HEATEX TECHNICAL INFORMATION

AIR-TO-AIR HEAT EXCHANGERS

HEATEX

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Contents

GENERAL TECHNICAL INFORMATION

AIR-TO-AIR HEAT EXCHANGER

1. HEAT EXCHANGER SELECTION

Heatex AB can offer a wide variety of plate and rotary heat exchangers when it comes to designs, sizes and plate distances/well heights. This enables the customer to choose from several alternatives regarding performance (efficiency and pressure drop) for each set of air data.

The selection and performance calculation is preferably done in our calculation software Heatex Select, which can be used online or downloaded at www.heatex.com, all for free. The program is regularly updated.

All heat transfer and pressure drop calculations are done with the actual heat exchanger geometry and based on correlation from scientifically well renowned sources such as VDI Wärmeatlas and International Handbook of Heat Exchanger Design. This means that the calculations are made in accordance with the European norm EN 308 and its sub documents.

NOTE! Applications with uneven air velocity or temperatures over the heat exchanger may affect calculated performance and are to be evaluated at given occasions. In case of uncertainty, do contact Heatex AB. Always contact Heatex for special calculations regarding heat management which are partly done in other programs than Heatex Select.

1.1. Basic Data Needed for the Selection Process

In order to be able to make a good selection and to speed up the selection process the following in Table 1 should be provided and should be as accurate as possible.

Exhaust air: • Airflow (either at standard air conditions that is 1013,25 hPa (406.78” WC) and 20°C (68°F) or else the temperature at which the airflow is given must be stated). • Air temperature • Relative humidity of the air.
Supply air: • Airflow (standard air conditions are atmospheric pressure of 1013,25 hPa (406.78” WC) and 20°C (68°F) or else the temperature at which the airflow is given must be stated). • Air temperature. • Relative humidity of the air.
Required performance: (Use the little “?” box next to the ”Exchanger model/type” in Heatex Select to come to this menu for plate heat exchangers) • Expected efficiency. • Maximum allowed pressure-drop in the heat exchanger. See separate information about the effect of differential pressure on the pressure drop.
Restrictions regarding dimensions: • Since space often is limited, the maximum allowed diagonal distance (or maximum allowed plate size) should be given. • Maximum allowed width of the heat exchanger should also be given.

Table 1. Basis for an informed selection process.

With the data requested in Table 1 it is possible to find one or several alternative selections that will meet the required performance.

As a guide to help choosing the correct heat exchanger size for a given airflow the diagram in Figure 1 can be used. The diagram shows for each heat exchanger size of width 1000 mm (39.37”), the maximum airflow and nominal plate distance for achieving minimum 50% efficiency (dry) and maximum 250 Pa (1” WC) pressure drop. A wider heat exchanger will give a lower pressure drop and a bigger heat exchanger or a smaller plate distance will give a higher efficiency.

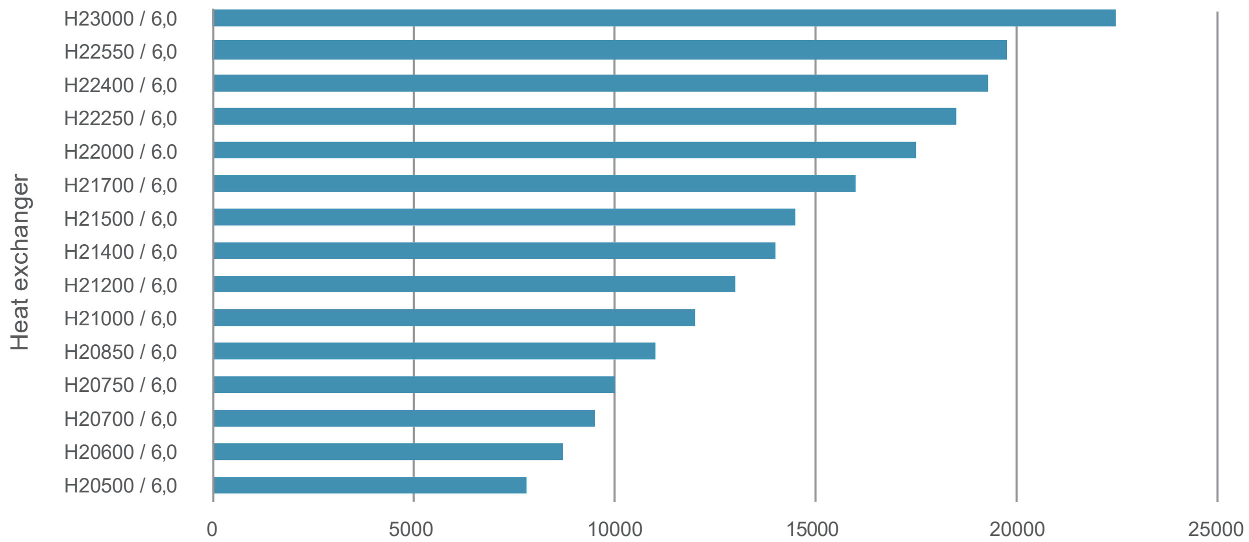


Figure 1. Maximum airflow at 250 Pa (1" WC) for different heat exchanger sizes at 1000mm heat exchanger width.

When the correct size of plate heat exchanger is determined, there are a number of options to choose such as:

- Integrated by-pass section
- Damper
- Epoxy coated aluminum plates
- Painted framework
- Sealant material for higher temperatures
- Different corner profiles
- Etc.

In the final selection price versus performance can be evaluated.

1.2. Useful Terms

Since we at Heatex are mostly concerned with air-to-air heat exchangers for ventilation or cooling applications, some useful technical notions will be described.

Term	Description
Exhaust air	This is the used air, mostly the hot air stream, and to save energy the heat of this air can be used to heat the fresh air (supply air) that will replace the exhaust air. **IMPORTANT:** Please note definition of Nm³/h (SCFM) and m³/h (CFM). Mostly airflows are given as Nm³/h or m³/h or per minute or per second instead of per hour. The "N" stands for normal and refers to the normal conditions of 1bar (1 atm) and 20°C (68°F).
Supply air	This is the fresh air, mostly the cold air stream, that will replace the exhaust air and that will be heated from the exhaust air.
Relative humidity	This is the amount of water the air contains in relation to the maximum possible at the actual temperature and pressure. The maximum possible amount of water will vary with the air temperature.
Moisture content	This is the amount of water the air is carrying in absolute terms, that is kg or pounds of water per kg or pounds of dry air.

Term	Description
Efficiency or effectiveness	Temperature efficiency of the heat exchanger. One of the most important ways to measure how well a heat exchanger performs is to look at the temperature efficiency of the exchanger. The efficiency on the hot side of the exchanger is defined as: $$\eta = \frac{t_{h, in} - t_{h, out}}{t_{h, in} - t_{c, in}}$$ *Definition of efficiency on the hot side. (EQ 1.1)* The efficiency on the cold side of the exchanger is defined as: $$\eta = \frac{t_{c, out} - t_{c, in}}{t_{h, in} - t_{c, in}}$$ *Definition of efficiency on the cold side. (EQ 1.2)* η – efficiency t – temperature (°C) c – cold side h – hot side in – into the exchanger out – out from the exchanger When the fluid flows (actually the mass flow multiplied with the specific heat) are equal on both sides the efficiency will also be equal on both sides. As you can see the efficiency tells you, how much of the maximum available temperature difference (the denominator) you can utilize in the heat exchanger.
Pressure drop	The price you have to pay for the heat transfer is the pressure drop in the heat exchanger. The pressure drop is most easily described as friction between the fluid and the wall surface in the heat exchanger and must be overcome by using a fan or a pump to force the fluid through the exchanger channels. Normally the pressure drop is given in Pa or inch water column.
Transferred heat or power	When the temperatures or efficiencies and the flows are known it is easy to calculate the amount of heat that is transferred from the hot to the cold side. On the hot side the amount of heat is: $$q_{hot} = \rho \dot{V} c_p (t_{h, in} - t_{h, out})$$ *Calculation of transferred heat (EQ 1.3)* q – is the amount of heat transferred (W) V – is air volume flow (m^3/s) r – is fluid density (kg/m^3) cp – is specific heat of fluid (J/kg°C) t – is temperature (°C). The same relation is valid for the cold side and they must also be equal since no heat is created or disappears. $$q_{cold} = \rho \dot{V} c_p (t_{c, in} - t_{c, out})$$ *Calculation of transferred heat (EQ 1.4)*

Table 2. Useful terms.

2. DEFINITION OF PRESSURE DIFFERENCES

The pressure difference that each individual plate in the heat exchanger experiences must never be so high that the plate will be permanently deformed (i.e. the stress in the plate may never in any point exceed the yield stress of the material). This means that the maximum pressure difference between the exhaust side and the supply side or the pressure difference between either side and the outside of the heat exchanger must never exceed a given maximum value that varies for different heat exchanger models.

Consider the following two examples:

Example 1:

The exhaust side has a fan that sucks air through the heat exchanger and the pressure entering the heat exchanger is –400 Pa (compared to atmospheric pressure). Pressure drop in the heat exchanger is 320 Pa so the pressure at the exhaust exit side is –720 Pa (- 400-320).

On the supply side, there is a fan before the heat exchanger pressing the air through the exchanger. Pressure at the inlet on the supply side is +840 Pa and the pressure drop in the heat exchanger is 265 Pa so on the supply exit side the pressure is +575 Pa (840-265).

The maximum pressure difference at steady state and with both fans running is in this case 1560 Pa (+840-(-720)). Please observe that at zero flow the fans will deliver a pressure that can be much higher than in the design point and if the fans are allowed to start against closed dampers the heat exchanger may be submitted to pressures that are high enough to cause permanent damage of the heat exchanger.

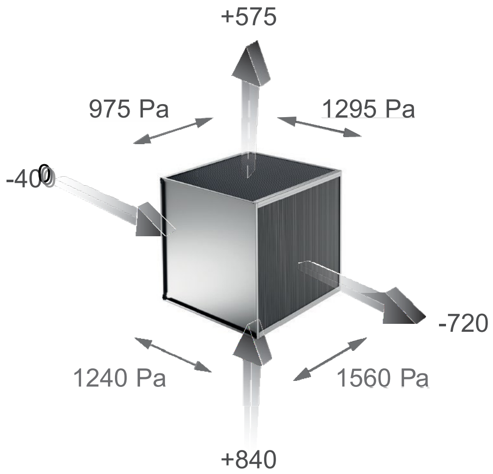


Figure 2. Pressure differences in Example 1.

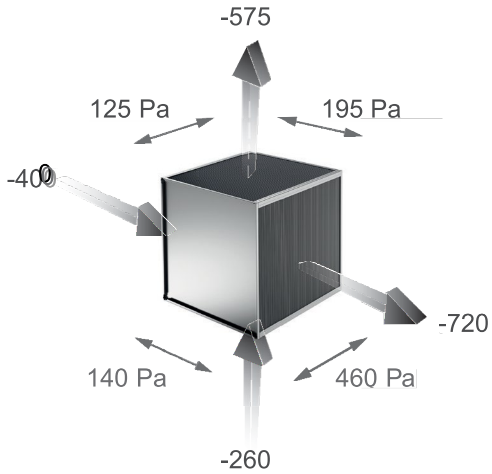


Figure 3. Pressure differences in Example 2.

Example 2:

In the following example, both exhaust and supply side have fans that suck the air through the exchanger:

The exhaust side pressure entering the heat exchanger is –400 Pa (compared to atmospheric pressure). Pressure drop in the heat exchanger is 320 Pa so the pressure at the exhaust exit side is –720 Pa (-400-320).

On the supply side pressure at the inlet on the supply side is -260 Pa and the pressure drop in the heat exchanger is 265 Pa so on the supply exit side the pressure is -525 Pa (-260-265).

The maximum pressure difference at steady state and with both fans running is now 460 Pa (-260-(-720)) but with only the exhaust fan running the maximum pressure difference is 720 Pa (0-720) compared to ambient pressure.

The same comment as in Example 1 about starting fans against closed dampers is valid also here but the maximum peak pressure difference value will be higher with one sucking and one fan pressing air through the heat exchanger compared to two sucking (or two fans pressing) air through the exchanger.

All pressure differences across the heat exchanger plates will cause the channels to deform. Small pressure differences of a few hundred Pascal's will hardly be measurable but at higher pressure differences the channel with the relatively higher pressure will expand (pressure drop will decrease) and the channel with the lower pressure will contract (pressure drop will increase).

Calculated values of pressure drop in the heat exchanger are always presented at zero pressure difference. This is in accordance with the European norm EN 308 and its subdocuments which state that pressure difference shall be zero and that velocity and temperature profiles entering the heat exchanger shall be uniform. In Heatex Select the effect of pressure differences can be calculated if a differential pressure is entered.

3. ALLOWED TEMPERATURES

Standard sealant material on all aluminum (and epoxy-coated aluminum) heat exchangers is a silicone free sealant. This can be used for temperatures up to 90°C (190°F). As an option, silicone-based sealant, which can be used up to 200°C (390°F), can be delivered at a price increase.

Please observe that silicone may never be used in connection with paint spray booths or with cooling of electronics because this might cause damage to components in the vented area.

For applications with higher air temperatures than 90°C (190°F) silicone-based sealant is used. However, the hot-melt glue in the folding is omitted since this would melt at above 90°C (190°F) temperatures. Therefore, the air leakage will be higher for heat exchangers built for higher temperatures than 90°C (190°F).

4. CONDENSATION IN HEAT EXCHANGERS

4.1. Condensation

Condensation is a phenomenon that takes place when an airstream containing water vapor is cooled down to the condensation temperature. At atmospheric pressure, the condensation temperature depends on air temperature and water content of the air (relative humidity or absolute moisture content).

As an example, the condensation temperature is given below for a few examples.

Temperature	Relative Humidity	Absolute Moisture (kg or lbs water/kg or lbs dry air)	Condensation Temp
20°C (68°F)	40%	0.0059 kg (0.0130 lbs)	6.0°C (42.8°F)
20°C (68°F)	20%	0.0029 kg (0.0064 lbs)	-3.6°C (25.5°F)
40°C (104°F)	20%	0.0093 kg (0.0205 lbs)	12.8°C (55.0°F)
100°C (212°F)	10%	0.0701 kg (0.1545 lbs)	46.1°C (114.9°F)

Table 3. Condensation temperature examples.

The first case above is a rather common value for the exhaust air condition, which means that at 50% heat exchanger efficiency, condensation will start at supply air temperatures of -8°C (18°F) (and at higher efficiencies, the condensation will take place for higher supply air temperatures).

From a heat transfer point of view, condensation will increase the supply air efficiency in wintertime because the latent heat that is released when water vapor condenses into liquid water will always increase the supply air temperature and thus improve the efficiency on the supply side. The exhaust side efficiency is then also lower than without condensation.

In the calculation program Heatex Select, condensation is taken into account in the performance calculation and the amount of condensing water is calculated. The calculations are limited to moisture contents of about 0.15 kg (0.33 lbs) water per kg (lbs) of dry air. This is a very large amount of water in the air, corresponding to about 60°C

(140°F) and 100% RH. Heavy condensation may cause a moderate increase in pressure drop on the exhaust side of the plate heat exchanger.

4.2. Design Guidelines

It is important during the design of the unit to take condensation into account. The plate heat exchanger should be oriented so that the condensing water easily can flow downward and means to collect the water and to drain it out from the unit should also exist.

At air velocities below about 3 m/s the water will not be carried by the airstream and this should be taken into account when designing an air handling unit if it is unacceptable that water is carried along by the airstream.

If it is desired to condense as much water as possible from the warm airstream then this air stream should move upwards but the air velocity must of course be lower than 3 m/s (9.843 ft/s). This is however not recommended if there is extremely much water in the air because if the water will block part of the channel the fans may start to pulsate. A downward flow will work in the same direction as gravity at all air velocities and is the best way to make sure the water leaves the heat exchanger.

Should there be a lot of condensation in the heat exchanger limestone and other contaminants may deposit on the surfaces and this will in time influence the performance of the exchanger, so provisions should be made to have access for cleaning.

In general, exhaust air containing corrosive vapors in moderate concentrations will not damage the heat exchanger surfaces unless condensation occurs. Even if during normal running no condensation will take place it can happen during start up or shut down of the unit and it is therefore important to vent out the unit thoroughly when it has been closed down.

5. MATERIALS AND CORROSION RESISTANCE

Heatex heat exchangers of type H2, H, P, T, M, O, E, EV, EQ and EN are manufactured in aluminum or epoxy coated aluminum.

The aluminum plate heat exchangers have end plates made of Aluzinc or aluminum depending of size. Corner profiles are made of aluminum. Rotor casings are made in robust Aluzinc material.

Stainless heat exchangers of type Z are manufactured in SS 316L (acid resistant). Framework of these heat exchangers are also made of stainless steel.

For special applications where there is a high risk of corrosion of the aluminum, for example in swimming pool environments with chlorine present, we can deliver epoxy coated exchangers with a painted framework that protects the corner profiles and the end plates from corrosion and we can also seal the cut edges of the epoxy coated plates with a coating.

NOTE! Corrosion resistance in consideration to used material.

5.1. Corrosion Resistance

Table 4 is a guide for choosing material when different substances are present in the airstream. We recommend that when possible, actual tests are made to verify that the chosen material will work in the real application.

The information in Table 4 is accurate to the best of our knowledge and experience but no guarantee is expressed nor implied in application or services over which we have no control.

Resistance to fumes at normal temperatures				
A=Excellent	B=Good	C=Fair	D=Poor	*=No Information

Substance	Formula	Aluminum	Epoxy Coated Aluminum	Stainless Steel 316L	MS Polymer
Acetic Acid	CH_3COOH	A	A	A	C
Acetone	C_3H_6O	A	A	A	C
Ammonium Hydroxide	NH_4OH	D	A	A	B
Ammonium Sulfate	$(NH_4)_2SO_4$	C	A	A	B
Bakery Vapors		A	A	A	A
Beer		A	A	A	C
Benzene	C_6H_6	A	*	A	*
Boric Acid	H_3BO_3	A	A	A	*
Calcium Chloride	$CaCl_2$	B	A	C	B
Carbon Dioxide	CO_2	A	A	A	A
Carbon Tetrachloride	CCl_4	B	*	C	D
Carbonic Acid	H_2CO_3	A	A	A	*
Chlorine, water		C	A	C	B
Chloroform	$CHCl_3$	*	*	A	D
Chromic Acid	CrO_3	B	B	B	D
Citric Acid	$C_6H_8O_7$	B	A	A	*
Copper Cyanide	CuCN	D	*	*	*
Creosote		*	*	*	*
Diesel Oil		A	A	A	D
Ethyl Alcohol	C_2H_5OH	A	A	A	D
Ethylene Dichloride	$C_2H_4Cl_2$	*	*	*	*
Fatty Acids		B	A	A	*
Ferric Chloride	$FeCl_3$	D	A	*	*
Fluorine Gas	F_2	D	*	D	*
Formaldehyde	CH_2O	*	A	A	*
Fruit Vapors		A	A	A	A
Fuel Oil		A	A	A	B
Gasoline		A	A	A	*
Glycerin	$C_3H_8O_3$	A	*	A	C
Glycol	$C_2H_6O_2$	A	*	A	*
Hydrochloric Acid	HCl	D	A	D	D
Hydrocyanic Acid	HCN	*	*	C	*
Hydrofluoric Acid	HF	D	A	D	*
Hydrogen Peroxide	H_2O_2	C	B	A	D
Hydrogen Sulfide	H_2S	D	A	B	D
Jet Fuel		A	A	A	D
Kerosene		A	A	A	D

Substance	Formula	Aluminum	Epoxy Coated Aluminum	Stainless Steel 316L	MS Polymer
Lactic Acid	$CH_3CHOHCOOH$	C	A	A	C
Lube Oils		A	A	A	*
Mercury	Hg	*	*	*	*
Milk		A	A	A	B
Mineral Thinner		A	*	A	*
Molasses		A	A	A	*
Nitric Acid	HNO_3	B	*	A	D
Oils & Fats		B	A	A	B
Oleic Acid	$CH_3(CH_2)_7CHCH(CH_2)_7COOH$	B	*	*	*
Oxalic Acid	$C_2Cl_2O_2$	C	*	C	D
Petroleum Oils		A	A	A	C
Phosphoric Acid	H_3PO_4	*	A	A	B
Photographic Chemicals		*	B	A	*
Potassium Permanganate	$KMnO_4$	*	*	A	*
Silver Cyanide	AgCN	*	*	*	*
Soaps		C	A	A	B
Sodium Hydroxide	NaOH	D	B	A	D
Sodium Hypochlorite	ClONa	D	B	C	D
Stearic acid	$C_{18}H_{36}O_2$	B	A	A	*
Sulfur Dioxide	SO_2	D	D	A	*
Sulfuric Acid	H_2SO_4	C	B	A	D
Sulfurous Acid	H_3SO_3	C	A	A	*
Syrups		A	A	A	B
Tannic Acid	$C_{76}H_{52}O_{46}$	C	A	A	*
Tetrahydrofuran	C_4H_8O	*	*	A	*
Toluene	C_7H_8	A	A	A	*
Tricresyl phosphate	$(CH_3C_6H4O)_3PO$	B	*	A	*
Turpentine		A	B	A	*
Urine		D	B	A	C
Vegetable Oils		A	A	A	B
Vegetable Vapors		A	A	A	A
Vinegar		D	A	A	*
Vinyl Acetate	$C_4H_6O_2$	*	*	A	*
Water, Fresh		A	A	A	B
Water, salt		D	A	A	B
Whiskey		A	A	A	C
Wine		*	A	A	C
Xylene	C_8H_{10}	A	*	A	*
Zinc Sulfate	$ZnSO_4$	D	A	B	*

Table 4. Corrosion resistance table.

5.2. Aluminum Material Standard

Alloy	8006/8009/8011/8111/1200
Temper	H00/H19

5.3. Epoxy Coated Aluminum

Covering Characteristics

Epoxy-phenolic gold color paint	
No toxic organic paint, as declared from Paint Producers, ”SUITABLE FOR FOOD CONTACT” as for Italian ”Ministry Decree”, ”D.M. 220” of the 26.04.93 (issued in accordance with EEC Directives)	
Total grammage per side	6 +/- 1 gr/m^2 corresponding to 5 +/- 1 microns

Corrosion-Resistance Tests

Salt-mist environment (salt spray) ASTM B117 (NaCl 5% at 35°C (95°F))	500 Hrs, no changes on the coating
Hot-wet environment ASTM 2247 (100% r.h at 38°C (100°F))	Tested for 1500 Hrs, without any remarkable variation of coating.

Mechanical Characteristics of the Paint

Pencil hardness (KOH-I-NOOR)	H
M.E.K. Resistance	50 double passing
Bending flexibility (ECCA T7)	OT without adhesion loss
Indentation, ”cupping test”, acc. EN 13523-6	No paint detachment before metal support breaking (aluminum)

Other Characteristics

1.1.1 Trichloroethane resistance	No paint detachment
Resistance to pressing lubricant	Good
Resistance to thermal shock (according to AICC N 13)	No alteration

NOTE! Epoxy coatings are not UV resistant. Epoxy coated surfaces should therefore never be exposed to sunlight, neither in installations nor during storage.

6. HEAT EXCHANGERS IN SPECIAL APPLICATIONS

6.1. Hygienic applications

Heatex Model H, H2, P, Model E and dampers have been tested and approved for hygienic applications by external institute. The requirements set by of VDI 6022, page 1, VDI 3803 page 1, SWKI 104-01, ÖNORM H6021 have been fulfilled by both the plate and rotor heat exchangers. Rotor heat exchangers also fulfill EN 13779 and plate heat exchanger also fulfill hospital related standards; DIN 1946-4, ÖNORM H6020 and SWKI 105.

Dampers fulfill the same above standards as plate heat exchangers.

Benefits of Using Model H and H2 in Hygienic Applications

- Model H, H2 has a corrugated surface that creates high turbulence and thus a high heat transfer rate in the heat exchanger channels. The corrugation is designed in such a way that it is self-cleaning i.e. no “dead zones” where dirt can accumulate.

- Due to the high heat transfer rate of the plates it is possible to have a bigger plate distance for a given heat exchanger efficiency compared with other plate designs. This bigger plate distance makes it easier to inspect the heat exchanger and should it for some reason be necessary to clean the heat exchanger the access is better.

6.2. Plate heat exchangers in ATEX environment

Heatex suggest using aluminium plate heat exchanger in ATEX environment. These allow for low electrical resistance and thus any static electricity due to the air flow is removed via the material. Heatex has also established a test protocol for plate heat exchangers to ensure low resistance between plates and gables to minimize the risk of static electricity building up. Our recommended product options are aluminium plates, aluzinc gables and the established test procedure with protocol. Contact sales or sales support for this specific option. Heatex do not recommend epoxy plates due to the insulating properties of the epoxy.

7. SUPPORT

For information or questions, please visit heatex.com or call customer support.

PLATE HEAT EXCHANGERS

8. DESIGN GUIDELINES

It is very important to be aware of that the performance (efficiency, pressure drop) that is calculated for an air-to-air plate heat exchanger as a component is valid under the following conditions:

- The velocity profiles entering the heat exchanger should be completely even, i.e. the mass flows must be the same in all parts of the heat exchanger.
- The temperature profiles entering the heat exchanger should also be completely even.

These are the only realistic conditions for which a general calculation of air-to-air plate heat exchangers can be based upon. It also makes it possible to compare the performance of different exchangers in a correct way.

NOTE! Deviations from EN 308 air flow characteristics will reduce the performance of the heat exchanger.

All deviations from these conditions will reduce the heat exchangers efficiency and it is therefore very important to take this into account, as far as it is possible, when making the design of the air handling unit.

A technical correct result considering given effects due to uneven velocity and/or temperature over the exchanger can only be evaluated when the corresponding profile is known.

An even velocity distribution is best achieved by the following:

- Avoid sharp bends immediately before and after the heat exchanger.
- Place the fans on the exit side of the heat exchanger so they are sucking air through the exchanger.
- If the pressure drop in the heat exchanger is very low then a more even air distribution can be achieved by placing a filter (or another restriction) that creates a pressure drop just before the heat exchanger.

For a diagonally mounted heat exchanger (which in itself will create some none uniformity of the airflows), it is very important to have enough room above and below the heat exchanger so that the air flows have a chance to distribute evenly and perpendicular to the inlets. A recommended distance to make sure that the heat exchanger is not affected by a too narrow enclosure is to have half the diagonal dimension of the heat exchanger between the heat exchanger corner and the top or bottom wall respectively (i.e. the internal height of the enclosure should be twice the heat exchanger diagonal).

Should it not be possible for different reasons to allow enough space around the heat exchanger and/or a favorable location of the fans, a performance reduction (i.e. lower efficiency and higher pressure drop) could be the result. The size of the reduction will depend on several parameters and their interacting with each other and may be calculated using CFD methods or estimated from measurements in tests.

It is in most cases possible to reclaim some of the performance loss by introducing sheet metal guides or other arrangements in the unit, which will deflect and distribute the airflows more uniformly at the heat exchanger inlets.

Other things to take into account in the design of an air handling unit (AHU) are for instance:

Condensation. Where it is important to make sure that the condensate can leave the heat exchanger without restricting the airflow. Completely horizontal plates should be avoided.

Leakage. Air that is by-passing the heat exchanger or leakage between the two sides in the heat exchanger will reduce performance and may also carry particles, odors, and condensate between the two sides. A good sealing between the heat exchanger frame and the air handling unit is very important just as it is important that the internal leakage in the heat exchanger is as small as possible.

With a special manufacturing process, plate heat exchangers can reach a certain level of water tightness. This process can be used for heat exchangers in indirect evaporative cooling (IEC) applications.

9. ALLOWED PRESSURE DIFFERENCES

The following maximum allowed pressure differences apply to the different heat exchangers:

H200, H300, T and M: 700 Pa (2.8" WC)

Model H, all other sizes: 1800 Pa (7.2" WC)

Model H2 1200 and 2400:
- Plate spacing 2.0: 1500 Pa (6.0" WC)
- Plate spacing 2.5: 1600 Pa (6.4" WC)
- Plate spacing 2.7-3.0: 1700 Pa (6.8" WC)
- Plate spacing ≥4.0: >3000 Pa (>12" WC)

All other Model H2 sizes:
- Plate spacing 2.0-2.2: 1800 Pa (7.2" WC)
- Plate spacing 2.5-2.8: 2000 Pa (8.0" WC)
- Plate spacing 3.0: 2200 Pa (8.8" WC)
- Plate spacing ≥4.0: >3000 Pa (>12" WC)

Model P all sizes: 3800 Pa (15.3" WC)

Model Z all sizes: 4000 Pa (16.1" WC)

The above pressure differences are the maximum values the heat exchangers can manage without permanent deformation of the channels. The pressure drop in the channels will however be influenced by pressure differences below these values. Heatex Select can calculate this effect if the differential pressure is entered.

9.1. Influence of Pressure Difference on Pressure Loss in Heat Exchangers

The pressure loss in a heat exchanger channel mainly depends on the air velocity in the channel and the channel geometry. If the plates (channel walls) in the heat exchanger is submitted to a differential pressure (i.e. the pressure is different in the exhaust and supply channels) then the plates will deflect. The amount of deflection will depend on plate material and material thickness, plate design, on how the plates are supported against each other and of course on the magnitude of the differential pressure.

When there is enough pressure difference for the plates to deflect, one channel will be narrower, and thus the pressure loss in that channel will increase, and the other channel will be wider with a lower pressure loss as a result.

With the diagrams below the effect on the H-series, size 600 and larger (Figure 1), H2-series (Figure 2 and 3) P-series (Figure 4) and Z-series (Figure 5) heat exchangers may be predicted. The diagram is built on a few measurements only, wherefrom general assumptions have been made.

The diagram is not to be understood as technical proven in detail but gives a rough general idea of the impact of differential pressures.

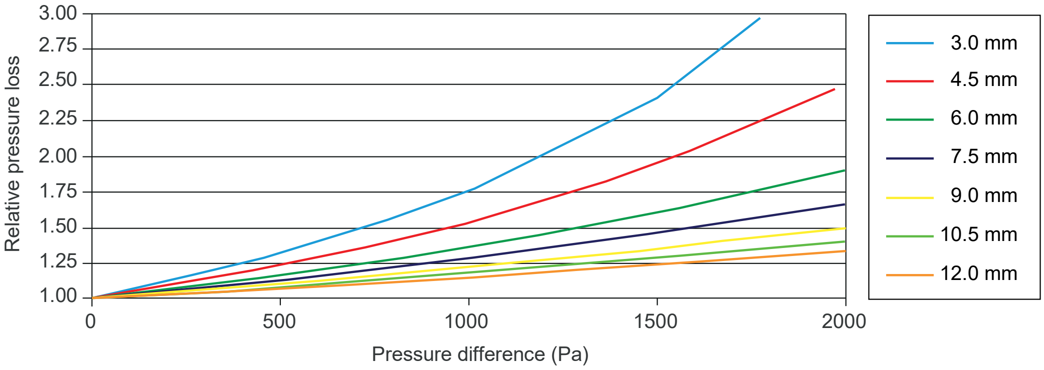


Figure 1. Effect of pressure difference on pressure loss, Model H.

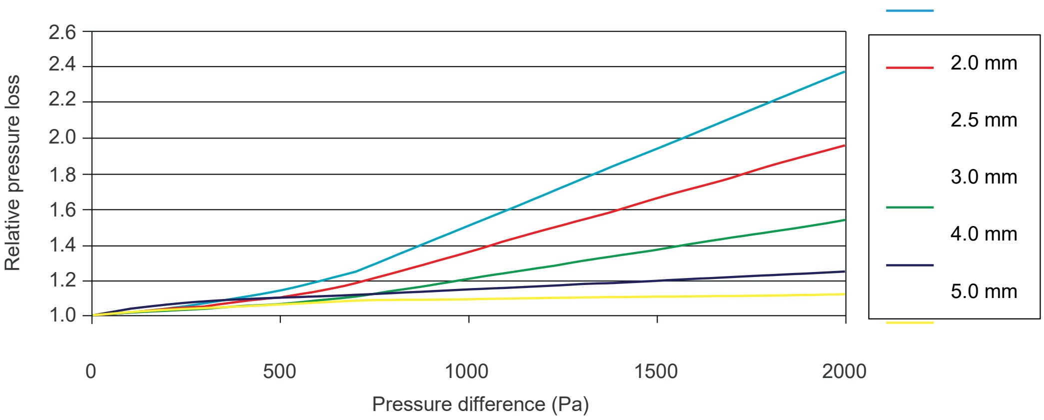


Figure 2. Effect of pressure difference on pressure loss, Model H2 (except 1200 and 2400).

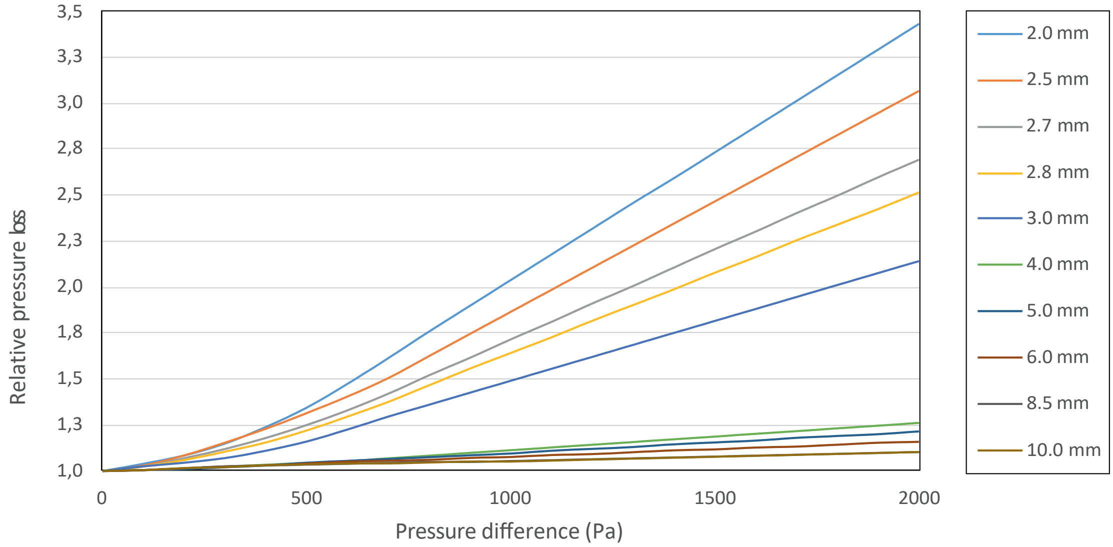


Figure 3. Effect of pressure difference on pressure loss, Model H2 1200 and 2400.

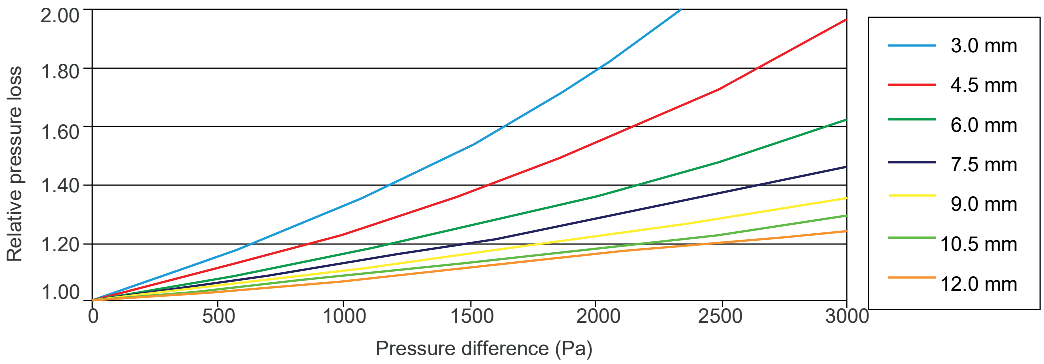


Figure 4. Effect of pressure difference on pressure loss, Model P.

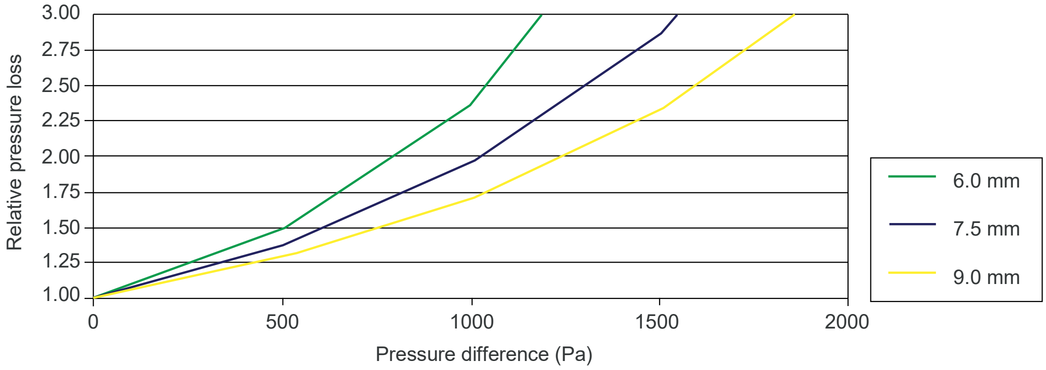


Figure 5. Effect of pressure difference on pressure loss, Model Z.

Heatex Select can simulate the effect of a differential pressure.

For normal applications with around 200 Pa (0.8" WC) differential pressure the effect appears to be only a few percent, and do not necessary need any further adjustments. However, at high differential pressures the calculated pressure drops should be adjusted.

10. FREEZING IN PLATE HEAT EXCHANGERS

Freezing will occur if the exhaust air is cooled down to the condensation temperature so that condensation takes place and the condensing water then comes into contact with a plate surface that has a temperature below 0°C (32°F).

The condensing temperature of the exhaust air depends on the temperature and relative humidity of the air when it enters the heat exchanger. Air containing a lot of water will have a high condensing temperature.

In a crossflow heat exchanger, the temperature distribution of the exiting air is uneven, and there will be one "warm" and one "cold" corner of the exchanger.

If freezing occurs, it will start in the cold corner and the exhaust airflow will then gradually decrease because of the blocking of the exhaust channel. If nothing is done this can continue until the exhaust side is completely blocked.

The ice (or snow) will affect operation and might also damage the plates. Therefore, freezing should be prevented, see chapter 10.1.

Since the heat exchanger plate will have a temperature that is in between the exhaust air temperature and the supply air temperature on each side of the plate, freezing will not start when the outside air temperature is 0°C (32°F) but at a lower outside air temperature. As a rough rule of thumb, for freezing to take place the temperature of the supply air must in most cases be below approximately -8°C (18°F) (equal supply and exhaust air flows) and the exhaust air must also contain enough water so that condensation will start. The selection software Heatex Select will give an indication of at which outdoor temperature freezing in the heat exchanger may start to take place.

10.1. Prevention from Freezing

One of the most common ways to prevent freezing is by totally bypassing the cold supply air when it is below a certain temperature (for example, -5°C (23°F)). Another way is to by-pass only part of the cold air stream, just enough so that freezing does not start. By mechanically blocking part of the heat exchanger the flow in the cold corner can be reduced and thus prevent freezing. Another common way is to use a heater to heat the supply air before it is entering the heat exchanger.

It should be noted that a higher efficiency of the exchanger will increase the amount of condensing water and will also lower the temperatures in the exchanger and thus the freezing will start earlier compared to a heat exchanger with lower efficiency. Therefore, it is not always the case that more energy can be recovered with an exchanger with high efficiency than with one with a lower efficiency if the average over a whole year is taken into account.

11. LEAKAGE OF PLATE HEAT EXCHANGERS

The exchanger will always have some small leakage so the design of the air-handling unit should be made in such a way that leakage will take place from the clean side to the less clean side. This is achieved by making sure that the pressure on the clean side is higher than on the other side.

If it is unacceptable with water leaking over to the supply side the design of the air handling unit must be made in such a way that there always will be a higher pressure on the supply side than on the exhaust side.

As a standard Heatex puts glue in the foldings of all plate heat exchangers. This results in a heat exchanger that has very low internal leakage, maximum 0.1% of the nominal airflow at a pressure difference of 400 Pa (1.6" WC) resp. 250 Pa (1" WC) for small sizes. Exceptions to this are H0200, H0300, H0415 and Model T where the maximum leakage rate is 1% of the nominal airflow. For lower pressure drops, the leakage will be smaller. This is probably the tightest air-to-air plate heat exchanger available as a standard. Model M-type exchangers have around 0.1% of the nominal airflow leakage at a maximum pressure difference of 700 Pa (2.8"WC).

For applications at higher temperatures than 90°C (190°F) (i.e. when silicone sealant is used) the glue in the foldings is omitted since it will melt at these temperatures. The leakage will nevertheless be below 1% of the nominal airflow at a pressure difference of 400 Pa (1.6" WC) resp. 250 Pa (1" WC) for small sizes.

Should an even tighter exchanger be required we can as an option offer an extra sealant that is achieved by adding a layer of lacquer, thereby coating all the joints. This will result in an extremely tight heat exchanger, suitable for applications where you find high humidity or direct water, such as adiabatic cooling and swimming pool areas. Please observe the above comment that pressure should be highest on the side where no water is acceptable so the leakage will take place in the right direction.

In general, statistical testing of leakage is performed. As an option you can have every single heat exchanger leakage tested and delivered with a leakage test protocol.

11.1. Sealant

Standard sealant material on all aluminum (and epoxy-coated aluminum) heat exchangers is a silicone free sealant. This can be used for air temperatures up to 90°C (190°F).

Other silicone-based sealant can be applied for higher air temperatures. Please observe that silicone-based sealant should not be used in connection with paint spray booths or with cooling of electronics because that will cause damage in the processes.

11.2. Sealant - Physical and Chemical Properties

Non-Silicone sealant

Type:	MS-hybrid polymer, 1-component	MS-hybrid polymer, 2-component
Colors:	Grey	Grey
Contains fungicide:	No	No
Consistency	Paste, thixotropic	Paste, thixotropic
Specific gravity:	approx. 1.50 kg/liter (12.52 lb/gal)	approx. 1.49 kg/liter (12.43 lb/gal)

Silicone sealant

Type:	Acetic curing 1-component silicone sealant
Colors:	Translucent
Contains fungicide:	No
Consistency	Paste, thixotropic
Specific gravity:	Approx. 1.04 kg/liter (8.68 lb/gal)

12. APPLICATIONS WITH HORIZONTAL HEAT EXCHANGER PLATES

Heatex Model H and H2 heat exchangers with corrugated surfaces have a very stable and light (weight) design. It is therefore possible to use Model H and H2 also for applications where the heat exchanger is mounted with the plates in a horizontal position.

The following restrictions regarding maximum module width must however be considered to fall below the maximum allowed vertical sag/deformation of 20mm:

Model H:

- For H0600 with plate distance 2.7 (0.106") and 3.0 mm (0.118") and for H0850 with plate distance 3.0 (0.118"), 3.5 (0.138") and 4.0 mm (0.157") a maximum module width of 800 mm (31.49") is recommended. Wider applications may be constructed using two (or more) exchanger blocks.
- For all other plate distances (smaller and bigger) full maximum module width is applicable.

Model H2:

Maximum module width for H2 is not dependent of plate size, except for H2 1200/2400 which has slightly different limits.

Channel height, h [mm]:	Channel height, h [inch]:	Max module width H2 1200 & 2400 [mm/inch]	Max module width all other H2 [mm/inch]
1.9 ≤ h < 2.5	0.075 ≤ h < 0.098	NOT ALLOWED	500/19.69
2.5 ≤ h < 3.0	0.098 ≤ h < 0.118	500/19.69	700/27.56
3.0 ≤ h < 3.5	0.118 ≤ h < 0.138	700/27.56	1000/39.37
3.5 ≤ h	0.138 ≤ h	1200/47.24	1200/47.24

Model P has no restrictions for horizontal applications.

If there is a risk for condensation, try to avoid horizontal plates. A large amount of condensed water together with low airflows might lead to water accumulation and thus damage the heat exchanger and/or reduce the efficiency. Installing the heat exchanger with an inclination of just a few degrees will in most cases be enough to drain the condensate.

13. SOUND DAMPENING PLATE HEAT EXCHANGERS

A plate heat exchanger is often a good sound damper in a ventilation system. The dampening depends on heat exchanger size and plate distance. Below is a guide of the dampening effect at different frequencies. (Similar sound dampening levels also apply to H2 heat exchangers.)

Exchanger Plate size	Plate distances	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
200	2.1-2.7	1	2	2	3	3	3	4	4
300	1.8-5.0	1	2	2	3	3	3	4	4
415/425	3.3-6.5	1	2	2	3	4	4	4	4
490	3.3-5.0	1	2	2	4	4	5	6	6
600	2.7-6.0	2	4	4	6	7	8	9	9
600	7.5-12.0	1	2	2	4	4	5	5	5
700	2.0-6.0	2	4	4	6	6	8	9	9
750/800	3.3-6.0	2	5	5	7	8	10	11	11
750/800	7.5-12.0	1	2	2	4	4	5	6	6
850	3.0-6.5	2	5	5	7	8	10	11	11
850	8.0-9.5	1	2	2	4	4	5	6	6
1000	3.3-6.0	3	5	5	8	9	11	12	13
1000	7.5-12.0	2	4	4	6	7	8	9	9
1200	2.7-6.0	3	5	5	8	9	11	12	13
1200	7.5-12.0	2	5	5	7	8	10	12	12
1400	2.0-6	3	6	6	8	10	11	13	13
1500	3.3-6.0	3	6	6	9	10	11	13	13
1500	7.5-12.0	3	5	5	8	9	11	12	13
1700	3.0-6.5	3	6	6	9	10	11	13	13
1700	8.5-12.0	3	5	5	8	9	11	12	13
2000	3.3-6.0	3	7	7	10	11	14	15	15
2000	7.5-12.0	3	6	6	9	10	12	13	14
2250/2400/ 2550/3000	3.0-6.0	4	9	9	12	14	16	19	19
2250/2400/ 2550/3000	6.5-12.0	3	7	7	9	11	13	14	14

Table 1. Example: Sound dampening in dB at different frequencies.

14. HANDLING INSTRUCTIONS FOR PLATE HEAT EXCHANGERS

14.1. Lifting

Heat exchangers from Heatex are designed for an optimal function with a frame that allows high performance. Heat exchangers with a size that makes it necessary to use some kind of lifting device must be handled according to the picture below.

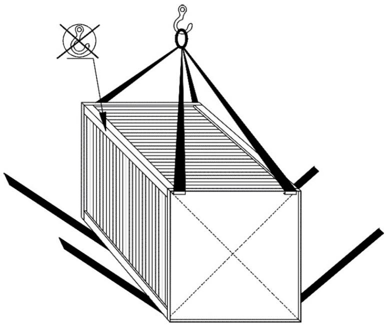


Figure 6. Recommended placement of slings.

14.2. Transportation

The heat exchangers should preferably be transported with the plates oriented in a vertical position. The plates are to be protected by cardboard or plastic wrapping during transportation. Make sure not to top-load in a way that can damage the plates and/or deform the framework.

14.3. Deformation

A framework that is not straight, irregular channels or any other deformation to the heat exchanger may seriously influence the performance of the heat exchanger.

14.4. Installation

If ducts shall be directly connected to the heat exchanger it is recommended that self-tapping screws or pop rivets are used. Make sure that the length is chosen so that the fastener does not penetrate the heat exchanger channels. In case of welding care must be taken not to melt or damage the sealant. The aluminum heat exchangers must never be submitted to larger pressure differences than those allowed during start-up or normal running.

15. MAINTENANCE AND CLEANING

15.1. General

All Heatex plate heat exchangers have been designed to prevent dirt from coming into contact with the heat transfer surfaces. Most of the dirt and pollutants in the air will just pass through the heat exchanger. Substances which have the highest risk of fouling the exchanger are sticky substances and fibers from, for example, dry tumblers.

From the heat exchanger point of view, it is preferable to use a filter before the exchanger to prevent dirt from depositing, but it is however not necessary except in a few special applications. The disadvantage of using filters is that they need to be changed regularly. There is also a hygienic risk because the filters will collect particles, which otherwise would leave the building (or process) with the exhaust airstream.

Experience has shown that the buildup of dirt in a heat exchanger is often limited to the first 50 mm (1.97”) in the exchanger, which simplifies cleaning. For normal ventilation applications, it is most of the time sufficient to clean the inlet and outlet with a brush.

For dirtier applications, compressed air or high-pressure water cleaning and disinfection may be necessary. For instructions regarding cleaning and disinfection, see below.

Please observe that high pressure cleaning must not be made directly against the plates and the pressure must be kept below 100 bar. Make sure that the plates do not deform or brake when removing dirt mechanically. Dampers have, when open, even larger channels/gaps than a plate heat exchanger. The risk for accumulating dust, particles etc. is thus even lower. If, for any reason, cleaning or disinfectant is needed it can be done in the same way as described below for plate heat exchangers.

15.2. Recommended Cleaning Products

The detergent recommended for cleaning is YES/Fairy. The detergent shall be sprayed on the heat exchanger with a low pressure sprayer. The detergent can be diluted with up to 75% water. YES/Fairy is available in grocery stores and can also be purchased through Heatex. Heatex article number: 42715.

The disinfectant recommended for disinfection is LIV +45. Do not dilute LIV +45 with water. LIV +45 is available for purchase through Heatex. Heatex article number: 42716.

Figure 7. YES/Fairy detergent.

Figure 8. LIV +45.

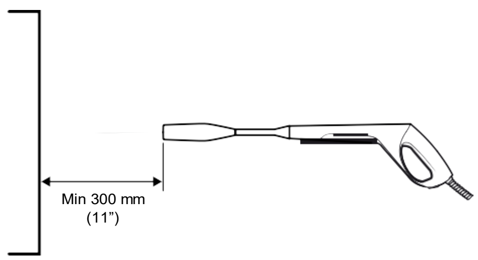
NOTE! The minimum space required for cleaning and disinfecting is 500 mm (20”).

15.3. Cleaning

The cleaning process consists of three steps. First, rinse the heat exchanger with water using a high-pressure cleaner to remove dust, particles, deposits etc. Then, use detergent to clean the heat exchanger. As a third step, remove the detergent with water. Make sure that the nozzle of the high-pressure cleaner is adjusted to a plain jet.

Plate Heat Exchanger Cleaning Procedure:

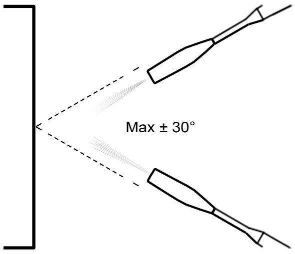
1. Place the nozzle at a distance of approximate 300 mm (11”) from the heat exchanger to not damage the plates.



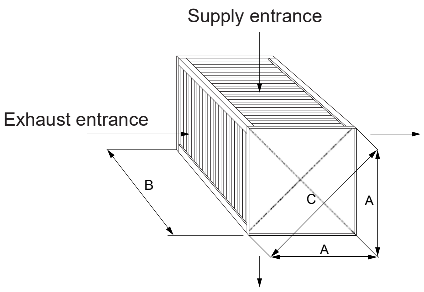
2. Have the nozzle adjusted to plane jet.

3. Clean the heat exchanger plates by spraying water into the area between the plates.

4. Vary the spray angle between + 30 and - 30 degrees from the openings at a distance of 300 mm (11”) from the entrance.



5. Repeat point 3 and 4 on one of each entrance.



6. Spray the heat exchanger with detergent (YES/Fairy detergent) with a low-pressure sprayer.
7. Repeat point 1-5 in order to remove all detergent.
8. Let the heat exchanger air dry.

15.4. Disinfection

The disinfection process consists of two steps. First, spray the heat exchanger with disinfectant LIV +45* and leave to dry. Then, rinse the heat exchanger with water using a high-pressure water cleaner. The disinfectant LIV +45 is used on both the plate and rotary heat exchangers. LIV +45 is used undiluted.

Plate Heat Exchanger Disinfection Procedure:

1. Spray the disinfectant into the heat exchanger at a distance of 50-100 mm (1.97-3.94”). Use the standard LIV +45 bottles with easy spray tap. If the big can (5L (1.32 gallons)) is used, fill up a standard spray bottle.
2. Spray both plates in every channel and spray into all four sides of the heat exchanger.
3. Let the heat exchanger air dry for 30 minutes.
4. Clean the heat exchanger in the same way as before (but without detergent) to assure all disinfectant has been removed.

*observe that LIV+45 contain alcohol which is flammable. Take precaution to avoid ignition.

16. DISPOSAL

Plate heat exchangers can consist of up to 98 % aluminum depending on size and configuration. Model Z are all stainless steel heat exchangers.

Different material such as Aluzinc, galvanized steel or painted steel may be used as gables.

Dampers can be attached to the heat exchanger and should be treated as aluminum waste. An actuator (damper motor) can be attached to the damper and should be treated as electrical waste.

16.1. Aluminum Plate Material

Heatex heat exchangers consist of two types of aluminum.

Epoxy coated (golden colored) marked with an E or pure aluminum marked with an A in the product code as the second or third letter.

Example:

HE/H2E/PE/TE/ME = Epoxy coated aluminum

HA/H2A/PA/TA/MA = Pure aluminum

16.2. Gables

Gables can be of aluminum or carbon steel and should be disposed as metal, either they are coated with Aluzinc, galvanized or painted. Local country regulations apply.

16.3. Glue

The glue used to hold the aluminum plates to the gable and corner profiles comply with combustible waste and can be sent with the aluminum waste and removed during fragmentation if needed.

ROTARY
HEAT EXCHANGERS

17. DESIGN CONSIDERATIONS

Compared to Plate Heat Exchangers (PHE), Rotary Heat Exchangers (RHE) exhibit several advantages and disadvantages and it is important to be aware of these so the optimal type is selected for a certain application and also that the respective characteristics are taken into account when the Air Handling Unit (AHU) is designed.

17.1. Advantages and Disadvantages with Rotary Heat Exchangers

The most important advantages compared to PHE's are:

- Higher temperature efficiency
- Possibility to transfer moisture
- Smaller volume (in particular less depth)
- Less risk of freezing

The disadvantages are:

- Much higher air leakage
- Requires maintenance due to moving parts
- Less hygienic

17.2. Calculated Performance

All heat and moisture transfer and pressure drop calculations are done with the actual heat exchanger geometry and based on correlations from scientifically well renowned sources such as *VDI Wärmeatlas and International Hand Book of Heat Exchanger Design*. This means that the calculations are made in accordance with the European norm EN 308 and its sub documents.

The accuracy and correctness of the calculated data has been proven in numerous tests performed at various independent accredited test institutes and Heatex rotary heat exchangers are approved by several different certifying bodies.

Testing and calculation of RHE performance can only be done with any accuracy when leakage is kept to a minimum and therefore the norms (EN308 for Eurovent certification and ARI 1060 for ARI certification) specifically state that conditions for testing and performance calculations are:

- Equal and uniform airflows, supply air leaving the rotor and exhaust air entering the rotor shall be equal.
- Zero pressure difference (static pressure difference between supply air immediately after the rotor and exhaust air immediately before the rotor must be between 0 and +20 Pa (0.08" WC)). At these conditions, the internal and external leakage can be kept at a minimum, which is necessary in order not to influence the performance data.

All measurements and performance calculations are based on this and any deviation may result in significantly different performance due to leakage.

There are also several other good reasons for designing the AHU with a low-pressure difference (see above) apart from the influence on performance. They are for example:

- Wear of sealant, bearings, drive system etc. will increase with high-pressure difference.
- Leakage will increase with high-pressure difference which apart from influence of performance will increase carry-over of odors and dirt to the clean side. The sealant is not designed for high pressure differences and will work much less efficient at high pressures.
- High pressure differences will put mechanical stress on the wheel and casing and depending on how the RHE is built into the AHU pressure can cause interference between the rotor wheel and the casing. The casing design is not strong enough to be used at high pressure differences without becoming deformed by the pressure.

Due to the above considerations, we have put a limit to maximum pressure drop and pressure difference. Pressure drop between inlet and outlet of rotor is recommended to be 100-200 Pa (0.4-0.8” WC) and absolute maximum is 300 Pa (1.2” WC) for rotors up to 1600 mm diameter and 250 Pa (1.0” WC) for larger diameters. Maximum allowed pressure difference is 600 Pa (2.4” WC) but recommended is as near 0 Pa as possible.

Just as for PHE’s applications with uneven air velocity or temperatures over the heat exchanger will adversely affect both calculated efficiency and pressure drop and are to be evaluated at given occasions. Uneven air distribution in the RHE can be caused by the following examples:

- Fans located close to the heat exchanger inlet.
- Fans located close to the heat exchanger outlet.
- Curved airflow before or after heat exchanger.
- Heat exchanger inlets shadowed by sheeting or other components.

An even velocity distribution is best achieved by the following:

- Avoid sharp bends immediately before and after the heat exchanger.
- Place the fans on the exit side of the heat exchanger so they are sucking air through the exchanger.
- Other things to take into account in the design of an AHU with a RHE are for instance: condensation and purge sector.

17.3. Casing Design

The standard casing is a built-in casing, which means that it has to be mounted and attached in the AHU (see specific documentation). The casing is adapted to the vertical or horizontal positioning and can handle both vertical and horizonal split of flows. The rotating heat exchangers can be equipped with the following options:

- Condensation tray
- Purge sector
- Cover plates
- Cable glands
- Inspections hatches
- Various drive solutions
- Different types of sealing systems

17.4. Condensation

In cases where there is a lot of condensation in a condensing (aluminum or epoxy coated) RHE it can occur that not all the water that has condensed will be picked up by the supply air. In that case, “free water” will come out of the rotor and a condensate tray for collecting the water should be installed. Large amounts of condensate can also affect the pressure drop through the rotor.

17.5. Purge Sector

A purge sector is used to minimize the amount of air that is carried over from the exhaust to the supply air due to the rotation of the wheel (air is trapped in the channels and moves with the rotation of the wheel). With well-adjusted brush sealants, a purge sector and a pressure difference of zero to +20 Pa (0.08" WC) and equal air mass flows the amount of internal leakage ("carry-over") can be less than 3% of the airflow. For all other conditions, the internal and external leakage will be higher.

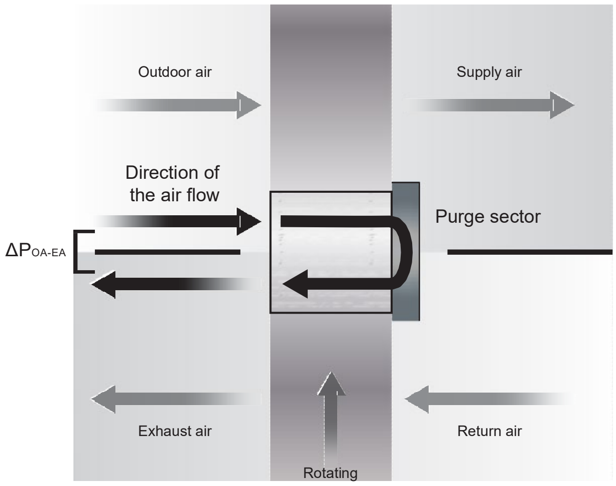


Figure 1. Description of purge sector's function.

The purge sector Heatex offer is covering 7-20 degrees (depending on model) of the wheel surface and for equal air flows and close to 0 Pa pressure difference the purge air flow will be 5/(360-5)/100=1.4% of the supply air flow. This means that for these conditions the supply air before the rotor will be 1.4% larger than after the rotor and since this purge air flow will end up on the exhaust side the exhaust air flow after the rotor will be 1.4% larger than before the rotor.

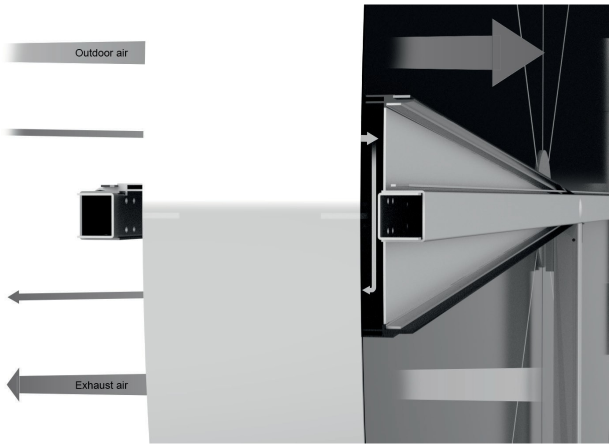


Figure 2. Purge sector angle.

For the purge sector to work properly the pressure difference between supply air immediately before the rotor and exhaust air immediately after the rotor should be somewhere between 200 Pa (0.8" WC) and 500 Pa (2" WC) at normal air flows. Fans should as always preferably be on the exit side (sucking air through the RHE) for both airsides. If the exhaust fan is before the rotor and the supply fan is after the rotor the purge sector will have a back flow, and in that case, the purge section should be removed.

In Heatex Select the airflows that actually participate in the heat and mass transfer should be used as input data (i.e. supply air leaving the rotor and exhaust air entering the rotor). The purge airflow does not affect the performance of the wheel but the calculation takes into account that 5 degrees (purge angle) of the total 360 degrees is used for the purge sector and not participating in the heat and mass transfer.

17.6. Actual Well Height

		Material			
Rotor product	**Well height**	**Aluminum**	**Hybrid**	**Silica-Gel**	**Molecular Sieve**
E/O/EQ/EV/EN	1.4	1.4 mm (0.055”)	1.4 mm (0.055”)	1.4 mm (0.055”)	1.4 mm (0.055”)
	1.6	1.6 mm (0.063”)	1.6 mm (0.063”)	1.6 mm (0.063”)	1.6 mm (0.063”)
	1.8	1.8 mm (0.071”)	1.8 mm (0.071”)	1.8 mm (0.071”)	1.8 mm (0.071”)
	2	2 mm (0.079”)	2 mm (0.079”)	2 mm (0.079”)	2 mm (0.079”)
	2.5	2.5 mm (0.098”)	2.5 mm (0.098”)	2.5 mm (0.098”)	2.5 mm (0.098”)

Table 1. Actual well heights.

The well height definition was standardized by the Eurovent organization and is defined as flat foil thickness plus total wave height (see picture below).

The well height is defined as flat foil thickness plus total wave height (see picture below).

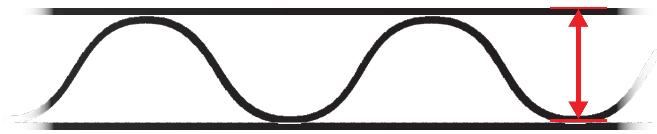


Figure 3. Well height definition.

17.7. Sound dampening rotor heat exchangers

A rotary heat exchanger can have a sound dampening effect in a ventilation system. Below is a guide of the dampening effect at different frequencies in the E, EQ and EN rotor matrix.

Matrix material	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Condensation	1	2	4	8	7	6	4	6
Adsorption	1	1	2	10	9	4	4	5

18. ADSORPTION MATERIALS

Adsorption materials are used in rotary heat exchangers due to their high moisture transfer capability. The two main types of adsorption materials used for moisture transfer in normal comfort ventilation applications are silica gel and molecular sieve.

Figures and data in this section are from SorbentSystems.com

18.1. Silica Gel

Silica gel is a partially dehydrated form of polymeric colloidal silicic acid. Silica gel has an amorphous micro-porous structure with a distribution of pore opening sizes of roughly 3-60 angstroms. These interconnected pores form a vast surface area that will attract and hold water by adsorption and capillary condensation, allowing silica gel to adsorb up to 40% of its weight in water. Silica gel is extremely efficient at temperatures below 25°C (77°F) (see Figure 4 and Figure 5) but will lose some of its adsorbing capacity as temperatures begin to rise (Figure 6). Much of silica gel’s popularity is due to its non-corrosive, nontoxic nature and its having received US government approval for use in food and drug packaging.

18.2. Molecular Sieve

Molecular sieves (also known as Synthetic Zeolite) adsorb moisture more strongly than silica gel. This can be seen by the high initial slope of the adsorption isotherm for molecular sieve as compared to the other desiccants (Figure 5). Where a very low relative humidity is required, molecular sieves are often the most economic desiccant because of their high adsorption capacity at low relative humidity. Also, molecular sieves will not give up moisture as readily as silica gel as temperatures rise (Figure 6).

Molecular sieve contains a uniform network of crystalline pores and empty adsorption cavities, which give it an internal adsorptive surface area of 700 to 800 m²/g (½ the total volume of the crystals). Molecular sieve can adsorb up to 25% of its weight in water. Because of its uniform structure, molecular sieve will not give up moisture as readily as silica gel as temperatures rise.

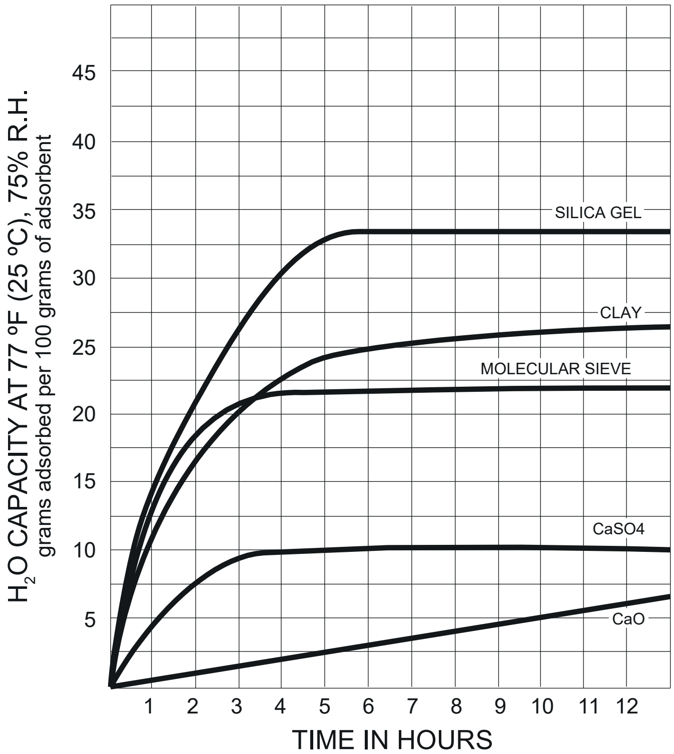


Figure 4. Adsorption rate (H2O) of various adsorbents.

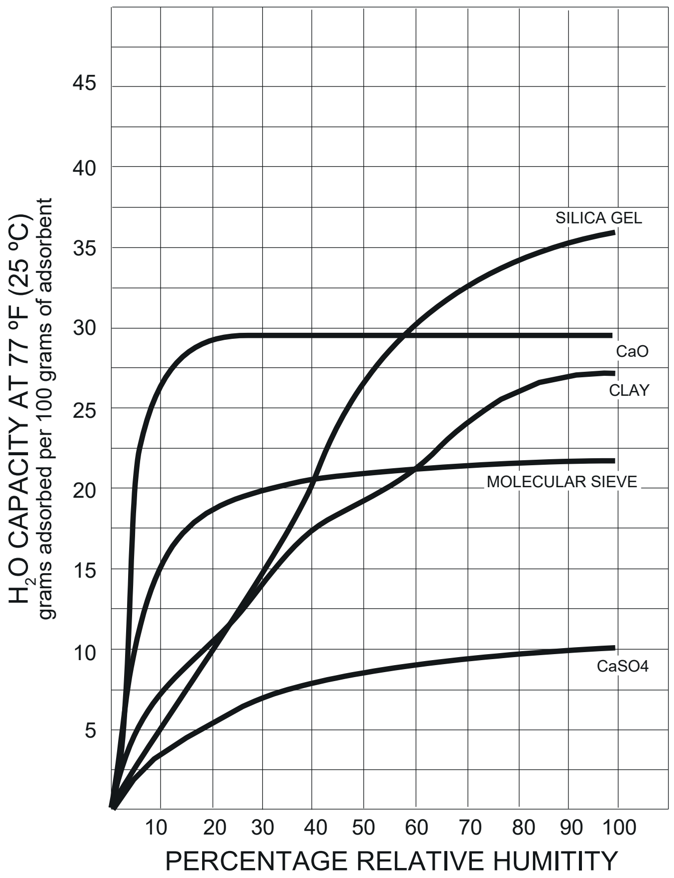


Figure 5. Equilibrium capacity (H2O) of various adsorbents.

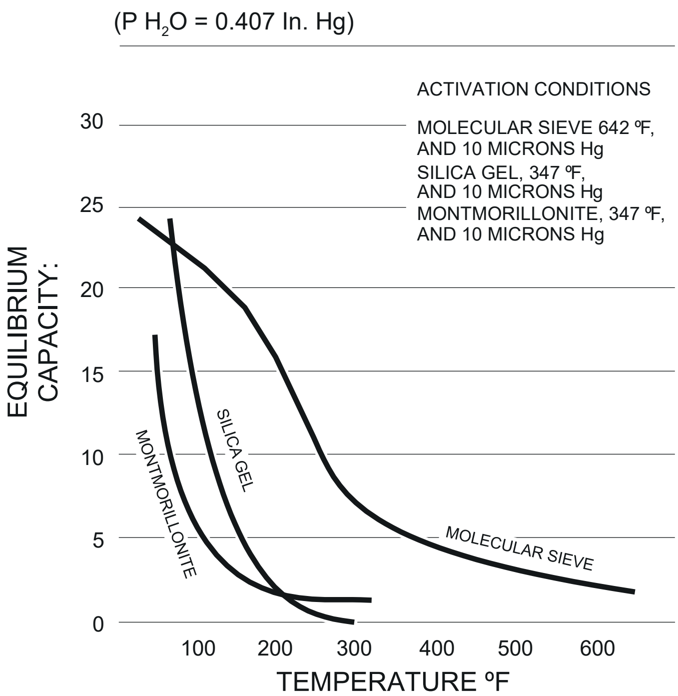


Figure 6. Equilibrium H2O capacity by temperature.

18.3. Comparison

From a moisture transfer point of view, silica gel has a higher capacity than molecular sieve at normally occurring outdoor temperatures and high relative humidity. Since the purpose of the comfort ventilation, where an adsorption rotor is the natural choice, is to precool and remove moisture from the warm supply air with high relative humidity (typical summer conditions in many Asian countries), silica gel is often the best alternative.

Molecular sieve has an advantage over silica gel in that the former has a uniform pore size and for example at (commonly used) 3 angstrom, molecular sieve will only adsorb molecules smaller than 3 angstrom (such as water, ammonia, methanol, ethanol, sulphureted hydrogen, sulfur dioxide, carbon dioxide, ethylene, propylene etc.) but larger molecules are not adsorbed.

When the exhaust air contains odors, molecular sieve will not adsorb most of them (ammonia however) and prevent that they are transferred to the supply air. In contrast, silica gel with larger porous structure will allow larger molecules to be adsorbed and transferred to the supply. This could potentially result in transfer of odor from the exhaust to the supply. On the other hand, when the supply air is contaminated silica gel will adsorb some of the contaminants and prevent them from entering the building whereas molecular sieve will let everything through.

Virus and bacteria are comparatively large in size (virus is about 100-3000 angstrom and bacteria about 100 times bigger) so they will not be adsorbed by neither molecular sieve nor silica gel.

19. MAINTENANCE AND CLEANING

19.1. General

High pressure water cleaning and disinfection of the heat exchanges may become necessary. For instructions regarding the cleaning and disinfection procedures, see below.

19.2. Recommended Cleaning Products

The detergent recommended for cleaning is YES/Fairy. The detergent shall be sprayed on the heat exchanger with a low-pressure sprayer. The detergent can be diluted with up to 75% water. YES/Fairy is available in grocery stores and can also be purchased through Heatex. Heatex article number: 42715.

The disinfectant recommended for disinfection is LIV +45. Do not dilute LIV +45 with water. LIV +45 is available for purchase through Heatex. Heatex article number: 42716.

Figure 7. YES/Fairy detergent.

Figure 8. LIV +45.

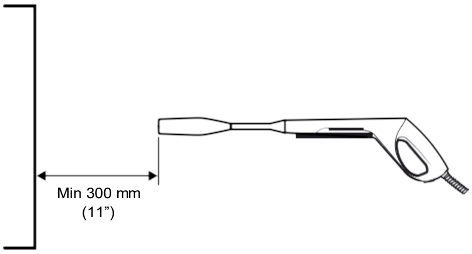
NOTE! The minimum space required for cleaning and disinfecting is 500 mm (20”).

19.3. Cleaning

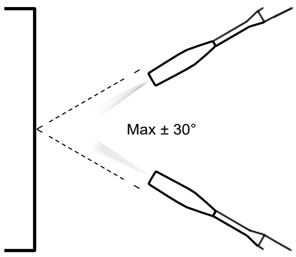
The cleaning process consists of three steps. First, rinse the heat exchanger with water using a high-pressure cleaner to remove dust, particles, deposits etc. Then, use detergent to clean the heat exchanger. As a third step, remove the detergent with water. Make sure that the nozzle of the high-pressure cleaner is adjusted to a plain jet.

Rotary Heat Exchanger Cleaning Procedure:

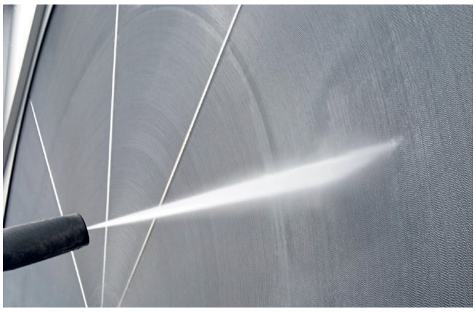
1. Place the nozzle at a distance of approximate 300 mm (11") from the heat exchanger.



2. Have the nozzle adjusted to plane jet.
3. Vary the spray angle between + 30 and - 30 degrees from the openings at a distance of 300 mm (11.81") from the entrance.



4. Spray the whole wheel. Don't forget to rotate the wheel in order to clean the parts hidden behind the framework.
5. Let the heat exchanger air-dry.
6. Spray the heat exchanger with detergent (YES/Fairy) with a low-pressure sprayer.



7. Repeat point 1-5 in order to remove all detergent.

19.4. Disinfection

The disinfection process consists of two steps. First, spray the heat exchanger with disinfectant LIV +45* and leave to dry. Then, rinse the heat exchanger with water using a high-pressure water cleaner. The disinfectant LIV +45 is used on both the plate and rotary heat exchangers. LIV +45 is used undiluted.

Rotary Heat Exchanger Disinfection Procedure:

1. Spray the disinfectant into the heat exchanger at a distance of 50-100 mm (1.97-3.94"). Use the standard LIV +45 bottles with easy spray tap. If the big can (5L (1.32 gallons)) have been bought, fill up a standard spray bottle.
2. Spray the entire wheel and don't forget to rotate the wheel to clean hidden parts behind the framework
3. Spray the wheel from both sides.
4. Let the heat exchanger air-dry for 30 minutes.
5. Clean the heat exchanger in the same way as before (but without detergent) to assure all disinfectant has been removed.

*observe that LIV+45 contain alcohol which is flammable. Take precaution to avoid ignition.

20. DISPOSAL

A rotary heat exchanger´s weight consists of around 50 % aluminum, 45 % Aluzinc coated carbon steel sheet metal and 5 % other materials (electrical motor/controller, belt, brush seal, silicone, pop rivets and screws).

The disposal of each component should be according to the regulations in the country where the dismantle of the product is made.

20.1. Aluminum Material

The wheel is, except for the center shaft and bearings, made of aluminum. The second or third letter of the product code explains the coating of the aluminum.

Example:

EA/EQA/ENA =Aluminum, not coated

EE/EQE/ENE = Epoxy coated aluminum (6 g/m² (0.18 oz/yd2))

EM/EQM/ENM = Molecular sieve coated aluminum

ED/EQD/END = Silica gel coated aluminum

EK/EQK/ENK = Hybrid unit using both aluminum coated with silica gel and non-coated aluminum.

EL/ENL = Hybrid unit using both aluminum coated with molecular sieve and non-coated aluminum.

Disposal are normally divided in two separate ways: Pure aluminum and coated aluminum.

Local regulations may apply.

20.2. Casing Material

The casing should be treated as metal and therefore be properly disposed as such according to regulations in each country.

20.3. Electrical Components

Motor, control, cables and rotation detector should be treated as electrical waste.

Some electrical motors have a gearbox which contains up to 0.4 liters (13.5 fl. oz) of mineral oil.

20.4. Other Components

Belt and brush seals are normally treated as combustible waste, but local country regulations apply.

Products from Heatex do not contain minerals known as conflict minerals.

As rotary heat exchangers contain a lot of thin cut metal, appropriate safety equipment should be used to secure the health of the personnel during the disposal procedure.