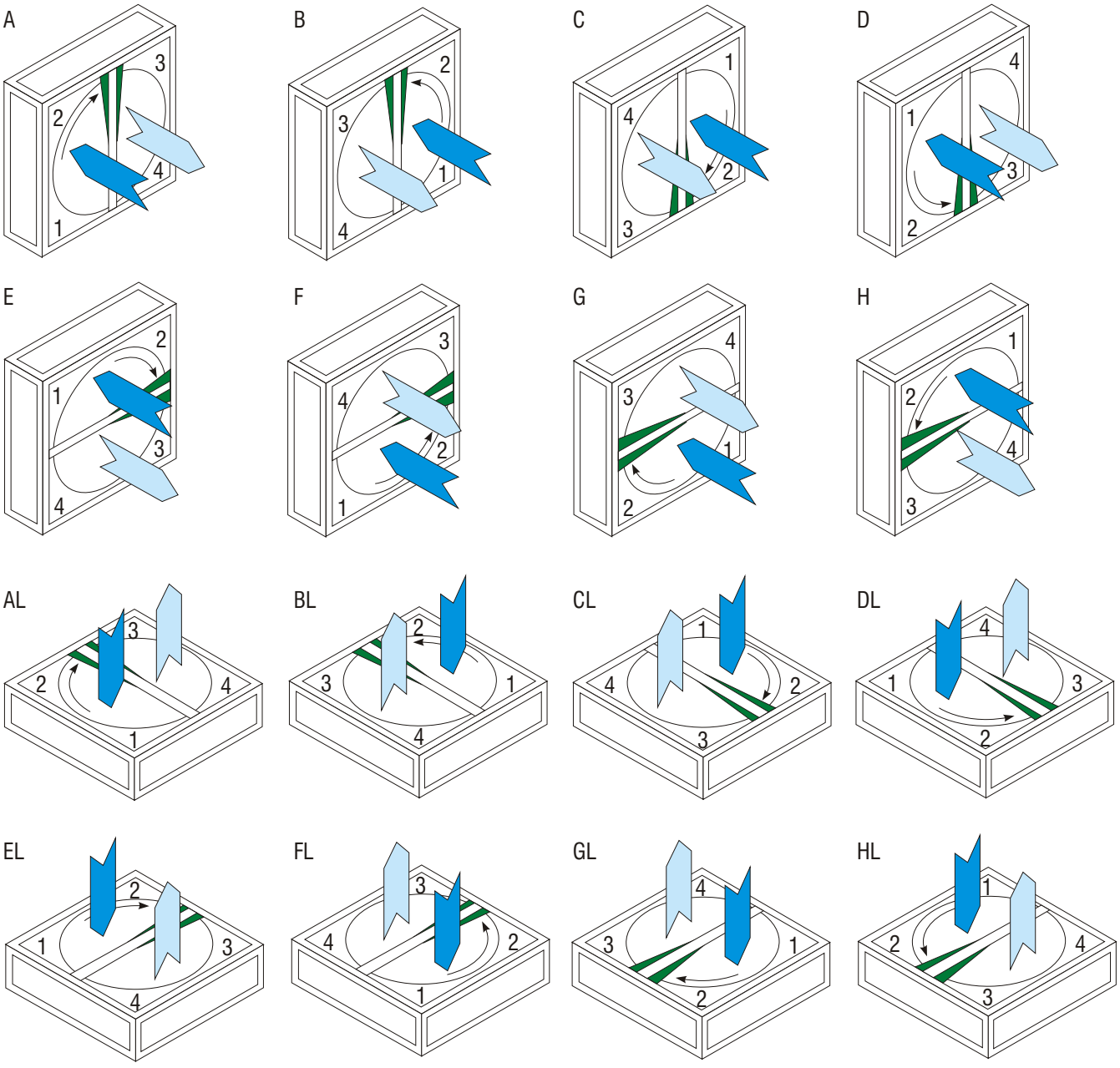
H Rotor core

I Tensioning belt

The circumferential tension belts offer additional strength. The drive belt runs over the tensioning belt.

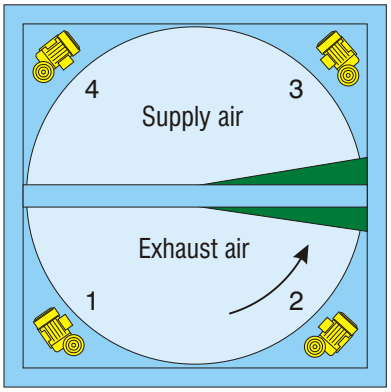


Rotor and motor position



Supply air

Exhaust air



Example for motor positions and cleaning sector arrangement F

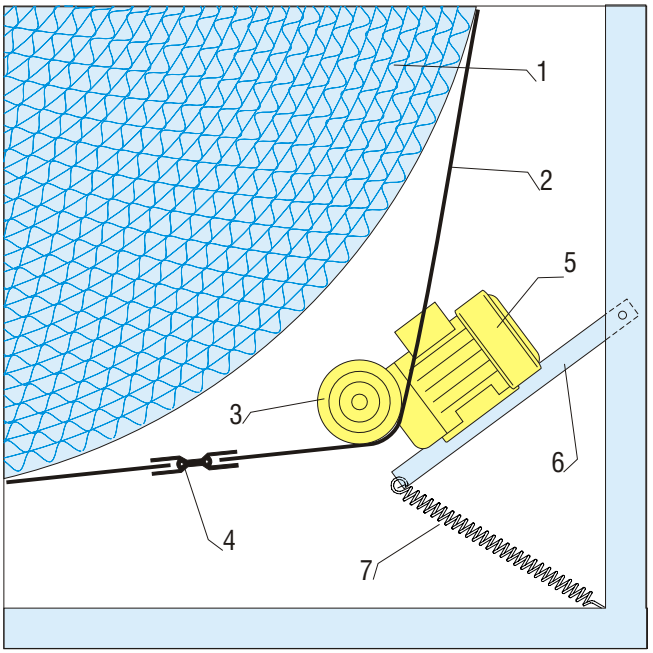
Drive motor and motor position

The housings illustrated on page 21 are seen from the warm side of the rotor. The cleaning sector is located also on the warm side of the rotor. The exhaust side rotates into the cleaning sector.

When placing the order, the code letters (e.g. A or CL) must be stated. The motor position is characterized by the figures in the rotor corners (between 1 and 4).

The motors are mounted on special motor frames which are held on a constant tension by a spring.
The mounting corner can be determined freely.

The drive is heavily affected, especially in the case of large rotors, by a current failure. The springs are tensioned in such a way that a slipping of the V belt is ensured in case of a full stop.



1 Rotor wheel
2 V belt
3 V belt pulley
4 Hinge connector
5 Motor
6 Motor frame
7 Spring

Sensor for rotor operation control

Motor data

Wheel diameter [mm]	Performance [W]	Current consumption [A]
upto 1419	90	0.36
1420 up to 2379	180	0.7
2380 up to 3759	370	1.2
from 3760	750	2

Rotor Controller

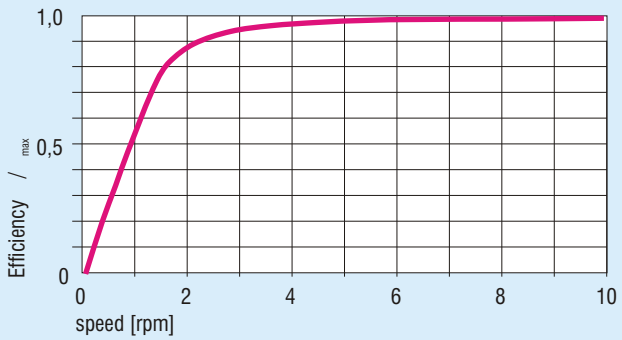
The Klingenburg control units and their central component, the frequency inverter, permit you to fully adjust the rotor speed for the entire permissible range.

Only two types are required for all rotor sizes:

KR4 = 400 Watt rotor diameters up to 3760 mm
KR7 = 750 Watt rotor diameters larger than 3760 mm

The rotor drive is effected through three-phase alternating current motors which can be operated for small diameters direct from the mains. Furthermore, an acceleration and deceleration ramp must be utilised for the gears. For the optimum control of the drive, a rotor controller is required.

The diagram shows the dependence of the efficiency on the rotor speed.



Motor data

Rotor size	Motor	Current Consumption	Control unit
600 - 1250	90 Watt	0.36 A	KR 4
1500 - 2250	180 Watt	0.7 A	KR 4
2500 - 3750	370 Watt	1.2 A	KR 4
4000 - 5000	750 Watt	2.0 A	KR 7

The controller is worldwide applicable and compatible with all current threephase motors.

Klingenburg controllers are unexcelled robust, extreme fail safe and durable.

Quality features

- Latest processor technology
- CE conformity
- Extruded aluminium casing IP 54
- Short-circuit-proof output
- EN 55011 tested
- EN 61000-3 tested
- EN 61000-4-2 tested
- EN 61000-4-4 (Burst) tested
- EN 61000-4-5 (Surge) tested
- EN 61800-3 tested
- Each single module is tested repeatedly
- exchangable info sheet

Performance features

- detailed fault display
- Thermal protection / PTC resistor including function display
- Starting and running out switching
- Menu controlled programming
- Clear text display via LCD display
- Three push-button operation
- External control signal processing
- Self-cleaning function
  Rotor operation control *)

Optional features

The following functions can be selected by means of the extended Z-controller:

- Summer operation including display of function *)
  - Enthalpy comparison
  - Temperature comparison
  - Temperature switching over
- Supply air temperature control *)
- Sequence switching register including function display

In this case the controller bears the model number KR4 Z or KR7 Z.

*) The corresponding sensors must be installed for the control features marked with an asterisk.

Cleaning devices

For the regenerative heat exchangers, there are several types of cleaning devices. They are selected according to the degree of soiling of the rotor.

The rotor has, under normal conditions, a high self-cleaning effect, on account of the continuously changing directions of air flow. The entrained rotation of the air is, in the case of the rotors, prevented by a cleaning sector. *This cleaning sector, however, does not contribute to the cleaning of the rotor.*

The cleaning units are subdivided as follows:

Compressed air cleaning
Water / compressed air cleaning
Steam cleaning
Warm water / compressed air cleaning
and some others.

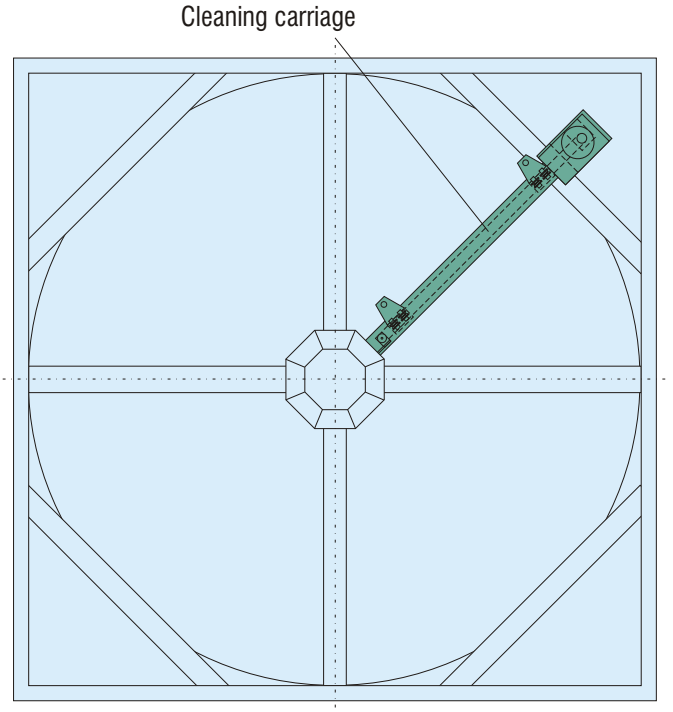
On page 25, the various arrangements of nozzles are illustrated.

In addition to the above-mentioned cleaning devices, other cleaning measures can be introduced, which have to be individually adjusted to the degree of soiling in question. In this case, there is particularly the soiling through long-fiber and adhesive impurities.

The cleaning can be carried out manually, for instance by means of pressure jet devices. It is more reasonable, however, to provide automatic cleaning devices which clean considerably more intensive and more thoroughly.

Cleaning carriage

For the automatic cleaning, a cleaning carriage is mounted on the exhaust air side of the rotor. The carriage drives the nozzles and collecting containers illustrated on page 25 in an adjustable cycle along the rotor matrix. For this purpose, the controller unit AS 1 is required.



Example: Compress air cleaning device for an aluminium rotor

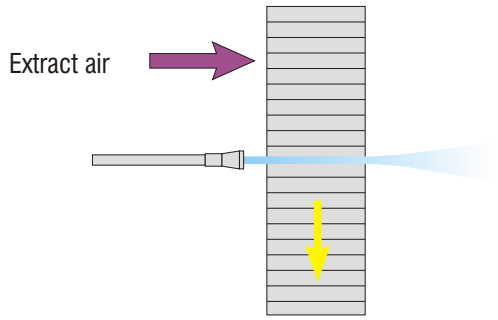
The cycle controller TR

In addition to the AS 1 unit, there is a cycle controller which can be programmed individually. The cleaning cycles, the cycles, advance and return movements can be adjusted depending on requirement. The device enables also a cleaning process with the rotor in operation. The cycle controller has been developed by the company Klingenburg particularly for lacquering production lines. This cycle controller can be adjusted precisely to the corresponding conditions.

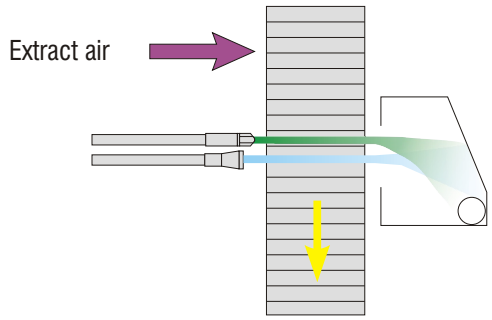
For further information,
please ask for our technical data sheets.

Types of cleaning devices

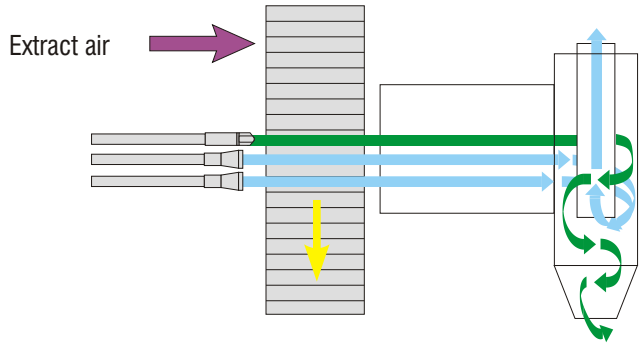
Air cleaning



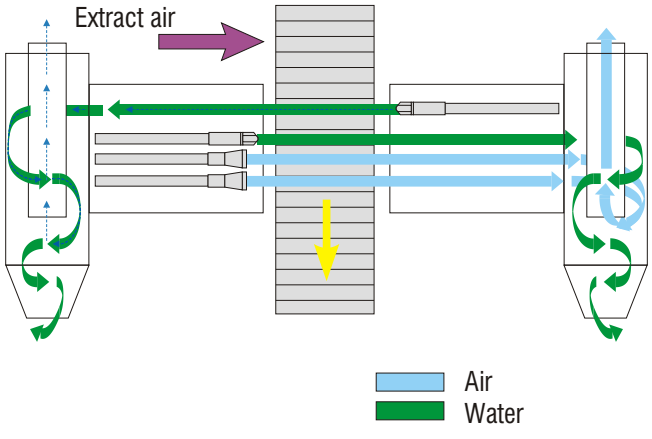
Air / water cleaning



Double air / water cleaning



Double-sided air / water cleaning



Compressed air cleaning

A compressed air nozzle is passed along the rotor matrix, at reduced speed. Dry, long-fiber or bulky particles can be blown off in this way. The material cleaned off in the course of this action must be removed from the rotor chamber because this type of dirt cannot pass through the rotor.

For this type of cleaning, the following devices are required:

- a rotor controller
- a cleaning controller AS 1
- a compressed air device
- a running rail with nozzle
- a vacuum cleaner, if required

Compressed air and pressure water cleaning

- one-sided
- double-sided
- warm one-sided
- warm double-sided

Adhesive impurities can be removed only by means of water, water and additives or with warm water. In the case of heavy impurities, a regular cleaning must be provided.

The water nozzle travels on a carriage at a pre-determined cycle across the rotor matrix and in such a way that the speed of rotation of the matrix at the nozzle is always constant. The rotation of the rotor is monitored also via the controller. Simultaneously, the remaining water is blown out by means of compressed air. During the return travel of the nozzle system into the starting position, the water is switched off, while the compressed air remains in operation. The residual water is, in this way, blown out.

For this type of cleaning, the following devices are required:

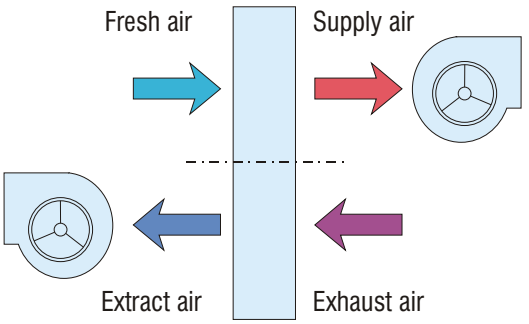
- a rotor controller
- a cleaning controller AS 1-L
- a water pressure device
- a compressed air connection

Fan arrangements

For reasons of the homogeneity of the incoming flow, ventilators which are designed so that they suck air in are preferable in the main.

Both fans with suction effect

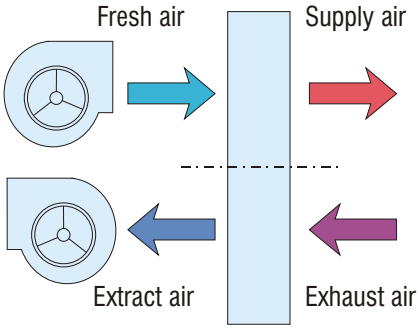
This arrangement should be given preference. The pressure potential of the supply air should be larger than that of the exhaust air. The standard cleaning sector 2 x 5 degrees will be used.



Fresh air fan pushing effect

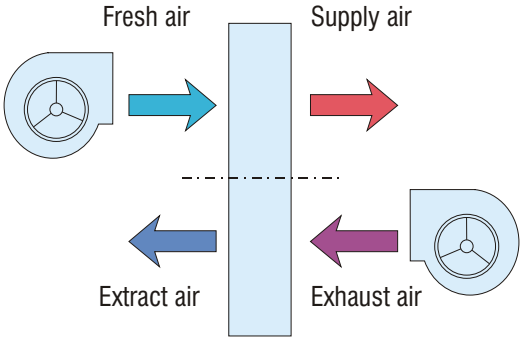
Extract air fan suction effect

Due to the great different pressure potentials, the air quantity flowing through the cleaning sector will increase. The cleaning sector should be reduced to 2 x 5 degrees.



Fresh air and Exhaust air fan pushing effect

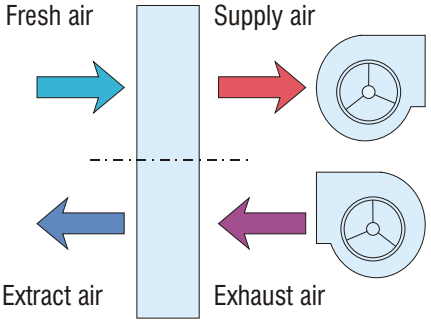
The pressure potential of the supply air should be larger than that of the Exhaust air. The standard cleaning sector 2 x 5 degrees will be used.



Supply air fan suction effect

Exhaust air fan pushing effect

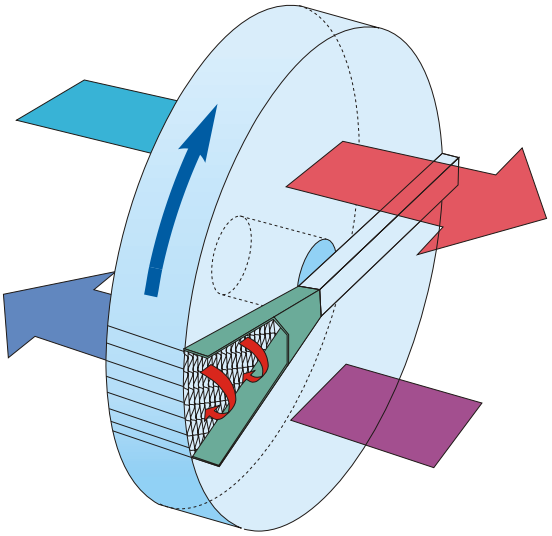
The installation of a cleaning sector must be omitted in this case. An overflow of exhaust air cannot be prevented.



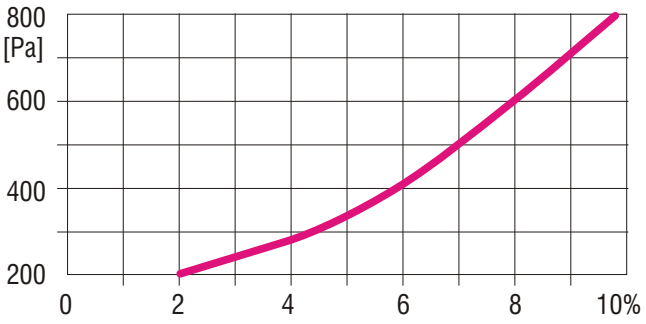
The cleaning sector

The cleaning sector

The cleaning sectors functions as follows: Part of the fresh air flow is deflected in order to achieve a cleaning effect. In the same way, the entrained rotation of exhaust air proportions is prevented. The efficiency of the cleaning sector is warranted only if the correct pressure potentials are provided (see in this connection on the right hand side).
Many customers order the rotors always without cleaning sector. The cleaning sector is used only if it is intended to prevent soiling or entrained rotation

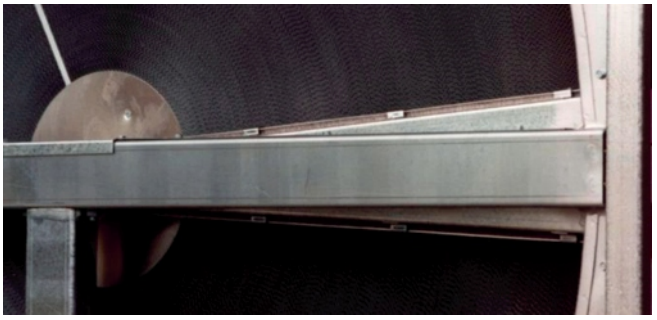


The following diagram lists the cleaning and slot air quantities. The data refer to a cleaning sector 2 x 5 degrees and a relative flow velocity of 3.5 m/s (690 fpm).



As the pressure difference, the static pressure difference between fresh and extract air is to be inserted.

With the power lay-out of ventilators which are to be placed on the side of the external or discharge air, the amount of scavenging air and leakage has to be taken into consideration. By using a special slide seal (optional), the amount of leakage can be reduced to a minimum.



Example: Cleaning sector of rotor type RRS up to size 3000

Difference pressure

0 - 200 Pa (0 - 0.80 in. W.G.)	Effect tof the cleaning sector not warranted. Use rotor without cleaning sector.
200 - 500 Pa (0.80 - 2.00 in. W.G.)	Standard cleaning sector 2 x 5 degrees required.
500 - 800 Pa (2.00 - 3.20 in. W.G.)	Cleaning sector 2 x 2,5 degrees required.
> 800 Pa (> 3.20 in. W.G.)	Cleaning sector installation should be refrained from.

Carry over of dust and smell

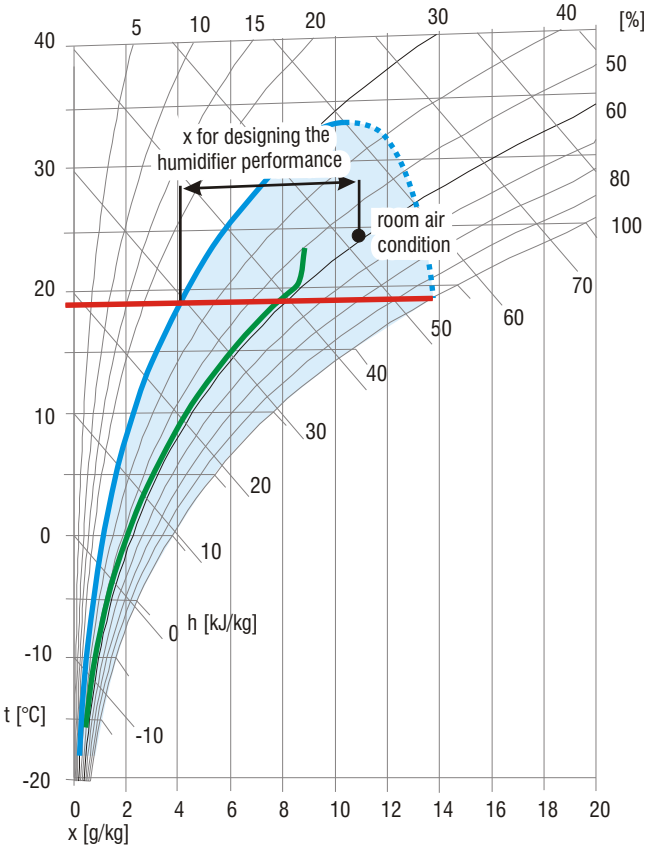
Due to the double purge sector there are, in fact, less leackages of exhaust air into the supply air. Tests according to DIN EN 308 made it quite clear that with a correctly operating double purge sector the rate of dust, gases etc. carried over from the exhaust air into the supply air is 0.2%. This rate carries over smells which are insoluble in water, e.g. from toilets. Smells which are soluble in water, e.g. kitchen smells, may be carried over in the enthalpy rotor, depending on water solubility and humidity efficiency. In condensation rotors smells which are soluble in water are carried over only when falling below the dew point on the exhaust air side.

That is why kitchens are to be provided with condensation rotors and must (in compliance with VDI 2052) to be seperate from the rest of the air handling system.

Humidifier dimensioning

When it comes to the dimensions of the downstream humidifier capacity, it is not only the minimum external air humidity which has to be taken into account. With temperature differences between external and discharge air below 2K, effective energy recovery (sensitive or latent) is not possible.

One of the humidifier installations downstream of the rotary heat exchanger must be placed so that the required level of humidity of the ingoing air is achieved across the entire temperature range after the set value has been attained. With increasing outside temperatures or a reduction in rotational speed of the rotor, the change in air condition achieved by the rotary heat exchanger continues to diverge from the junction between external air and discharge air.



minimum value of outside air humidity

maximum value of outside air humidity

average value of outside air humidity

required supply air temperature

Freezing behavior of rotary heat exchangers

In winter time, it is possible that freezing may occur with a high water content in the exhaust air and at temperatures below 0°C (32°F). The resulting condensation water will not freeze immediately at 0°C (32°F). The freezing point is far below 0°C (32°F). This is a special advantage of the rotor.

Tip: in Central Europe and similar climates, ventilation systems are, in general, in no danger of freezing.

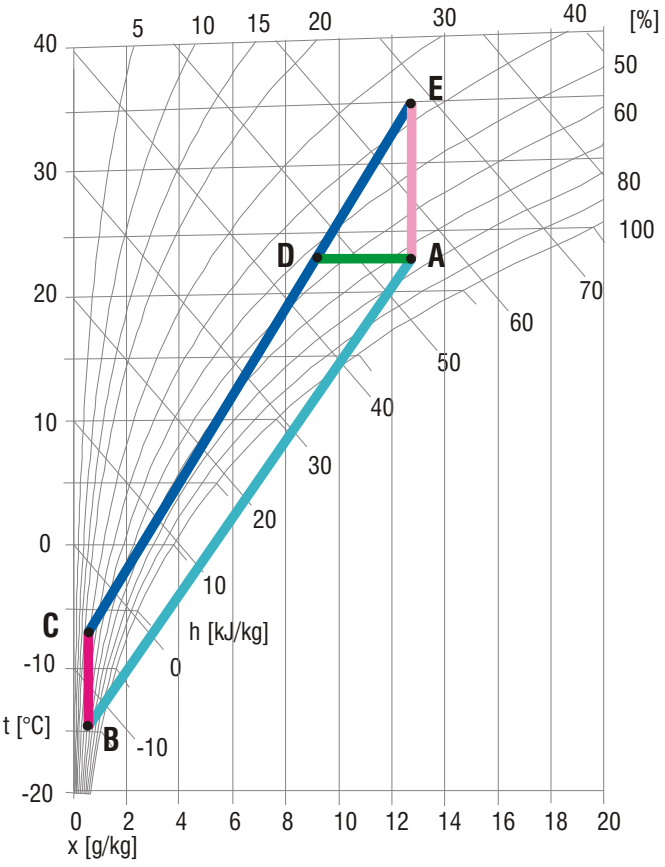
Condensation rotor

In these cases, it is not so easy to determine the freezing limits at low temperatures. The freezing temperature is determined by the extract air temperature, the exhaust air moisture content and the temperature efficiency. Possible measures to reduce the freezing risk are the reduction of the rotor speed, the heating wedge and the possibilities described for the enthalpy rotor.

For the use of rotors in RLT units, there is a freezing risk only at low Fresh air temperatures < -20 °C (-4°F).

Enthalpy rotors

In case the mixture straight line of the entrance conditions A and B in the rotary pre-heating exchange the saturation line = 1, then it can be expected that there will be an excessive quantity of water in the wheel. This operation condition is to be prevented by anti-freeze measures, as shown in the diagram.



Freezing of enthalpy rotors:

A - B: Freezing operation conditions

Anti-freeze measures:

B - C: Pre-heating of fresh air
A - D: Lowering of air humidity of exhaust air
A - E: Re-heating of exhaust air

Arrangement of the air filters

Thanks to its good self-cleaning properties rotary heat exchangers are rather insensitive to dry pollutants in the air. Only when sticky or greasy pollutants are to be expected, there must be installed an additional filter to protect the rotor.

The surface of the heat wheel must be inspected at least once per year. Possibly required cleaning is to be done manually or automatically with compressed air, water, steam or special detergents according to our cleaning instructions.

Uneven or diagonal airflow

Our perfermance data are based on measurements according to EN 308. Please consider, that depending on flow conditions and fan arrangement deviations are possible in performance and pressure drop.

If, for reasons of space, it is not possible to achieve a straight flow of air through the rotor, it is advisable to install baffles at the point where the air comes in to guide the airflow perpendicularly towards the rotor wheel. A diagonal flow of air would lead to a reduction in performance and can cause unwanted exchange in-between seasons due to the rotor wheel turning by itself.

Supporting construction

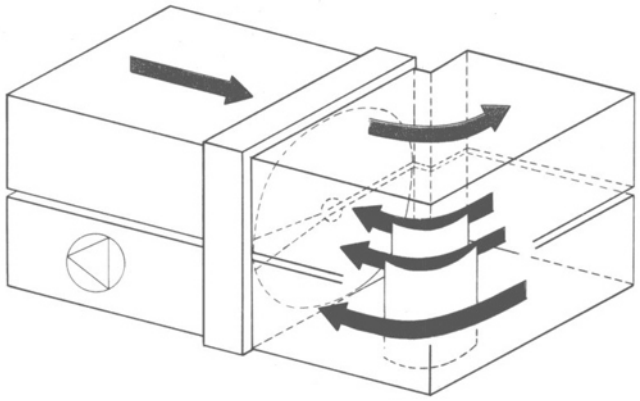
with horizontal installation

The sub-floor must be level so that the rotor can lie on it without strain. The introduction of forces through the connection conduits into the frames of the rotary heat exchangers must be avoided.

Important: the support point of the lower rotor bearing must be supported in a stable way on-site and has to be easily accessible for maintenance purposes.

The forces which have to be absorbed due to this support of the bearing add up to 2/3 of the entire mass of the rotor.

One must ensure that the flow of air into the rotor is even and straight.



Description
Regenerative heat recovery systems

Klingenburg Rotary Heat Exchanger in PREMIUM execution

MODEL RRT

Designed as:
Condensation Rotor according to VDI 2071*
or
Enthalpy Rotor according to VDI 2071*

- For optimal multiple use by sensible and latent energy in the extract air.
- Vertical and horizontal installation position possible for every size, convenient for fitting in air conditioner or for direct connection to aeration system.
- Variable housing dimension for all construction sizes, maximal height or width up to 8000 mm.
- Housing and rotor wheel standard up to 2380 mm undivided, however divided execution available for all dimensions.
- Heat storing matrix out of sea water resistant aluminium alloy, composed of waved and flat, continuous wound layers to guarantee laminar air flow. Compact and smooth heat wheel face.

Housing

- Stable continuous welded aluminium housing design, made of rectangular profiles.
- Seewater resistant aluminium, all coating sheets removable.
- Low weight and simple access to all components.
- Adjustable and wear resistant seals completely adjacent round the wheel.
- Maintenance-free antifriction bearings, up to size 1250 inside located, protected by surrounding hub, above size 1250 outside located, for better load suspension, protected by the bearing frame.

Heat storing matrix

P/E/N: Condensation Rotor (P) for sensible, Enthalpy Rotor (E) resp. Sorption Rotor (HUgo N) for sensible and latent energy recovery. Matrix mechanical fixed with opposite arranged welded internal and external double spoke system, as well as framed segments in case of divided rotor. Prevention of non aerated areas and consequently avoidance of corrosion and increased life time.

PT/ET/NT: Condensation Rotor (PT) for sensible, Enthalpy Rotor (ET) resp. Sorption Rotor (HUgo NT) for sensible and latent energy recovery with inside installed radial tension rods.

KT: Condensation Rotor with special epoxy coating, for increased corrosion protection.

Example description of product type: **RRT - E - C19 - 2000 / 1800 - 1720**

- Housing
- Heat storing matrix
- Wheel geometry (see technical documentation)
- Housing Height
- Housing Width
- Wheel Diameter

*) VDI: Association of German Engineers

Description
Regenerative heat recovery systems

Klingenburg Rotary Heat Exchanger in CLASSIC execution

MODEL RRS

Designed as:
Condensation Rotor according to VDI 2071*
or
Enthalpy Rotor according to VDI 2071*

- For optimal multiple use by sensible and latent energy in the extract air.
- Vertical and horizontal installation position possible for every size, convenient for fitting in air conditioner or for direct connection to aeration system.
- Variable housing dimension for all construction sizes, maximal height or width up to 4250 mm.
- Housing and rotor wheel standard up to 2380 mm undivided, however divided execution available for all dimensions.
- Heat storing matrix out of sea water resistant aluminium alloy, composed of waved and flat, continuous wound layers, to guarantee the laminar air flow. Compact and smooth heat wheel face.

Housing

- Stable continuous welded frame construction, made of galvanised steel.
- Coating sheets made of galvanised steel.
- Low weight and simple access to all components.
- Adjustable and wear resistant seals completely adjacent round the wheel.
- Maintenance-free antifriction bearings, up to size 1250 inside located, protected by surrounding hub, above size 1250 outside located, for better load suspension, installed in the housing frame.

Heat storing matrix

P/E/N: Condensation Rotor (P) for sensible, Enthalpy Rotor (E) resp. Sorption Rotor (HUgo N) for sensible and latent energy recovery. Matrix mechanical fixed with opposite arranged welded internal and external double spoke system, as well as framed segments in case of divided rotor. Prevention of non aerated areas and consequently avoidance of corrosion and increased life time.

PT/ET/NT: Condensation Rotor (PT) for sensible, Enthalpy Rotor (ET) resp. Sorption Rotor (HUgo NT) for sensible and latent energy recovery with inside installed radial tension rods.

KT: Condensation Rotor with special epoxy coating, for increased corrosion protection.

Example description of product type: **RRS - E - C19 - 4000 / 3850 - 3610**

- Housing
- Heat storing matrix
- Wheel geometry (see technical documentation)
- Housing Height
- Housing Width
- Wheel Diameter

*) VDI: Association of German Engineers

Description
Regenerative heat recovery systems

Klingenburg Rotary Heat Exchanger in STANDARD execution

MODEL RRU

Designed as:
Condensation Rotor according to VDI 2071*
or
Enthalpy Rotor according to VDI 2071*

- For optimal multiple use by sensible and latent energy in the extract air.
- Vertical installation for every size, preferred use as fitting rotor in air conditioner.
- Square housing, maximal dimensions up to 2500 mm.
- Housing and wheel undivided.
- Heat storing matrix out of sea water resistant aluminium alloy, composed of waved and flat, continuous wound layers, to guarantee the laminar air flow. Compact and smooth heat wheel face.

Housing

- Stable screwed housing design, made of galvanised steel.
- Low weight and simple access to all components.
- Adjustable and wear resistant seals completely adjacent round the wheel.
- Maintenance-free antifriction bearings, up to size 2000 inside located, protected by surrounding hub, above size 2000 outside located, for better load suspension, installed in the housing.
- Easy mounting of the motor position and air flow separation, thereby optimal use for direct and subsequent storage.
- Execution with square housing sizes up to 2500 mm.

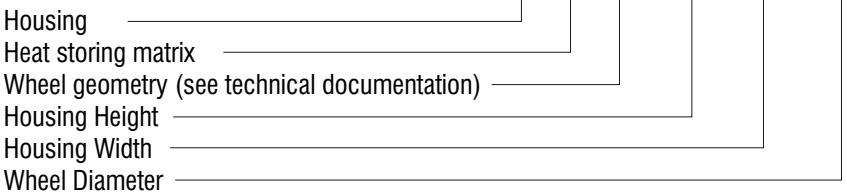
Heat storing matrix

P/E/N: Condensation Rotor (P) for sensible, Enthalpy Rotor (E) resp. Sorption Rotor (HUgo N) for sensible and latent heat recovery. Matrix mechanical fixed with opposite arranged welded internal and external double spoke system. Prevention of non aerated areas and consequently avoidance of corrosion and increased life time.

PT/ET/NT: Condensation Rotor (PT) for sensible, Enthalpy Rotor (ET) resp. Sorption Rotor (HUgo NT) for sensible and latent heat recovery with inside installed radial tension rods.

KT: Condensation Rotor with special epoxy coating, for increased corrosion protection.

Example description of product type: **RRU - E - C19 - 2000 / 2000 - 1880**



*) VDI: Association of German Engineers

We reserve the right to introduce technical changes and alterations without prior notice

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