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Rotors for paint spray plants

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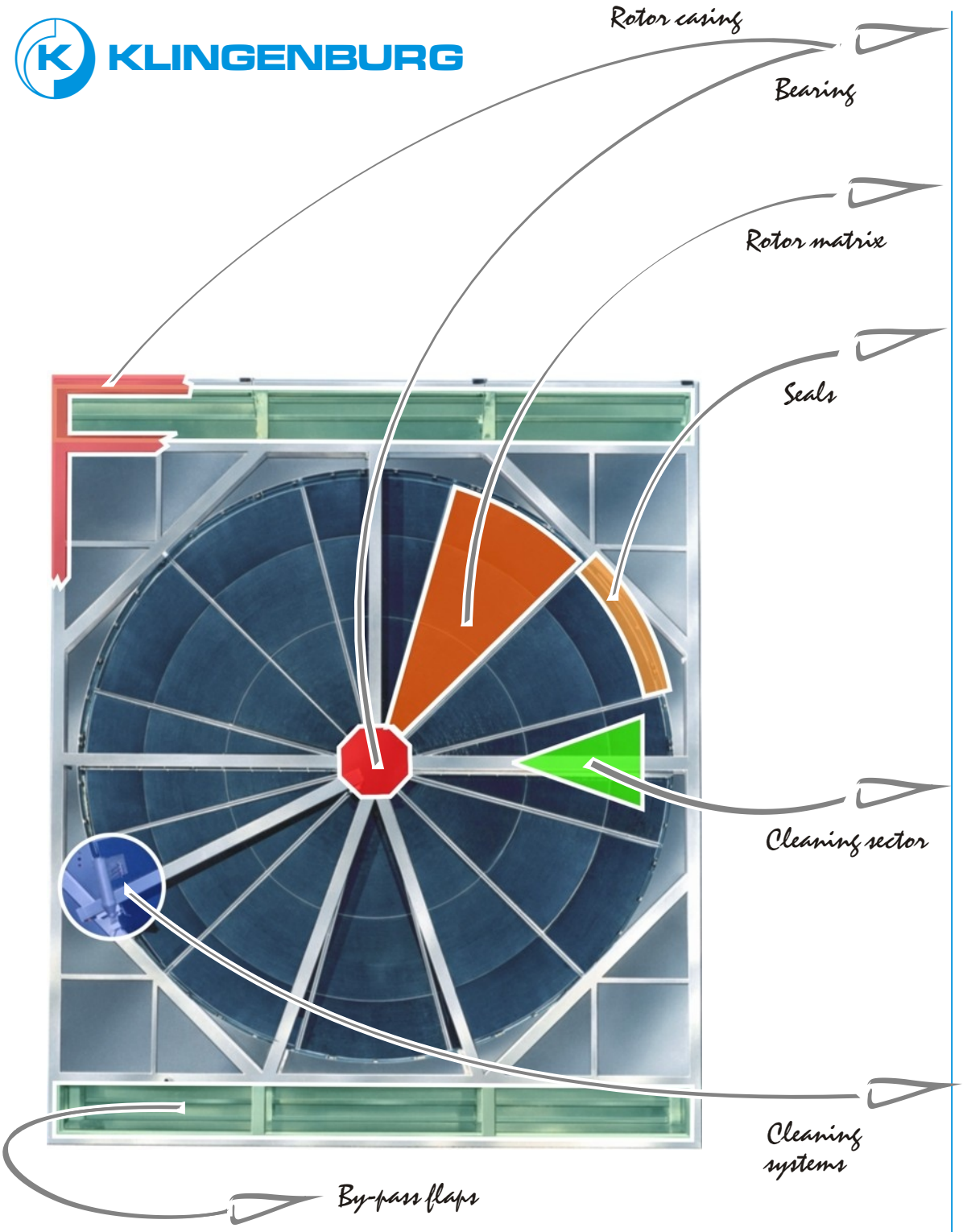


Paint shop rotors

Rotor Casings

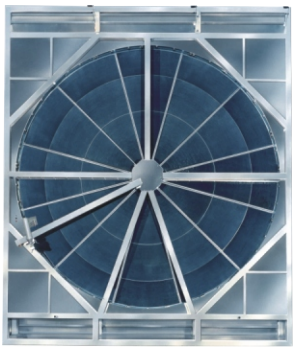
Rigid construction optionally consisting of

- Aluminium alloy FT-RRT
- Stainless steel FT-RRV
- Sheet steel, hot-dip galvanised FT-RRB

with internal inclined condensation tub and condensation drain.

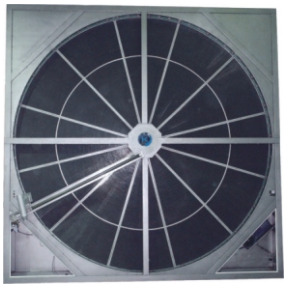
All frames can accommodate rotor wheels up to 6000 mm in size. The casing houses the rotor wheel, bearings, rotor drive, cleaning device, gasket system and integrated air sealing system. Inspection doors on one or both sides allow easy access to all components.

Aluminium casing FT-RRT



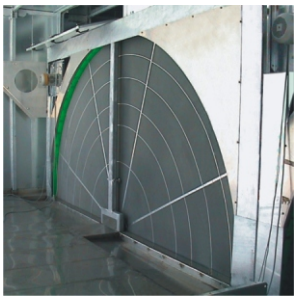
- made of corrosion-resistant aluminium alloy
- especially suitable for use in plants with dry or wet paint deposition
- low static load smaller than 750 kg/m², based on entire unit

Stainless steel casing FT-RRV



- made of stainless steel
- especially suitable for use in plants with dry or wet paint deposition
- static load greater than 750 kg/m², based on entire unit

Galvanised Steel Casing FT-RRB



- made of hot dip galvanised sheet steel and stainless steel cover plates
- suitable for use in plants with dry or wet paint deposition
- static load greater than 750 kg/m², based on entire unit

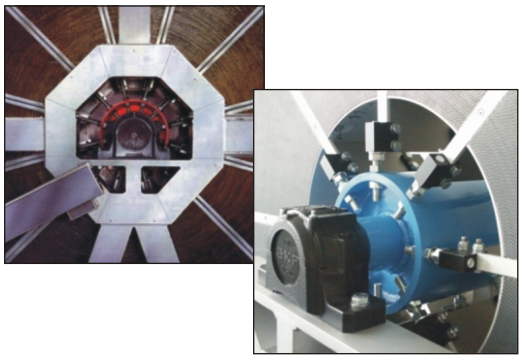
The bearings

The rotor matrix is supported adjustably, outside in the rotor frame or inside in the rotor hub. Outside located bearings are able to absorb loads considerably better than inside located bearings. The outside bearings offer, in addition, the advantage to be disassembled more easily.

Outside bearings

Designed as pillow block bearing SNV 130 with or without relubrication, insensitive to the entry of dirt, with preservation as condensate anti-adhesive layer.

Loads are absorbed more efficiently than by inside bearing; bearings can be changed (if necessary) without disassembling / assembling of the rotor matrix.



Inside bearings

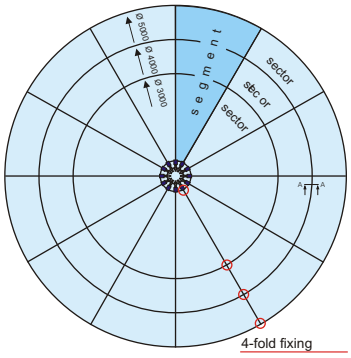
Designed as hub bearing, with relubrication, insensitive to the entry of dirt.
Large dimensioning is necessary because of poor leverage ratio, some fine adjustment of the rotor matrix is possible. Bearing change only with disassembling / assembling of the rotor matrix.

Bearing inspection door

Independent of the type of bearing inspection openings on both sides have to be designed over the entire supported area.

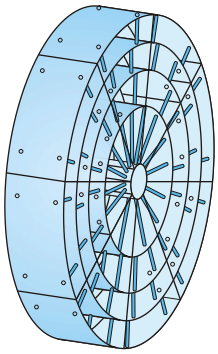
The matrix is coiled with waved and flat, continuous wound layers. The wheel which turning at 10 rpm is able to transmit sensible and latent heat with a high degree of efficiency.

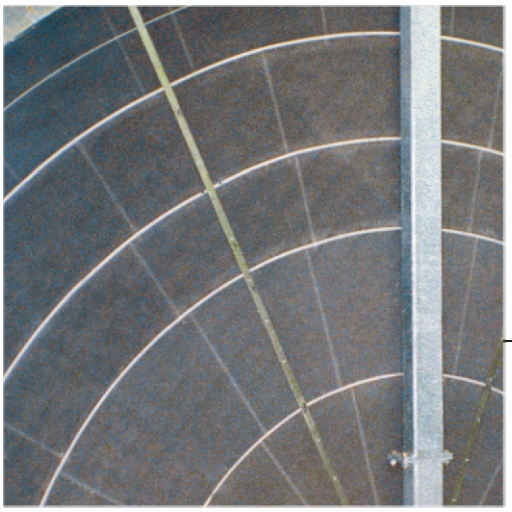
Sectorally-reinforced design



- Sectoral construction of the rotor segments with intermediate profiles to compensate for any forces arising
- Extremely stable construction for particularly contaminated exhaust air
- Assembing of the rotor from the centre to the outside

Con-rod design





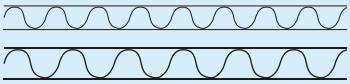
- Stabilisation of the sectors achieved by con-rods and pressure rods
- Assembling of the rotor from the outside to the centre

The rotor profile has to be selected in consideration of the degree of soiling, required cleaning intervals as well as the required efficiency. The material should be resistant to the chemicals in the exhaust air, and where a wet paint deposition process is applied, it must also be resistant to the different types of system tank water and their

Rotor profile and material grade

The rotor profile is characterised by the material thickness and the wave height.

Wave height



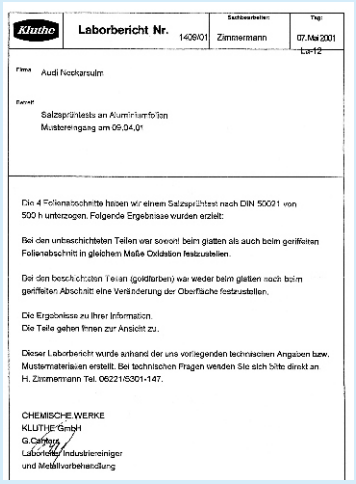
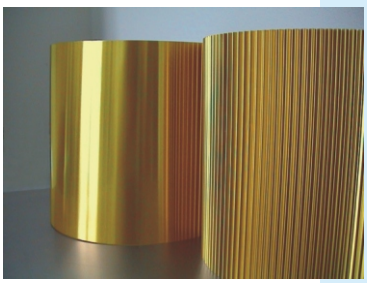
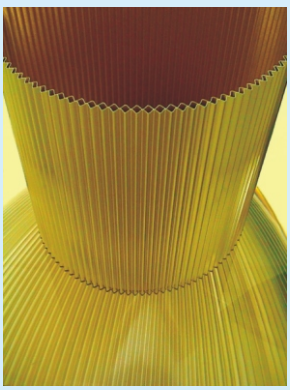
from
1.9 mm - 2.4 mm
and from
2.5 mm - 2.7 mm

Material thickness

0.08 mm

0.10 mm

0.12 mm

Grades (typical)	Features	Application conditions
AL 326/46 AL 60/60	■ high tensile strength ■ high yield point ■ good mechanical workability ■ good corrosion resistance	all painting method
Alloy 3.003 	■ good mechanical workability ■ high stability of form ■ good corrosion resistance (tested and confirmed repeatedly under service conditions)	all painting method
Alloy 5052 	■ best corrosion resistance ■ good mechanical workability without surface damage 	all painting method 

ILK Dresden

Fachbericht
ILK B 8/96-1683

Untersuchung von Korrosionserscheinungen an einer Regeneratormatrix aus Aluminium

Auftraggeber: Klingenburg GmbH

Kluthe

Laborbericht Nr. 1408/01

Sachbearbeiter: Zimmermann

Tag: 07.Mai 2001

Firma Audi Neckarsulm

Betreff
Salzsprühtests an Aluminiumfolien
Mustereingang am 09.04.01

Die 4 Folienabschnitte hatten wir einem Salzsprühtest nach DIN 50021 von 500 h unterzogen. Folgende Ergebnisse wurden erzielt:

Bei den unbeschichteten Teilen war sofort beim glatten als auch beim gerifften Folienabschnitt in gleichem Maße Oxidation festzustellen.

Bei den beschichteten Teilen (goldfarben) war weder beim glatten noch beim gerifften Abschnitt eine Veränderung der Oberfläche festzustellen.

Die Ergebnisse zu Ihrer Information.
Die Teile gehen Ihnen zur Ansicht zu.

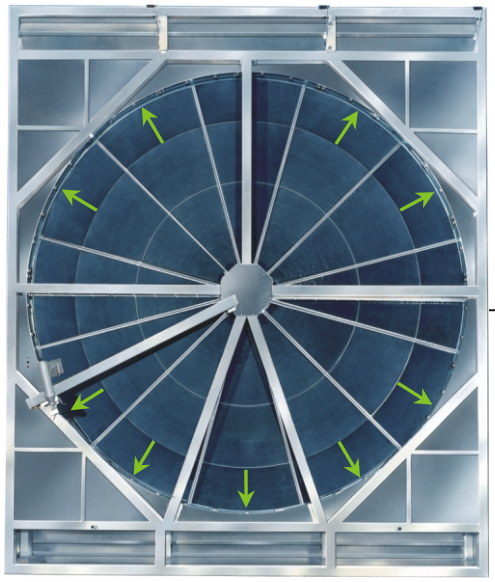
Dieser Laborbericht wurde anhand der uns vorliegenden technischen Angaben bzw. Mustermaterialien erstellt. Bei technischen Fragen wenden Sie sich bitte direkt an H. Zimmermann Tel. 06221/5301-147.

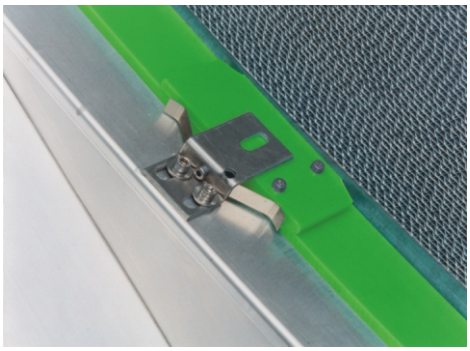
CHEMISCHE WERKE
KLUTHE GmbH
G.Calsow
Laborleiter Industriereiniger
und Metallvorbehandlung

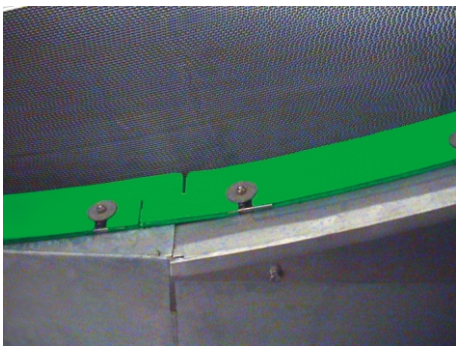
Seals

Highly efficient sealing systems minimize the loss of air due to leaks.

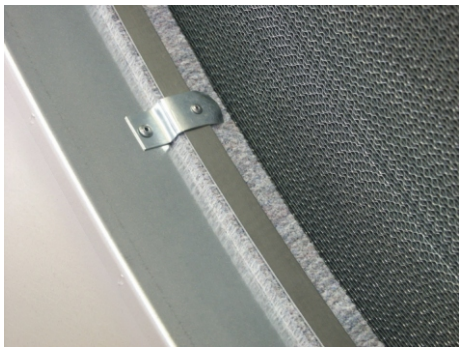
The circumferential seals are self-adjusting and permanently adapt to the rotation of the rotor wheel.







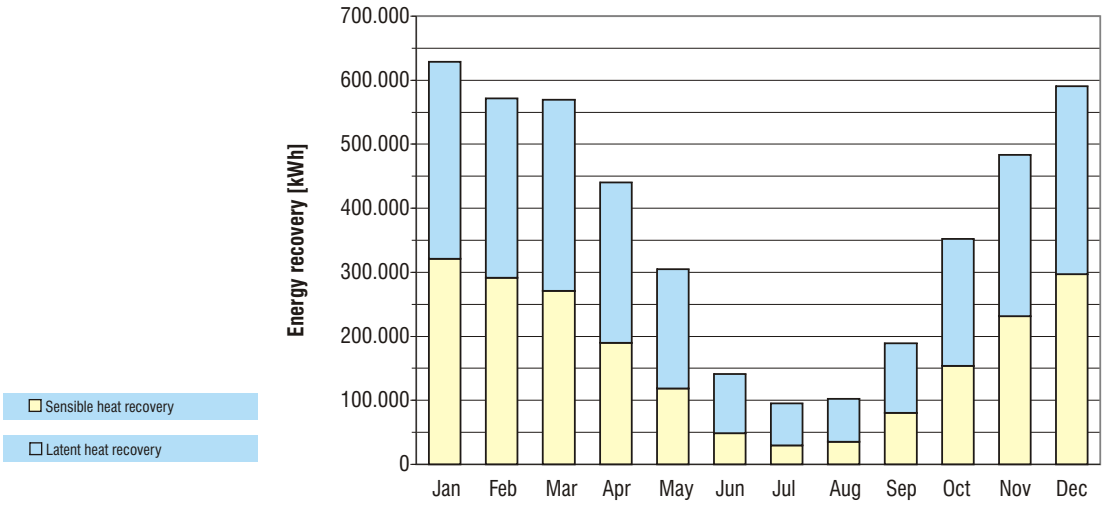
Permanently fixed plastic seals or profiled sheet metal with extremely small clearance to the rotor are used as center seals.
The fan arrangement "pushing exhaust air fan and succing supply air fan" requires a scavenging and sealing air system or the controlled chamber air sealing system to avoid entrained rotation and leakage of exhaust air (see chapter "controlled chamber air sealing").



Systems in which sealing is not a main requirement use felt or rubber lip seals. These seals can be adjusted but they are not self-adjustable.

Spray-painting systems are major energy consumers. Energy recovery as a cost saver is therefore of particular importance in paint spray systems. The economy calculation according to VDI 2071 as a decision-making tool shows a significant energy saving potential:

Rotational heat exchanger		**Enthalpy rotor**	
		Wheel diameter	5010 mm
		Thickness of the foil	0,12 mm
		Wave height	2,5 mm
Design specifications			
	Supply air	Exhaust air	
Airflow	120.000	120.000	m³/h
Temperature		18	°C
Relative humidity		90	%
Outside air		**Climate zone 2**	



Energy recovery

	Energy recovery Sensible [kWh]	Latent [kWh]
January	320.849	308.015
February	291.508	280.023
March	270.969	298.671
April	189.480	251.138
May	118.596	186.405
June	48.393	92.946
July	29.710	65.317
August	34.997	67.155
September	80.130	109.317
October	153.503	198.961
November	231.670	251.799
December	297.428	292.908
Total	2.067.233	2.402.655

Total energy recovery:	4.469.888 kWh/a
Moisture recovery:	3.458.442 kg/a

Regulation

Operating time:	00:00 to 24:00
Total operating hours:	8,760 h/y
7 days a week	

Annual savings:

Heating energy	135 000 EUR*
CO_2	1 800 000 kg*

* 30 EUR / MWh energy, 400 kg CO_2 / MWh energy (VDI 2071)

Depending on the paint deposition process (wet or dry), the potential recovery of latent heat should be considered. This is of particular importance to the selection of system components, such as humidifiers, and also the rotor equipment.

Rotor and housing are not assembled when supplied		**Rotor type**	**RRT-E-A25-5250/5250-5010**				Aluminium housing 0,12 mm thickness of the foil 2,5 mm wave height
			Dry paint deposition		***Wet paint deposition***		
			Supply air	***Exhaust air***	***Supply air***	***Exhaust air***	
Standard volume (20°C / 50% / 1013 mbar)			120 000	120 000	120 000	120 000	m³/h
Inlet condition	Temperature		9,5	22	9,5	18	°C
	Air volume		115 438	120 768	115 438	119 489	m³/h
	Rel. humidity		47	40	47	90	%
	Abs. humidity		3,44	6,56	3,44	11,61	g/kg
Outlet condition	Temperature		17,0	14,5	14,6	12,9	°C
	Air volume		118 620	117 590	118 308	116 627	m³/h
	Rel. humidity		33	59	74	80	%
	Abs. humidity		4,01	5,99	7,60	7,42	g/kg
Face air velocity			3,25	3,40	3,25	3,37	m/s
Pressure drop			86	92	86	90	Pa
Pressure drop (standard density)			91	91	91	91	Pa
Sensible efficiency			60	60	60	60	%
Moisture (latent) efficiency			18	18	51	51	%
Heat recovery							
Sensible heat			305		211		kW
Latent heat			56		414		kW
Total heat			361		625		kW
Moisture recovery			81		596		kg/h
The calculation is based on							
Atmospheric pressure			1013 mbar				
Altitude above sea level			0 m				

The following principles should be observed in planning rotating heat exchangers for paint spraying systems:

1. Mounting condition

- Vertical mounting should be preferred, horizontal mounting is possible, but not recommended for systems with wet paint deposition.
- Horizontal and vertical separation of the air flows is possible, for horizontal separation the exhaust air should be the down flow - if possible.
- The installation surface must be level and plane, if the equipment is installed on a steel platform or a base, a base frame all around is necessary, also sections supporting point loads. (center beam)
- Sufficiently dimensioned water-tight tubs should be provided before and after the heat wheel for no-loss drainage of condensate and cleaning fluid.
- The sections of the heat wheel encasing (frame construction) should be mounted at a minimum distance of 500 - 600 mm to the heat wheel. Inspection doors should be provided in the areas of the bearings (see chapter on rotor housing and support), assess to bearing and plate bolts must be possible.
- The rotor requires free lenghts for incoming and outgoing flow for proper operation.

2. Rotor dimensioning

- We determine the size of the rotor and the thermodynamic parameters with a software program. We would be pleased to perform the calculations for you. The following recommendations are based on many years of experience in this field:
  - The velocity of the air in relation to the rotor face area should be ≤ 4.0 m/s
  - The rotor profile, correct choice of the film thickness and lamella height see thermal mass chapter
  - Wet paint deposition: 2.5 - 2.7 mm wave height
  - Dry paint deposition: 1.9 - 2.7 mm wave height depending on the kind of filters in the exhaust air

- Fan arrangement:
  + suction/suction, double purge chamber is possible
  + exhaust air pushing /supply air sucking, sealing and purge air system is needed

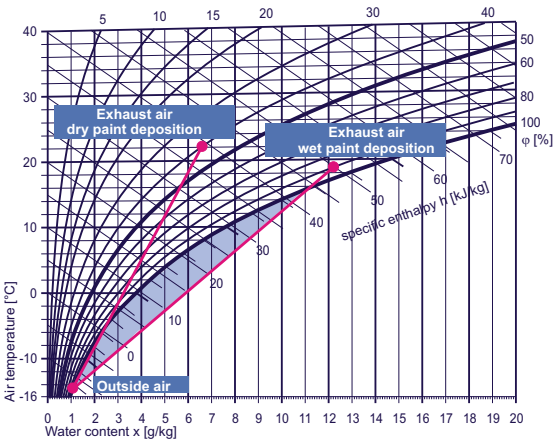
3. Definition of the required accessory items for the heat wheels

Item	Accessory name	Remarks
1.	Watertight housing tub with condensate drains	Is part of the standard system
2.	Double purge chamber sealing air system purge air system / heating wedge	Is defined as function of the fan arrangement
3.	Chamber air seal	Detailed description in the chapter “Chamber air seal”
4.	Electrical components	Check for make specifications and explosion proof requirements (detailed description in the chapter “Electrical components”)
5.	Cleaning system	Definition of cleaning equipment (detailed description in the chapter “Cleaning systems”)
6.	Utilities supply and release for cleaning systems	Definition of the required water and compressed air volumes, with reference to customer's flowchart data

4. Rotor icing

The high moisture content of the exhaust air causes much water to condense at the extract air side of the heat wheels of paint spraying plants with wet paint deposition. The changes of state are illustrated in the psychometric chart. It is clear from the chart that the connecting line of the entry states, the outside air and exhaust air in wet paint deposition plants intersects the saturation line at two points and lies in the mist area. As a result of this **condensate** forms at the rotor, which cannot be absorbed by the heating outside air/supply air. So called excess water forms in the rotor, one of the most dangerous conditions for **icing up of the rotor**.

Mollier - h.x chart, exhaust air before heat recovery



Higher exhaust air moisture produces more condensed water and excess water in the rotor.

To avoid icing up or glaciation of the rotor, observe the following:

- Reduce the rotor speed to 2 rpm (ice speed) at outdoor temperatures ≤ 0°C.
- Use the heating wedge from outdoor temperatures ≤ 0°C.
- Monitor the differential pressure.
- Visually inspect the heat wheels.
- Open the outdoor by-pass flap if ice starts forming.
- After extended downtime: Dry the heat wheel at outside temperatures < 0°C before starting the fans (e. g., by the heating wedge or controlled chamber air seal).

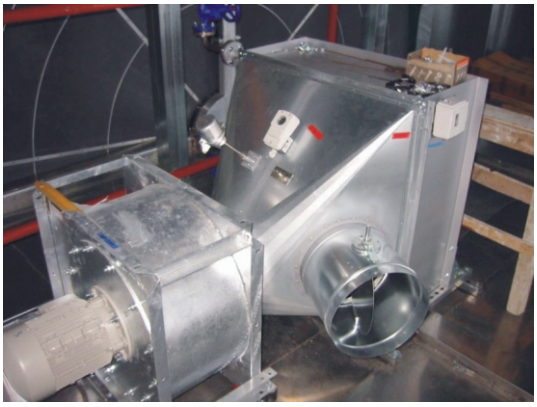
Experience with running systems has shown that despite measures to control icing, the likeliness of icing rises if the outdoor temperature drops to ≤ 10°C below zero.

Glaciation of the rotor matrix obstructs the drainage of “free water”.

Water puddles and dirt deposits form and these cause icing up of the rotor.

Typical heater wedge design

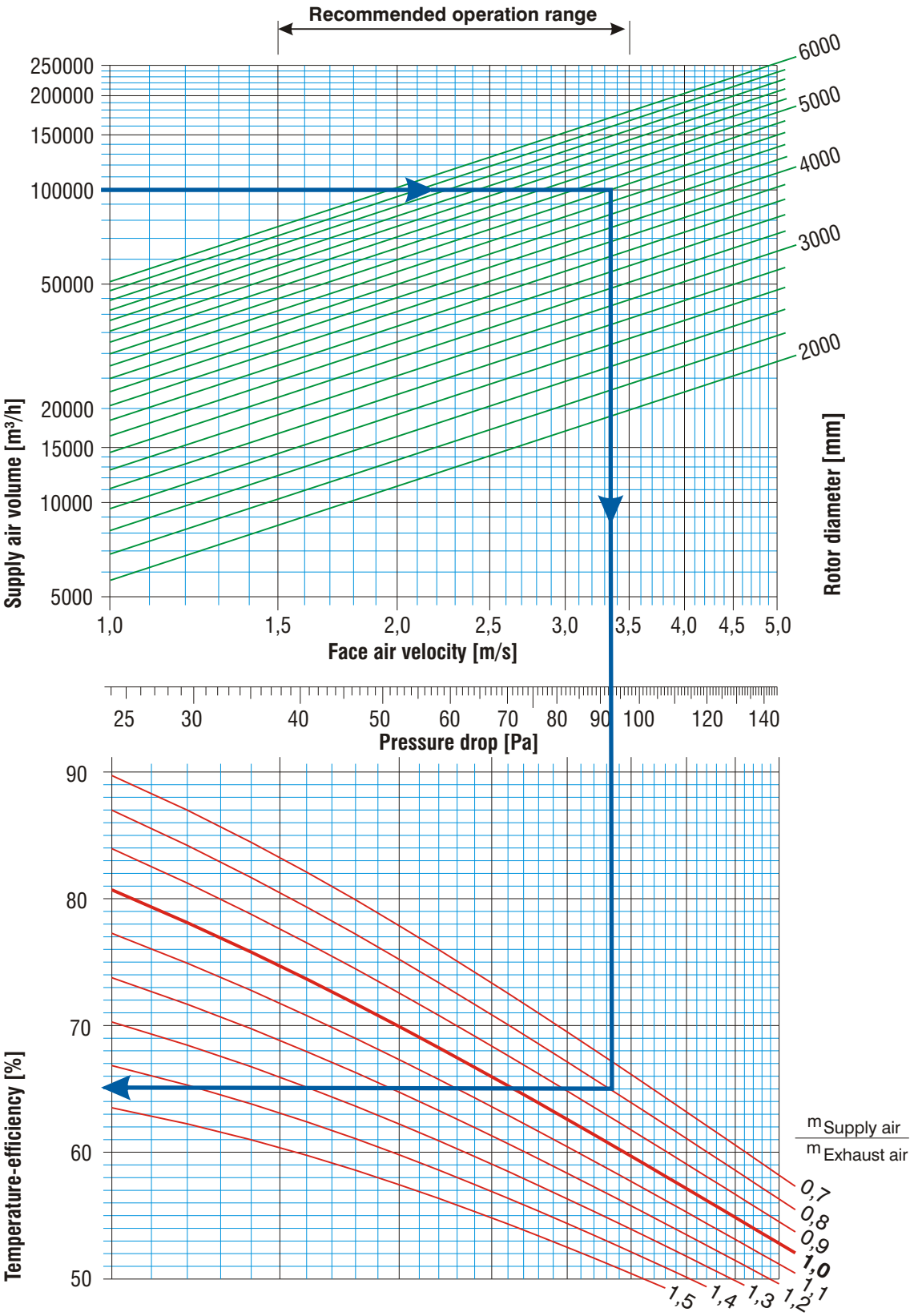
The purge air fan takes in hot air from the HW register...



... and, through the connecting duct in the outgoing air section, blows it in the pulse chamber of the heat wheel in opposite direction of the exhaust air flow.

Heating output: 100-130 KW
Flow rate: up to c. 5000 m³/h at c. 2000 Pa
Outlet temperature at the pulse chamber: c. 40°C
The purge air intake can also be located downstream the preheating register.

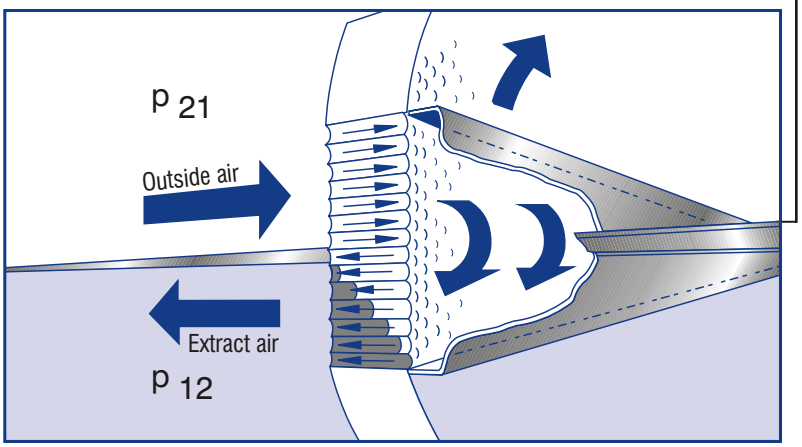
Layout diagram



The design program for rotor profile A25 is most commonly used in paint spraying systems.
Air flows relate to standard density of $\rho = 1.20$ kg/m³

The cleaning sector

The double cleaning sector prevents entry of exhaust air into the supply air due to entrained rotation of exhaust air within the rotor matrix.



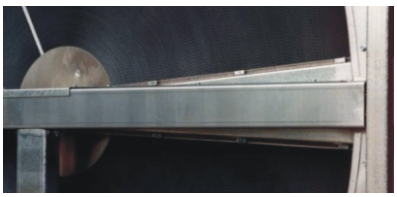
Part of the outside air flow is deflected in order to achieve a cleaning effect.

This avoids entrained rotation of exhaust air within the rotor matrix into the supply air.

This purge effect is obtained due to the pressure difference $\Delta p = p\ 21 - p\ 12$ between the outside air and the extract air.

Pressure differences

0 - 200 Pa	Effect of the cleaning sector not warranted. Use rotor without cleaning sector.
200 - 500 Pa	Standard cleaning sector 2 x 5 degrees required.
500 - 800 Pa	Cleaning sector 2 x 2.5 degrees required.
800 Pa	Cleaning sector installation should



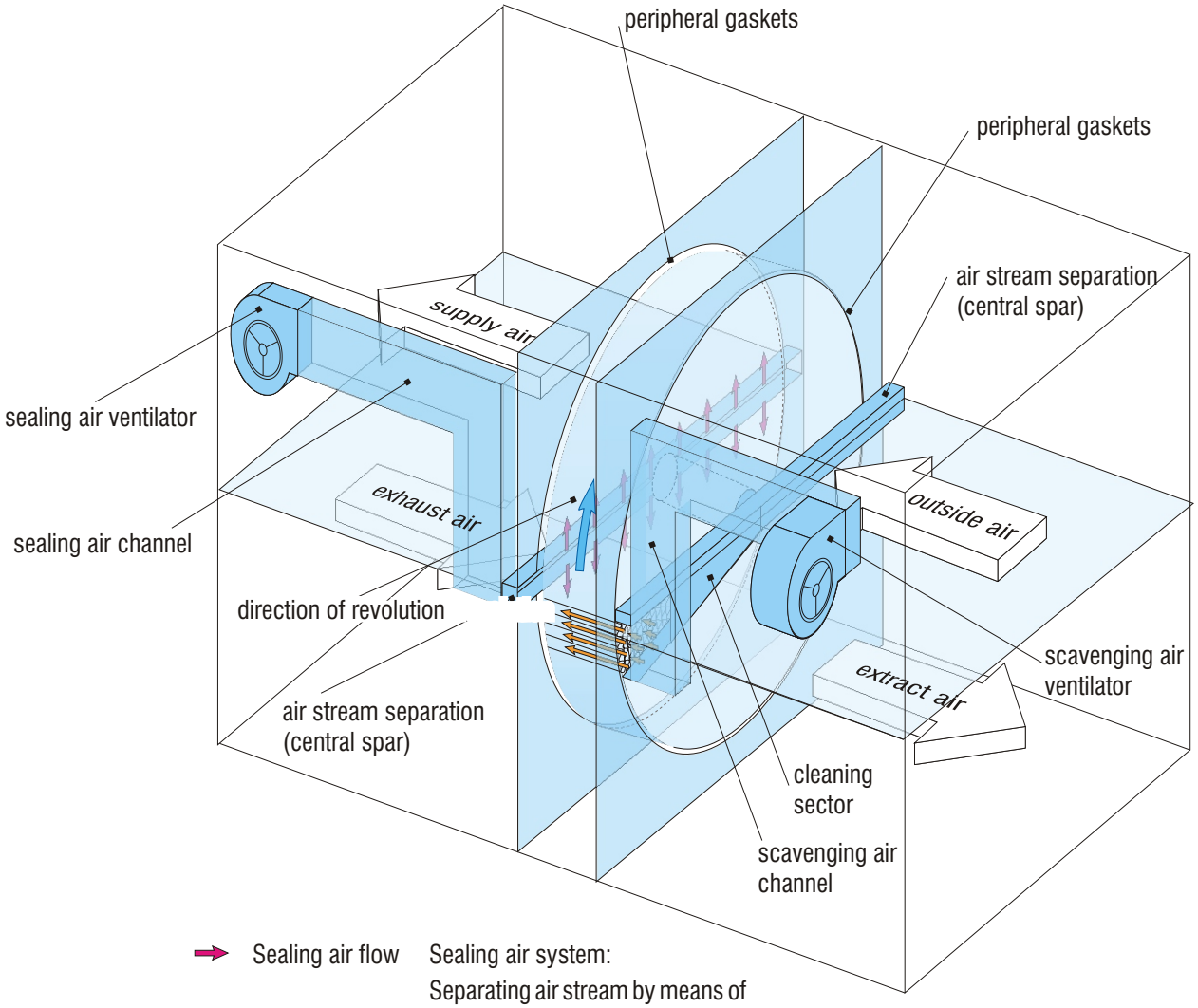
Cleaning and leakage air volumes

Cleaning and leakage air volumes must be considered in the calculation. A special seal type allows to reduce leakage air to a minimum (see chapter "seals").

Scavenging and sealing air systems for rotary heat exchangers

The layout of the air streams determine the leakage volume and direction.

If the exhaust air ventilator pushes the air onto the rotor with concurrent sucking supply ventilator, additional motor-driven air systems will be required.



Sealing air flow — Sealing air system:
Separating air stream by means of separate ventilators between supply and exhaust air prevents overflow in the area where air stream separation occurs (central gasket).

Scavenging air stream — Scavenging air system:
Entrained rotation of exhaust air into the supply air is avoided by means of the ventilator-supported cleaning sector.

Controlled chamber air sealing for rotary heat exchangers

NEW

Patent applied for

Advantages:

- Avoidance of icing on the gaskets
- Scavenging air function and double-sided sealing air function with one system
- Avoidance of condensation in the casing
- Bearing area remains clean and dry
- Explosion-proof of the device by overpressure with “clean” air
- Pollution-resistant cleaning device by means of overpressure operation
- Only one ventilator with low drive power necessary:
  - Reduced need for maintenance
  - Increased operational safety
  - Ventilator could be integrated into casing
  - No additional space required, turbulent-free incoming flow
  - No connection channels necessary

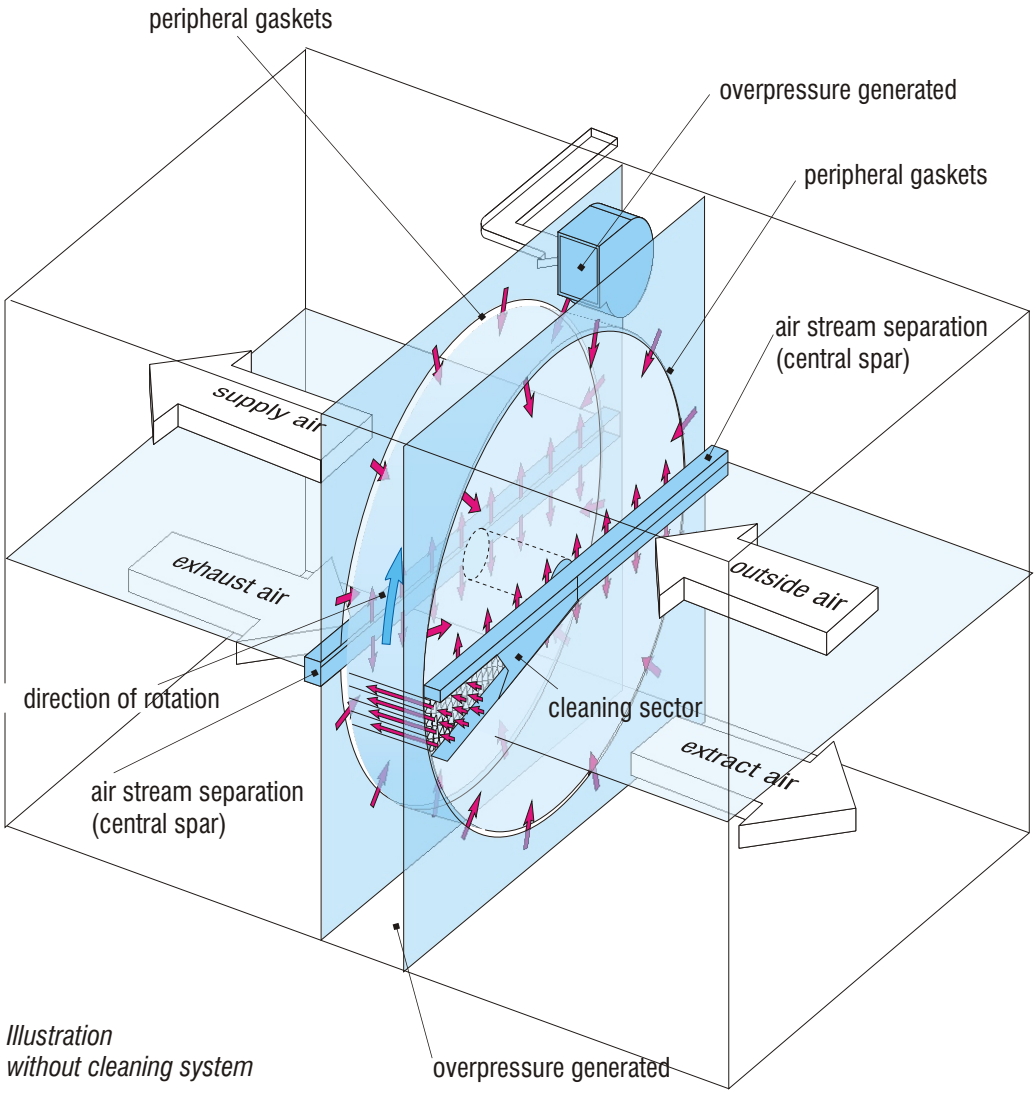
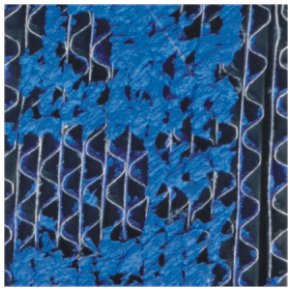


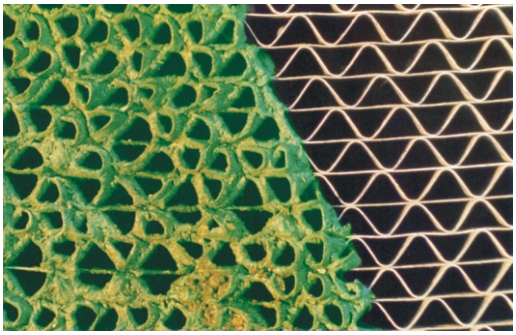
Illustration
without cleaning system

Cleaning systems

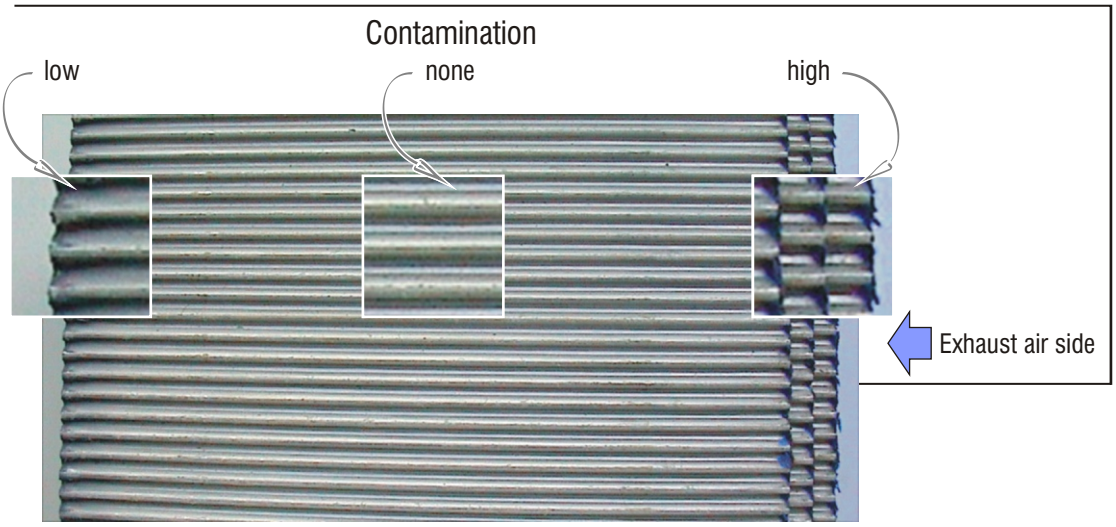
Independent of the type of deposition process or the filter levels used in the exhaust air — paint shop rotors are exposed to strong contamination.



contaminated rotor wheel



before and after cleaning



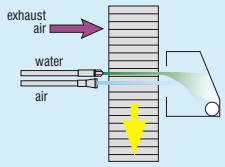
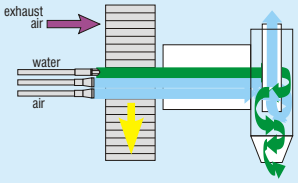
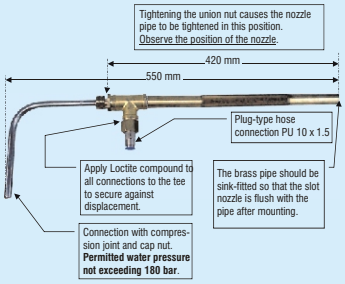
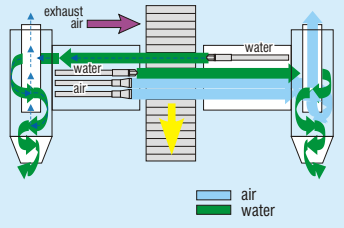
Due to the various paints and exhaust air treatment processes used in surface technology, the cleaning of the rotors demands the highest standards.

The cleaning must fulfil two functions:

1. Cleaning of paint particles on rotor wheel surface
2. Removal of substances in the exhaust air which will effect corrosion of the rotor wheel (especially in case of wet paint deposition due to concentration of system tank water)

Cleaning of the rotor matrix

The selection of the optimum cleaning methods depends on the degree of contamination of the rotor and the exhaust air's paint deposition process.

Cleaning technology	Characteristics	Condition for use
Air - water cleaning		
	■ Exhaust air side cleaning, collecting tub at cold side ■ Cleaned when the ventilation system is not running	■ Dry paint deposition ■ With combined spraying and drying process ■ Manual activation of the cleaning system
	■ Exhaust air side cleaning ■ Separation of air and water in cyclone funnel ■ Cleaning possible while the ventilation system is running	■ Dry and wet paint deposition ■ Manual or automatic activation of the cleaning system
	■ Cleaning at both sides with collecting funnels and combined nozzle ■ Cleaning possible while the ventilation system is running	■ All kinds of paint ■ High degree of contamination ■ Dry and wet paint deposition ■ Automatic activation by PLC
Double-sided		
	■ Double-sided cleaning with optimum air-water separation in cyclone funnel ■ Especially suited for cleaning during operation	■ All paints ■ High degree of contamination ■ Dry and wet deposition ■ Activation via PLC

The operational availability and lifetime of the heat wheels depend critically on the efficiency of the cleaning system.

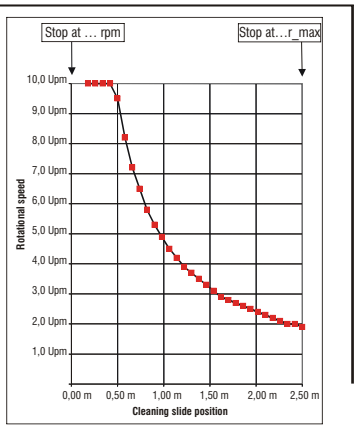
Cleaning technology

The conditions for optimum rotor operation are:

- Cleanness of rotor
- Lowest possible amount of residual water in the rotor wheel and nearly complete controlled drain of the cleaning materials so that the condition of the air inside the paint booths is not effected.

Cleaning process:

The nozzle slide is timed over the rotor radius, the rotor speed adapts to the nozzle position to ensure that always the same area is cleaned within the same time.

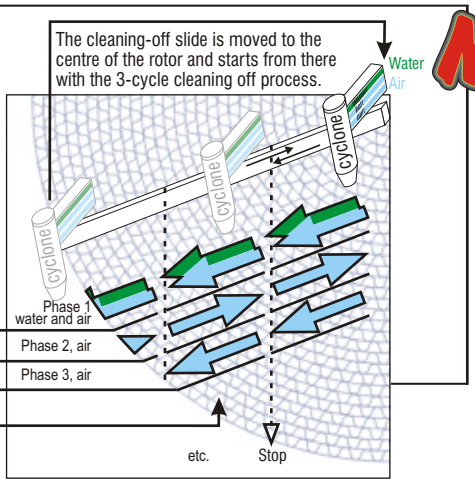


Rotational speed control in cleaning mode as a function of the timing of the cleaning slide

Advantages of THREE-PHASE TECHNOLOGY

- Cleaning during normal operation!
- Improved water extraction increases operational safety

The BEST of the best



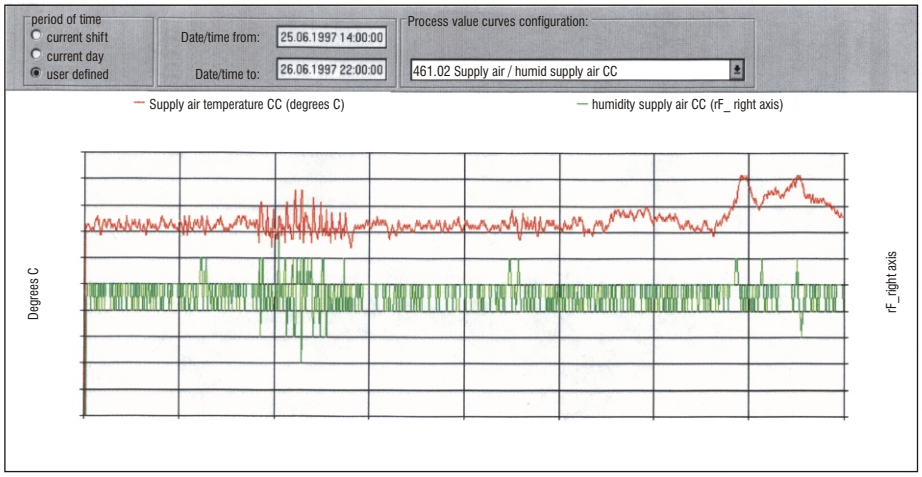
Phase 1: behind the water nozzle, the air stream pushes the water out of the rotor.

Phase 2: expulsion of water = backward, only with air.

Phase 3: expulsion of water = forward, only with air.

New position = new process start (phase 1-3).

With THREE-PHASE TECHNOLOGY rotors can be excellent cleaned *during* operation of the ventilation plant.



The diagram shows the low level of influence on the air condition parameters in the paint booth during cleaning operation process.

Supply air temperature CC (degrees C)

humidity supply air CC (rF_ right axis)

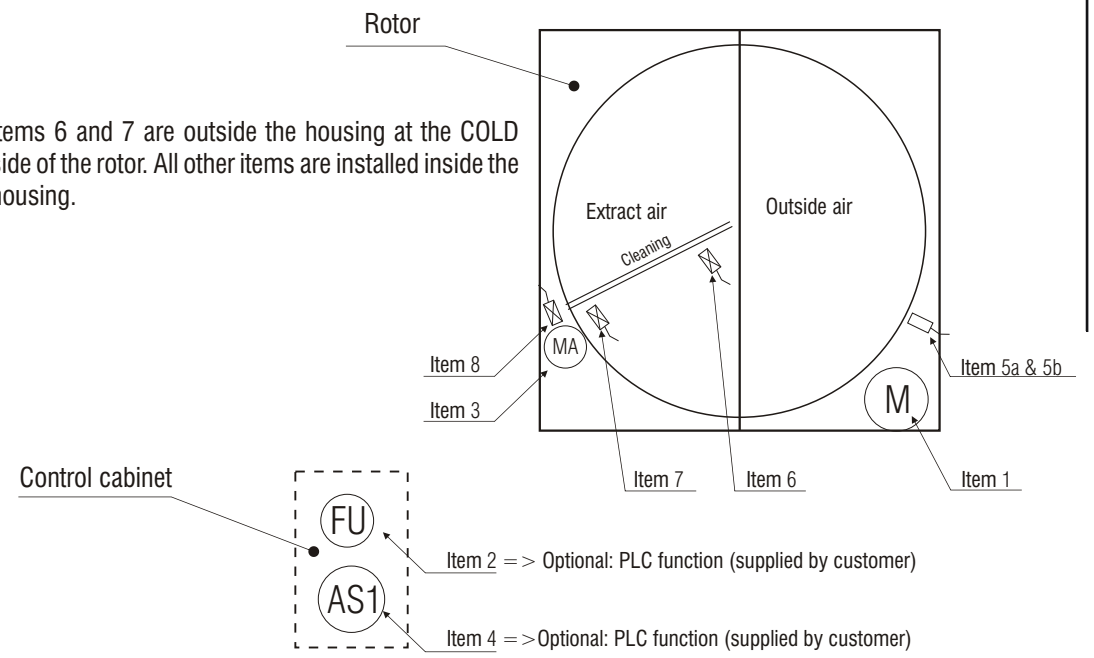
Besides this efficient form of cleaning, there are also various other possibilities.

We would be pleased to inform and advice you!

Profit from our long know-how experience!

Illustration of electrical components - typical examples

Items 6 and 7 are outside the housing at the COLD side of the rotor. All other items are installed inside the housing.



TYPICAL EXAMPLE

ITEM	DESIGNATION	MANUFACTURER / TYPE / SIZE	
1	Rotor wheel drive motor	Make Type Output Explosion proof Motor voltage Motor rated current Insulation class Enclosure Motor protection Fan voltage	SEW- Eurodrive S67 DT90 L4 BMG/TF/VS 1,5 kW no 220 / 380 Volt 6.5 / 3.75 A F IP 54 Temperature sensor (full winding protection) 220 Volt
2	Frequency converter of rotor wheel drive motor	Make Type Supply voltage Supply frequency Output Enclosure Explosion proof	TO BE PROVIDED BY CUSTOMER Belt pulley was designed for 87 HZ(1) => Rotor speed = 10 rpm at Controller frequency =87 Hz
	Frequency converter accessories	Control unit EMC module Braking resistance Guard grating	without or provided by customer

TYPICAL EXAMPLE

ITEM	DESIGNATION	MANUFACTURER / TYPE / SIZE	
3	Cleaning system drive motor	Make Type Explosion proof Output Voltage Rated current	Ruhrgetriebe SN 4 D Yes 0.09 kW 380 Volt 0.4 A
4	Cleaning system control unit	Make Type Explosion proof Supply voltage	Klingenburg AS 1 w. autom. cleaning speed No 380 V
5	a) Inductive proximity switch for the cleaning mechanism => cycle sensor b) Rotor run monitor	Make Explosion proof	Pepperl&Fuchs Yes
6	Inductive proximity switch for the cleaning mechanism = > Rotor center sensor	Make Explosion proof	Pepperl&Fuchs Yes
7	Inductive proximity switch for the cleaning mechanism = > Rotor circumference sensor	Make Explosion proof	Pepperl&Fuchs Yes
8	Inductive proximity switch for the cleaning mechanism = > Hopper st. sensor	Make Explosion proof	Pepperl&Fuchs Yes

About us

Since 1979 we've been manufacturing rotors for the automobile and paint industry with great success!

For over 20 years we have been noticed as a leading manufacturer, developer and supplier of devices for heat and humidity recovery.

We realise the high standards demanded in our industry sector with regard to the stability required by the automobile and paint shop industry. Highly efficient cleaning systems and easy service are basic conditions and part of our services.

Ongoing dialogue with plant operators and manufacturers is an essential basic principle.

Our newly-developed “controlled chamber air sealing” reaffirms that we are on the right track to ever-better solutions with our efforts.

Due to the Rototherm production plant merged in Poland, we were able to increase our production capacity again. This company has 40 employees, is located near Breslau, and specialises in the manufacture of rotors of all sizes.

Our company building
4.200 m² production area

Newly-added production halls
8.400 m² production area

72.890 m² total area

Klingenburg GmbH
Boystraße 115
45968 Gladbeck
GERMANY
Tel. +49 (0) 20 43 / 96 36 - 0
Fax +49 (0) 20 43 / 7 23 62
e-mail: klingenburg@klingenburg.de
web: www.klingenburg.de

Klingenburg International sp. z o.o.
ul. Metalowców 5
58-100 Swidnica
POLAND
Tel.: +48 (0) 74 / 851 54 00
Fax: +48 (0) 74 / 851 54 01
e-mail: klingenburg@klingenburg.pl
web: www.klingenburg.pl

Klingenburg USA. LLC
503 Old Thomasville Road
PO Box 165
High Point, NC 27260
USA
Tel.: +1 336-884-5050
Fax: +1 336-884-8058
e-mail: info@klingenburg-usa.com
web: www.klingenburg-usa.com

Klingenburg Shanghai Representative Office
Room 24/P Jinsui Mansion
No. 379 Pudong South Road
Shanghai
P.R. CHINA
Tel.: +86 (0) 21 / 68 86 92 51
Fax: +86 (0) 21 / 68 86 99 31
e-mail: klingenburg@klingenburg.cn
web: www.klingenburg.cn