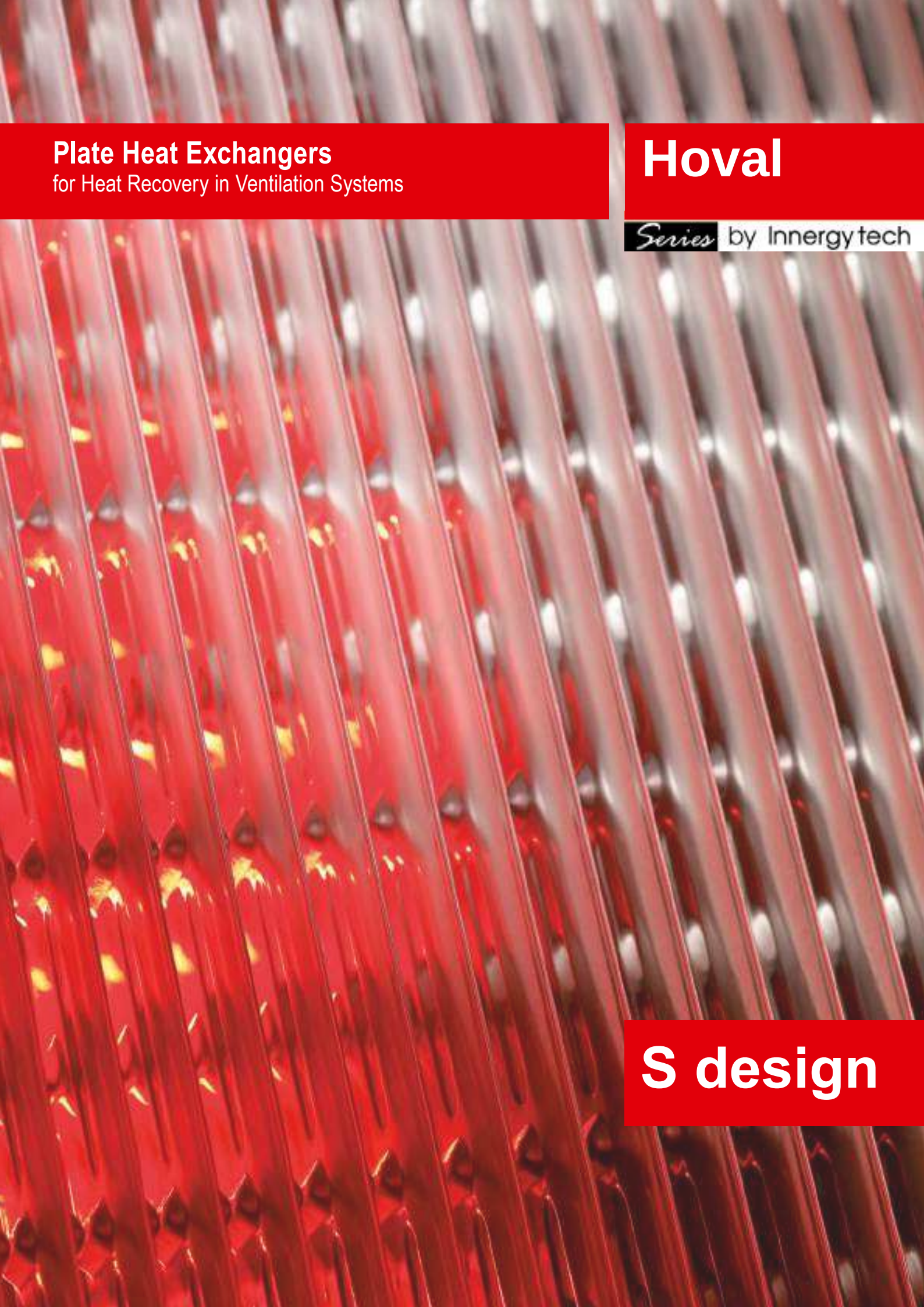


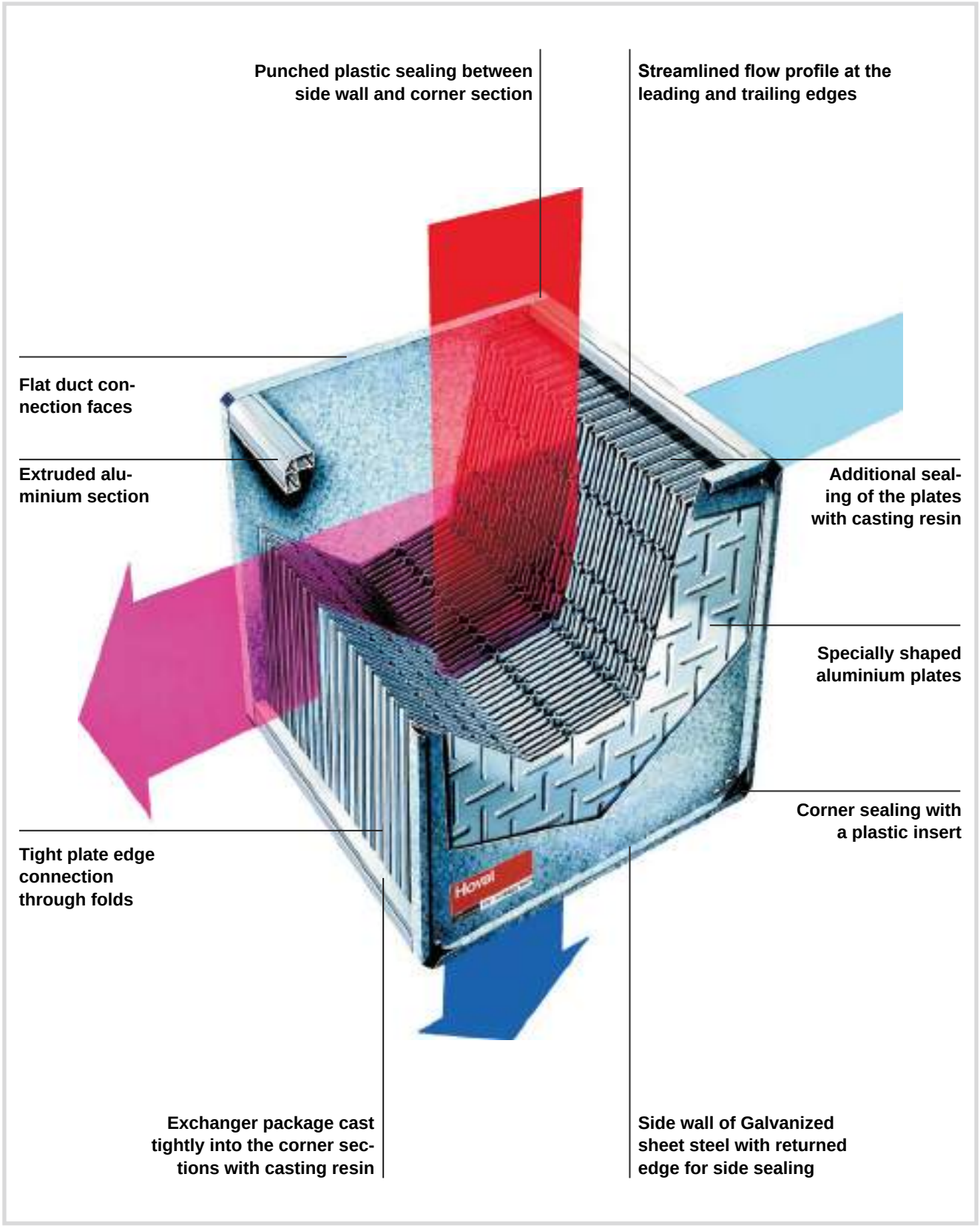
Plate Heat Exchangers
for Heat Recovery in Ventilation Systems

Hoval

Series by Innergy tech

S design

Cut-Away View of S design



Hoval

Hoval Plate Heat Exchangers
Handbook for Design, Installation and Operation

Subject to technical alterations.
Art.Nr. 4 209 956 – 09 / 2010
Innergy tech, Canada, 2011

Heat recovery reduces costs and protects the environment

Hoval plate heat exchangers are important elements in saving energy in industrial and commercial buildings such as hotels, hospitals, sports halls, office buildings, seminar rooms, swimming pools, drying processes, paint spray booths and extraction plants. They are used in air handling units, ductwork systems and in process technology. This investment pays off in several ways:

- Lower energy consumption
- Lower investment for heat generation and distribution
- Less damage to the environment

No cross-contamination of the air streams

In the Hoval plate heat exchanger the warm extract air and the cool fresh air, separated by thin plates, pass each other in cross-flow. No mixing of the two air streams takes place. Therefore, the transmission of dirt, odours, moisture, bacteria, etc. is impossible. Heat is transmitted from extract air to fresh air purely by conduction as a result of the temperature difference between the two air streams: The warm extract air is cooled down; the cool fresh air is heated up. All of the Hoval plate exchangers manufactured by Innergy tech are AHRI certified to have 0% contamination for up to 3" pressure differential.

Wide variety of sizes available

Hoval plate heat exchangers are available in a wide range of sizes to suit every application:

- Exchanger lengths from 24 to 79 inches (0.6 to 2.0 meters)
- Packages from 8 to 118 inches wide (0.2 to 3.0 meters)

The individual exchanger packages can be supplied with different plate spacings for different effectiveness levels.

Three designs

Hoval manufactures 3 designs to satisfy the technical demands on the exchanger package (dimensions, plate spacing, rigidity). The S designelection depends on the air flowrate and the application.

- **S design (manufactured in America)**

Perfect for up to 30,000cfm applications.
Optimized for the greatest effectiveness.

Sizes :
60-70-85-100
120-140-170-200

- **Design F (manufactured in Europe)**

Perfect for applications 30,000cfm and up, when compact plate exchangers are required or when low pressure drops are important.

Sizes :
100-120-140-170
200-240

- **Design P (manufactured in Europe)**

In stainless steel for applications in process technology.

Sizes :
100-200

Materials which suit the applications

Three series are available to suit a wide variety of applications:

- **Series V (standard)**
With the exchanger package of aluminium and the casing of aluminium extrusions and galvanized sheet steel.

- **Series G (corrosion-protected)**
With coated exchanger package and casing.

- **Series T (high temperature)**
With a special sealing agent resistant to temperatures up to 392 °F (200 °C).

Reliable in operation

Hoval plate heat exchangers have no moving parts. Their function requires no electrical connection. There are therefore no extra running costs and operation is always guaranteed: 100 % reliability.
Many years of operation in numerous applications have proved that Hoval plate heat exchangers are extraordinarily resistant to dirt build-up. Therefore no special maintenance is required.

Wide range of accessories

The Hoval plate heat exchanger is available with the following well-proven accessories:
- Bypass for performance control
- Recirculation bypass

Hoval plate heat exchangers offer many advantages

- High heat recovery effectiveness
→ Low investment costs
- No moving parts
→ No wear, always ready for operation
- Separated air streams
→ No cross-contamination (AHRI tested and certified)
- No electrical connections
→ No extra running costs
- 3 designs, 3 series, a wide variety of sizes and plate spacings, any desired width
→ The optimum solution for every application
- Lightweight, compact design
→ Easy to install
- Automated production
→ Constant high quality
- Recirculation bypass available
→ No mixed air section required
- Certified hygiene conformity
→ Also suited for applications in hospitals

Reliable data

Hoval S design plate exchangers (Manufactured by Innergy tech) are fully AHRI certified and bear the AHRI certified seal. Hoval F and P design plate exchangers (Manufactured in Europe) are fully Eurovent certified.The technical data are based on these results. The Innergy tech Winnergy PRO selection software is based on the AHRI tested results and allows easy and quick selection of the optimum S design plate heat exchanger. For the F and P design plate exchangers, the Hoval CAPS selection software is required.

1 Principle and Operation

Hoval plate heat exchangers operate within the guidelines for heat recovery as recuperators with joint faces. The heat releasing and heat absorbing air streams pass along the joint face, through which the heat is directly transmitted. Supply and extract air must therefore be brought together and flow through the heat exchanger.

1.1 Heat transmission

Hoval plate heat exchangers operate on the cross-flow principle. Heat is transmitted via the plates from the warm to the cold air stream. A much simplified performance calculation is:

$$Q = k \cdot A \cdot \Delta t$$

When temperatures are given, the transmitted heat performance is assumed by design characteristics.

Heat transfer rate
The k-value is calculated from the thickness and heat conductivity of the plates, as well as heat transfer on both sides:

$$\frac{1}{k} = \frac{1}{\alpha_1} + \frac{d}{\lambda} + \frac{1}{\alpha_2}$$

As thin plates are used, for cost reasons, the influence of the material can be neglected. This is shown in table 1:

Material	Thickness [mm]	λ [W/mK]	$\alpha_1 = \alpha_2$ [W/m²K]	k [W/m²K]
Aluminium	0.125	200	40	19.9998
Aluminium	0.250	200	40	19.9995
Stainless steel	0.125	15	40	19.9967
Plastic	0.250	0.2	40	19.5122

Table 1: Plate thickness and material have only a slight effect on the effectiveness.

For good heat transmission, the heat transfer α must be high on both sides of the plates. For this reason Hoval optimised the plate profiles with extensive testing resulting in high effectiveness relatively independent of the flow velocity.

Exchanger surface area
The amount of heat transmitted is directly dependent on the exchanger surface area. With the number of plates and their spacing, the effectiveness is easily changed, optimised or selected to meet a particular specification. Therefore different plate spacings are available for most types of Hoval plate heat exchangers. The optimum economic exchanger can be selected for a specific project.

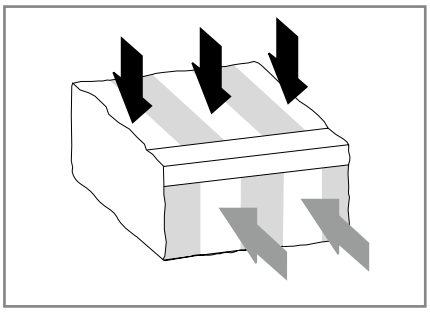


Fig. 1: The air streams, separated by thin plates, pass next to each other.

1.2 Leakage

Components of air handling units, for example dampers, ducts or casings, are not normally 100 % leakproof. This is mainly because it is not necessary to ensure the correct function and it would be very expensive. In practical use, however, leakage must not exceed technically justifiable limits. For heat recovery units, there is no such data at the moment. Nevertheless, actual values are known from tests.

A difference has to be made between the following:
- Leakage to outside (external)
- Leakage between supply and extract air (internal)

While sealing to outside normally does not cause any problems (it is above all a question of assembly quality), the internal leakage mainly depends on the system and exchanger construction. As an approximate value for the internal leakage of Hoval plate heat exchangers a maximum of 0.1 % of the nominal air flowrate can be used (at a pressure difference of 1.0'' w.g. (250 Pa)).
The leak tightness of Hoval plate heat exchangers is far better than other manufacturers' data. Nevertheless, it must be noted that exchangers are not 100 % leakproof unless special measures are taken.

1.3 Moisture transmission

The two air streams are separated in the Hoval plate heat exchanger and transmission of moisture is therefore not possible. This is a special advantage when moisture is removed with the warm air, e.g. in swimming pools, drying processes, etc.

1.4 Condensation

Hoval plate heat exchangers do not transmit moisture but still can use part of the latent heat of moist extract air. At low outside temperatures, when there is a high heat demand, the extract air is cooled down to such a degree that the saturation temperature is reached and condensation is formed. Thus the latent heat of evaporation is released. This reduces further cooling of the extract air, i.e. the temperature difference between the air streams in the plate heat exchanger is greater than when there is no condensation. Also the heat transfer is better; consequently the efficiency is raised significantly. This can be seen clearly in the hx diagram. The cold air stream is heated more than the warm air is cooled. Nonetheless the enthalpy difference is the same, assuming equal water content.
Condensation in the extract air reduces the free area of the airway and is responsible for an increase in pressure drop. Therefore it is important that the condensation can drain away. This depends mainly on the fitting position of the heat exchangers and on the form of the plates. Hoval plate heat exchangers offer advantages because of their special profiles.
If condensation occurs the internal and external leakage of the exchanger is of particular importance. Even with a leakage rate of only a maximum of 0.1 % of the nominal air flowrate – as with the Hoval plate heat exchanger – up to 0.3 gallon (3 liters) condensate an hour can leak out, even more in extreme cases. The absolute value depends on the size of the exchanger, the number of plates, the amount of condensate and the pressure difference.

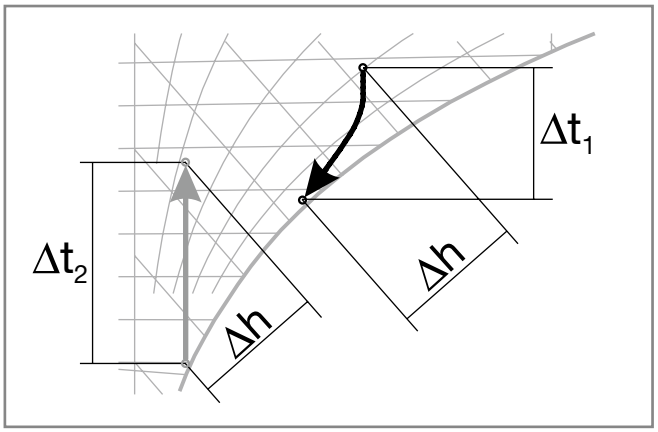


Fig. 2: Changes of condition in the hx diagram

1.5 Temperature profile

With the cross-flow heat exchanger, the air streams are not heated and cooled evenly. This means that the temperatures vary along the cross section of the air stream. The computer graphic, calculated by the finite element method, shows this. Because of the temperature variation the verification of the effectiveness under operating conditions is practically impossible. For this reason, the performance of representative Hoval plate heat exchangers has been empirically tested, measured and agreed by independent test institutes – to safeguard the consultant, installer and operator.

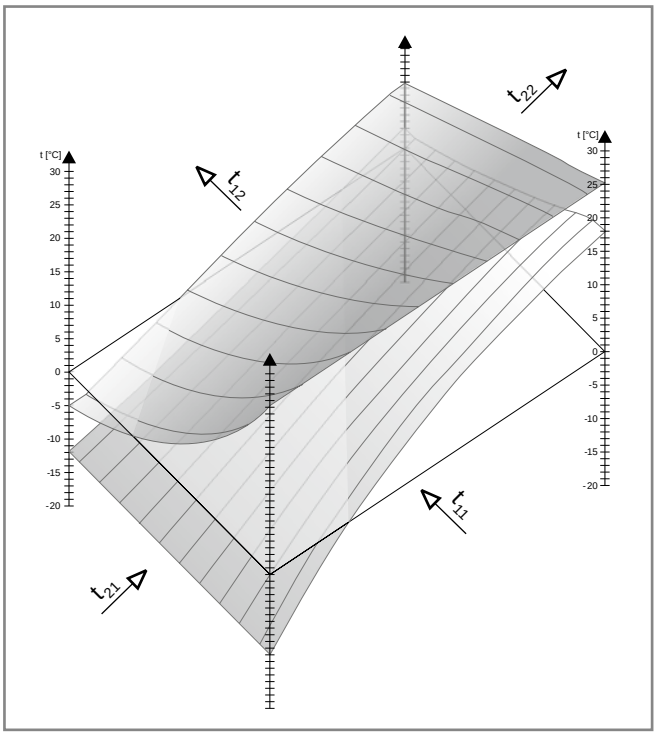


Fig. 3: Temperature profile of the air streams

1.6 Frost limit

If the warm air stream is severely cooled down, it is not only possible for condensation to form, but also to freeze. The cold air temperature at which freezing starts, is called the 'frost limit'. For a frost condition to occur, several factors must coincide:

- Very low temperature of the cold air stream
- Cold air volume is greater than warm air volume.
- High effectiveness of the exchanger
- Relatively little condensation
- The condensation cannot drain away easily.

If several of these circumstances coincide the plate heat exchanger can ice up starting at the cold corner. The Hoval plate heat exchanger is not damaged, but the pressure drop is increased and the air flowrate is reduced. In extreme cases the whole exchanger can slowly ice up. It is recommended to calculate the frost limit for each project with the computer program and to take necessary precautions (de-icing exhaust fan switch, preheating, bypass).

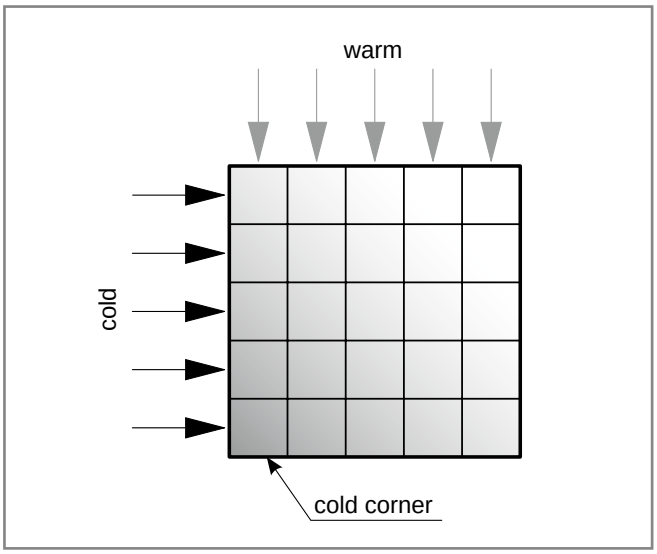


Fig. 4: Under extreme conditions the exchanger can ice up, starting at the 'cold corner'.

1.7 Heat recovery effectiveness

In principle, nearly any effectiveness can be achieved if sized and designed to suit. For instance, the effectiveness can be substantially raised by installing two exchangers in series. However, this increase in effectiveness

- either is at the expense of a high pressure drop,
- or at the expense of a large space requirement,
- and an increase in cost.

The 'correct' effectiveness depends on applicable regulations and on the economic calculation, i.e. on operating data such as energy prices, useful life, running times, temperatures, maintenance costs, interest rates, etc.
It is important that the calculated optimum values for heat recovery effectiveness and pressure drop are then put into practice. Even small deviations (a few percent less effectiveness, a little more pressure drop) can cause substantially worse values for the present value and payback period.

1.8 Pressure drop

Heat recovery units cause additional pressure drop on the extract and fresh air sides; incurring higher running costs. Under present conditions the economical values range between 0.6'' w.g. and 1.0'' w.g. (150 Pa and 250 Pa). However, to cut down costs, heat recovery units whose pressure drop exceeds these values are often installed. The profitability of heat recovery is thereby jeopardised. But there is also an economic limit: The efficiency for generation of electrical current ranging between only 35 % to 40 %, the expenditure for the additional pressure drop must not exceed this value in relation to the energy savings in total.

1.9 Pressure difference

A distinction is made between:

- the external pressure difference (between inside and outside of the exchanger)
- the internal pressure difference (between fresh air and extract air)

External pressure difference
This pressure difference has a major effect on the external leakage of the plate heat exchanger. Yet when the exchanger is properly and carefully installed in a ductwork system, its effect can be neglected. More important is the influence on mechanical resistance, particularly if the side walls are flat. Hoval therefore strengthens the side walls of large plate heat exchangers with a special reinforcing section.

Internal pressure difference
Likewise, the internal pressure difference has a crucial influence on internal leakage between the two air streams. Although Hoval plate heat exchangers are very tight in comparison with other constructions, the following should be considered when designing:

- The pressure difference in the heat exchanger should be kept to a minimum.
- The pressure gradient and thus leakage should be from the supply air to the extract air side.

The internal pressure difference also may cause a deformation of the plates. The plate spacing is then narrowed and/or widened, resulting in corresponding variations of pressure drop. Extensive tests have shown that the influence of deformation depends on the plate spacing (see diagram 1).
The permitted pressure difference between the two air streams, with the S design, is limited to 10'' w.g. (2500 Pa) and 8'' w.g. (2000 Pa) for the F design.

This is geared to the still acceptable pressure drop increase; a permanent deformation does not occur. The expected pressure drop increase depending on the exchanger type and the existing internal pressure difference can be calculated with the Innergy tech Winnergy PRO.

Notice
The pressure difference depends on the position of fans. Overpressure on one side and underpressure on the other side add up.

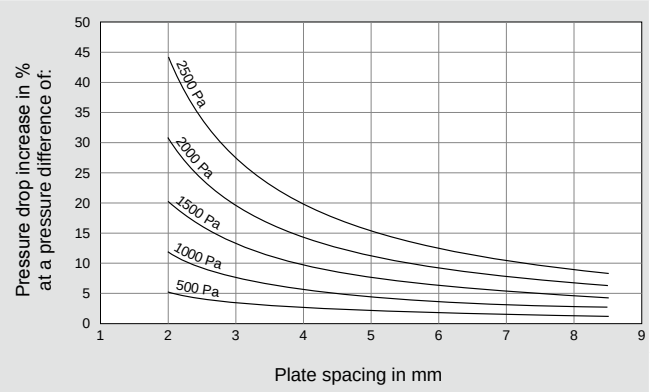


Diagram 1: Pressure drop increase due to internal pressure difference for exchangers S design

1.10 AHRI Certified Performance

The Innergy tech Hoval S design products are fully tested and certified for performance under AHRI 1060-2011 (Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment), bear the certified seal and appear in the AHRI online directory (http://www.ahridirectory.org).

To earn the AHRI Performance Certified seal, a product must go through continuous and extensive laboratory testing in order to verify the manufacturer's claimed performance ratings. Furthermore, through its production, units of the certified product are randomly selected and evaluated using procedures stipulated in the applicable AHRI standards to certify that they meet the manufacturers' published performance ratings. A test failure requires re-rating or ceasing production of the failed product.


AHRI CERTIFIED

Certificate of Product Ratings

Fig. 5: AHRI Certified document

1.11 Hygiene

Hoval plate heat exchangers were subjected to hygiene conformity testing in Europe at the ILH Berlin (institution of air hygiene). Test criteria were the hygiene-relevant requirements for applications in general air conditioning systems and in hospitals. All hygienic requirements were met.

INSTITUT FÜR LUFTHYGIENE

ILH BERLIN

Certificate

Hygiene conformity test

Fig. 6: Certificate of hygiene conformity test

2 Performance Control

The Hoval plate heat exchanger operates as a temperature moderator between the two air streams. The direction of the heat transmission is of no consequence, i.e. depending on the temperature difference between extract and fresh air, either heat recovery or cool recovery takes place. Therefore performance control of the Hoval plate heat exchanger is not necessary when the extract air temperature is identical to the desired room temperature. In this case, the outside temperature is always either heated or cooled through the plate heat exchanger in the direction of the set temperature.
In many cases, however, heat gains are present in the ventilated space (people, machinery, lighting, solar, process plants), which increase the room temperature, so that the extract air temperature is higher than the set temperature. In this case, at full performance of the heat exchanger, check at which outside temperature heat-up begins, and if this cannot be tolerated, the performance of the heat exchanger must be controlled.

Example

In an industrial building the room air is heated from 64 °F to 75 °F through lighting and machinery. The heat recovery figure Φ_2 is 66 %. With equal airflows, at which outside temperature t_{21} is the space heated only by heat recovery without additional heating?

$$t_{21} = \frac{t_{22} - (\Phi_2 \cdot t_{11})}{(1 - \Phi_2)}$$

$$t_{21} = \frac{64 - (0.66 \cdot 75)}{(1 - 0.66)} = 43\ °F$$

At higher outside temperatures the hall is heated above the desired room temperature, this means the performance of heat recovery should be controlled.

With the Hoval plate heat exchanger the performance control through change of the mass flow ratio is simply and economically accomplished with the bypass. All Hoval plate heat exchangers can therefore be supplied with integral bypass. Exchanger and bypass width are automatically selected using the computer program in such a way that pressure drop is equal. Whether a bypass is fitted on the side or in the middle depends on local conditions and on the width of the exchanger. The arrangement of further ventilation components after the bypass, e.g. air heater, moisture eliminator, etc., must take into consideration the fact that the velocity profile can be uneven.

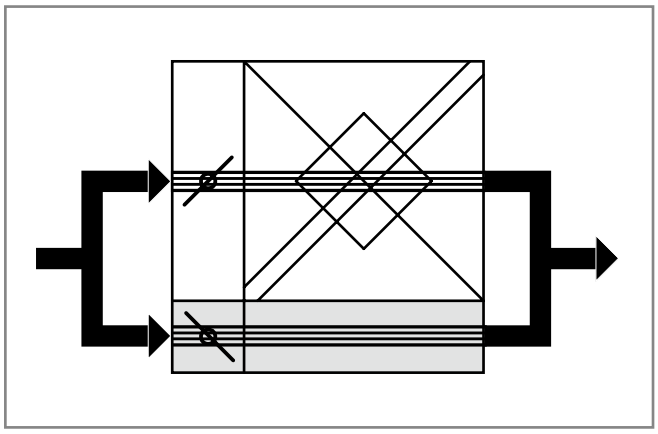


Fig. 7: The bypass is the most common method to control performance.

There are two options for the fitting of the bypass:

Bypass in the fresh air:
Depending on damper position, between 0 % and 100 % of the fresh air passes through the bypass. The extract air always flows through the heat exchanger and is cooled according to the fresh air flowrate. With this arrangement the cooling of the extract air and thus freezing can be avoided.

Bypass in the extract air:
Between 0 % and 100 % of the extract air passes through the bypass. The fresh air always passes through the plate heat exchanger. This arrangement is recommended when the extract air is very dirty, as during summer operation the extract air does not pass through the plate heat exchanger.

3 Construction

Hoval plate heat exchangers consist of the exchanger package and the casing. Sizing of the exchanger package (plate size and plate spacing) depends mainly on the air flowrate. To achieve an optimum result with regard to heat recovery efficiency, pressure drop and costs Innergy tech offers different size and spacings:

- Sizes from 24 to 79 inches (0.6 to 2.0 meters)
- Spacings from 0.079 to 0.354 inches (2 to 9 millimeters)

3.1 Exchanger package

The exchanger package consist of specially formed aluminium plates. Their profile with V-shaped spacing ribs is an optimum design resulting from detailed tests for heat recovery effectiveness, pressure drop and rigidity. The main advantages are:

- Little dependency of the heat recovery effectiveness on the air velocity
- Exact spacing between the plates through positive/negative stamping
- High rigidity of the thin aluminium plates through the special arrangement of the vertical and horizontal ribs
- The profiles are arranged in such a way that the condensation can drain in every direction.
- Uneven flow patterns can even out inside the heat exchanger.

There are 8 different plate sizes, which are formed with different profile depths, i.e. for different plate spacings. Thus a great variety of different exchanger packages can be made, independent of width.

3.2 Plate connection

The connection of the plates is made by a fold. This gives a severalfold material thickness for the leading and trailing edges, which gives good rigidity to the exchanger package. Also a streamlined flow profile is given, which reduces not only pressure drop but also the possibility of dirt deposits.

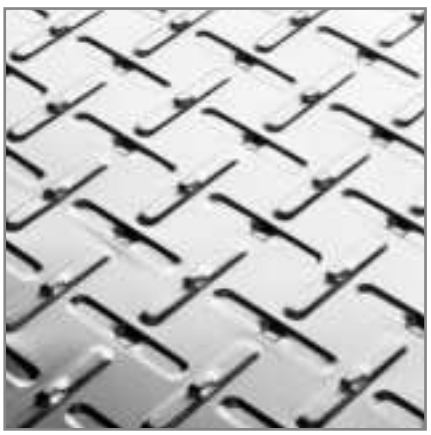


Fig. 8: The special profiles of Hoval plates are the result of extensive tests and measurements (S design shown here).

Fig. 9: Folded connections give the exchanger package severalfold material thickness for the leading and trailing edges (S design shown here).

3.3 Casing

The exchanger package is fitted into a casing of corner sections and side walls. The specially developed aluminium sections offer many advantages:

- The corners of the exchanger package are sealed into the sections with a sealing compound. This technique ensures optimum integration of the package into the casing.
- Other components can be bolted or riveted directly to the hollow sections without affecting the rigidity of the exchanger or damaging the exchanger package.
- At the corners the sections are flattened by 45°, which facilitates installation of the plate heat exchanger and reduces the diagonal dimension.

The side walls are bolted to the corner sections. This creates flat surfaces for connecting ducts or other components. In addition, the returned edge of the side wall allows easy installation of a side sealing all round, facilitating integration into a casing.

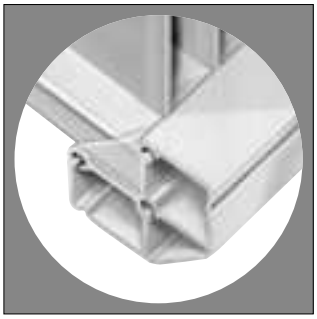


Fig. 10: The specially developed aluminium sections offer many advantages.

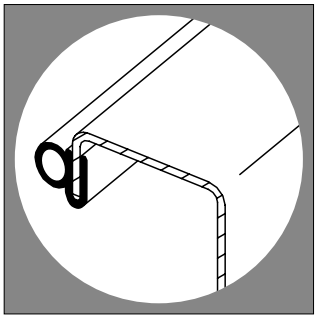


Fig. 11: A side sealing can be fastened to the returned edge of the side wall.

The side walls of all compound plate heat exchangers have a special profile for a sealing bead. This together with the sealing bead in the corner section ensures tight connection of the individual exchanger blocks.

Fig. 12: The circumferential sealing bead in the frame of each exchanger block ensures tight connection of compound exchangers (here a cut-away model).

Fig. 13: Plate exchangers installation.

4 Model Range

4.1 Design

This design mainly covers 'normal' applications in air handling installations.

4.2 Series

3 different material types are available to suit a wide variety of applications:

Series V (Standard)	The exchanger package consists of aluminium plates, the casing of aluminium extrusions and side walls of galvanized steel. The exchangers are silicone-free. The maximum permissible temperature is 194 °F (90 °C). This provides high resistance against corrosion for 'normal' applications in air handling installations.
Series G (corrosion-protected)	The basic materials correspond to those of series V, however, the complete casing and the plates are coated. The exchangers are silicone-free. The maximum permissible temperature is 194 °F (90 °C). This series is used when large amounts of condensate occur (e.g. in swimming pools, kitchens and certain industrial applications).
Series T (high temperature)	The construction is identical to series V, however, a high-temperature silicone is used for sealing of the corner sections. Thus the exchangers are resistant to temperatures up to 392 °F (200 °C).

The Innergy tech technical department will advise which series is suitable for specific applications.

4.3 Exchanger sizes

The exchanger package is responsible for the air performance (heat recovery efficiency, pressure drop, air flowrate). Depending on the design, different sizes are available.
Sizes 060 t0 100 consist of one exchanger package.
Sizes 120 to 200 are compound exchangers, made up of four exchanger packages.
The size designation indicates the exchanger lengths in centimeters.

4.4 Plate spacing

The plate spacing effects the surface area and thus the heat recovery efficiency, the pressure drop and the price. Hoval offers several spacings for most sizes so that an optimum solution can be achieved for each project.

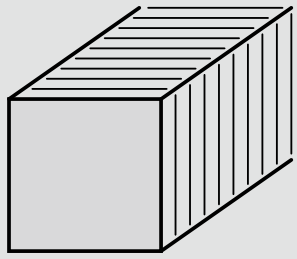
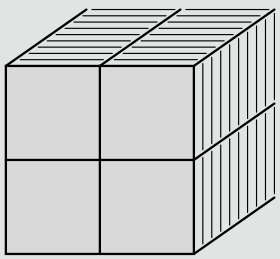
Size Plate spacing	S design								Heat recovery effectiveness	Pressure drop
	060	070	085	100	120	140	170	200		
in mm	23.6 (600)	27.6 (700)	33.5 (850)	39.4 (1000)	47.2 (1200)	55.1 (1400)	66.9 (1700)	78.7 (2000)		
C	0.08 (2)	0.08 (2)	0.08 (2)	–	–	0.08 (2)	0.08 (2)	–	max.	max.
D	0.10 (2.5)	–	0.12 (2.9)	–	–	–	0.12 (2.9)	–		
R	0.12 (3)	0.12 (3.2)	0.15 (3.9)	0.10 (2.5)	0.12 (3)	0.12 (3.2)	0.15 (3.9)	0.10 (2.5)		
X	0.16 (4.1)	0.17 (4.3)	0.20 (5.1)	0.17 (4.4)	0.18 (4.6)	0.17 (4.3)	0.20 (5.1)	0.17 (4.4)		
L	0.18 (4.6)	0.21 (5.3)	0.25 (6.3)	0.25 (6.3)	0.25 (6.3)	0.21 (5.3)	0.25 (6.3)	0.25 (6.3)	min.	min.
W	0.25 (6.3)	0.25 (6.3)	–	–	–	0.25 (6.3)	–	–		
Construction										

Table 2: Clear plate spacings for S design (nominal value in in (mm))

4.5 Exchanger width

The width of Hoval plate heat exchangers can be as desired. It can be selected according to local conditions and design criteria (e.g. pressure drop). For stability reasons the maximum exchanger width is limited to 118 in (3000 mm).

5 Options

5.1 Bypass B

If performance control of the plate heat exchanger is necessary, a bypass is built into the casing besides the plate package. This can be on the side or in the middle. The minimum width is 2 in (50 mm).

Notice
To ensure good flow conditions, installation in the middle is strongly recommended for total widths of 60 in (1500 mm) and more.

Dampers can be fitted directly to the flanges of the casing, in front of the exchanger face and bypass.
The width of the bypass is automatically calculated with the Innergy tech Winnergy PRO computer selection software in such a way that the bypass has approximately the same pressure drop as the exchanger package. However, the width of the bypass can also be made to specification. The pressure drop to be expected can be calculated with the Innergy tech computer selection program.

Attention
In bigger exchangers reinforcing bar spacers are fitted in the bypass; do not use these spacers for lifting the exchanger!

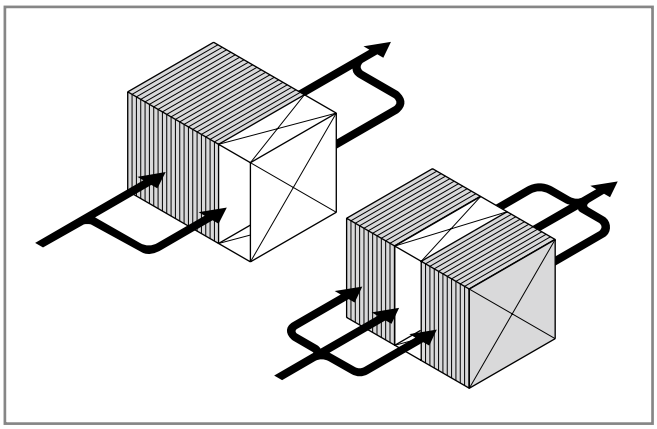


Fig. 14: Bypass built-in at the side or in the middle.

5.2 Recirculation bypass U

A bypass with bypass damper (opposed dampers in front of the bypass and exchanger face) is installed in the plate heat exchanger. One side wall of the bypass damper is replaced by the additional recirculation damper. This arrangement is called recirculation bypass.
The width of the recirculation bypass is either made to specification or it is calculated with the computer program so that pressure drop through the bypass roughly corresponds to pressure drop through the exchanger package.

The recirculation bypass installed in the plate heat exchanger allows for:

- Control of heat/cool recovery in fresh air operation
- Recirculation and mixed air operating modes

Control is effected via the bypass damper by means of an actuator. The recirculation damper must be opposed to the fresh air and exhaust air dampers.
Please contact Innergy tech for more information.

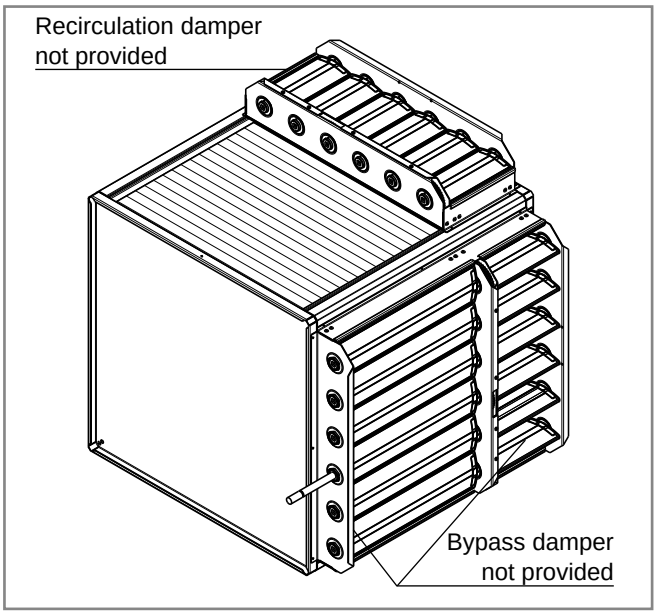
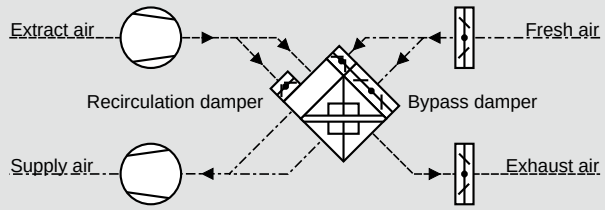


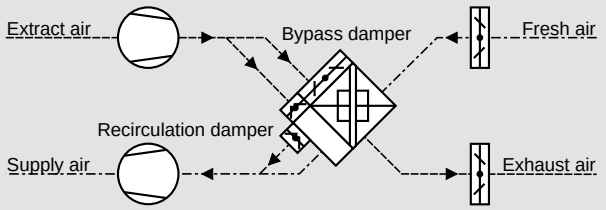
Fig. 15: Plate heat exchanger with side recirculation bypass

Bypass in the fresh air



- Fresh air operation: The recirculation damper is closed; fresh air and exhaust air dampers are open. The bypass damper is used for control of heat recovery, depending on heat demand.
- Recirculation: The recirculation damper is open; fresh air and exhaust air dampers are closed. (The position of the bypass damper can be as desired.) Extract air passes through the bypass of the plate heat exchanger and is supplied back into the room.
- Mixed air operation: Recirculation, fresh air and exhaust air dampers are partly open. The bypass damper is (usually) closed so that heat/cool recovery can be used to its full potential.

Bypass in the extract air



- Fresh air operation: The recirculation damper is closed; fresh air and exhaust air dampers are open. The bypass damper is used for control of heat recovery, depending on heat demand.
- Recirculation: The recirculation damper is open; fresh air and exhaust air dampers are closed. Extract air passes through the bypass of the plate heat exchanger and is supplied back into the room.

  Attention
  The bypass damper must be open!
- Mixed air operation: not possible

5.3 Added full edges seal

As mentioned above (see section 1.2 and 1.4), plate heat exchangers are not 100 % leakproof unless special measures are taken. Yet, by additional sealing Innergy tech can guarantee that the exchanger is delivered watertight in the tested installation position.
Depending on requirements, the exchangers can be additionally sealed on two sides (2P = one air stream) or four sides (4P = both air streams).
The leakage test is not available for exchangers of series T.

Notice
Exchangers for horizontal installation should always be sealed on all 4 sides.

5.4 Horizontal installation L

Normally the Hoval plate heat exchanger is installed in such a way that the plates are vertical. Horizontal installation is also possible, considering the following:

- There is a higher icing-up hazard because condensate can remain on the plates.
- Due to uncontrolled condensate a drain pan should be installed below the exchanger.
- Condensate drops can be carried along with the air flow; (drop eliminator recommended).
- Install plate heat exchangers of designs F and P in such a way that the spacing ribs stand upwards.
- To increase stability, supports are fitted in the exchanger package.
- Unless otherwise expressly requested, the side bypass is positioned on top.

Notice
For horizontally installed exchangers the width B in the unit type reference becomes the exchanger height.

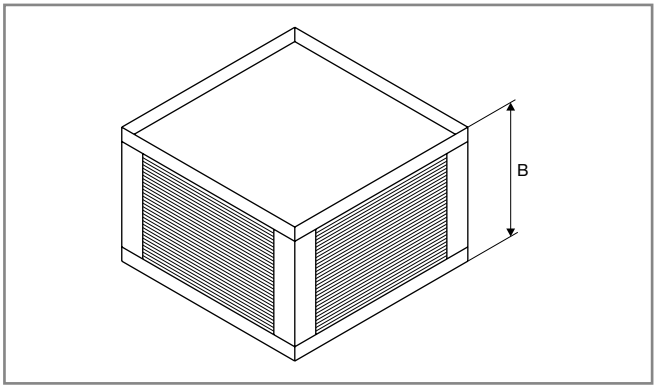


Fig. 16: Schematic view of a plate heat exchanger installed in horizontal position

6 Application Limits, Specification of Material

6.1 Application limits

Series	Temperature °F (°C)	Width in (mm)	Pressure difference in w.g. (Pa)	Pressure difference to outside in w.g. (Pa)	Pressure drop
V + G	-40 to 194	8 to 118	max. 10		Pressure drop should be around 1 in. w.g. (250 Pa) for economical reasons.
	(-40 to 90)	(200 to 3000)	(max. 2500)		
T	-40 to 392	8 to 118	max. 4	max. 4	
	(-40 to 200)	(200 to 3000)	(max. 1000)	(max. 1000)	

Table 3: Application limits for Hoval plate heat exchangers

6.2 Specification of Material

Series	V	G	T
Plate exchanger			
Plates	Aluminium	Aluminium epoxy-coated	Aluminium
Side walls	Galvanized steel	Galvanized steel, powder coated red	Galvanized steel
Corner sections	Aluminium	Aluminum, powder coated orange	Aluminium
Sealing	Silicone-free 2-component-adhesive	Silicone-free 2-component-adhesive	HT silicone

Table 4: Specification of material for Hoval plate heat exchangers

Notice
A hygiene certificate of ILH Berlin (institution of air hygiene) confirms the exchangers suitability for use in general air handling systems as well as in hospitals.

7 Unit Type Reference

Hoval plate heat exchangers are clearly defined with the unit type reference. This shows all possibilities for design and options.

8 Exchanger Dimensions

The following drawings show various designs and exchanger sizes. The dimensions given are those relevant for connection of the plate heat exchanger. For clarity, details of type sizes made up of four exchanger packages have been omitted.

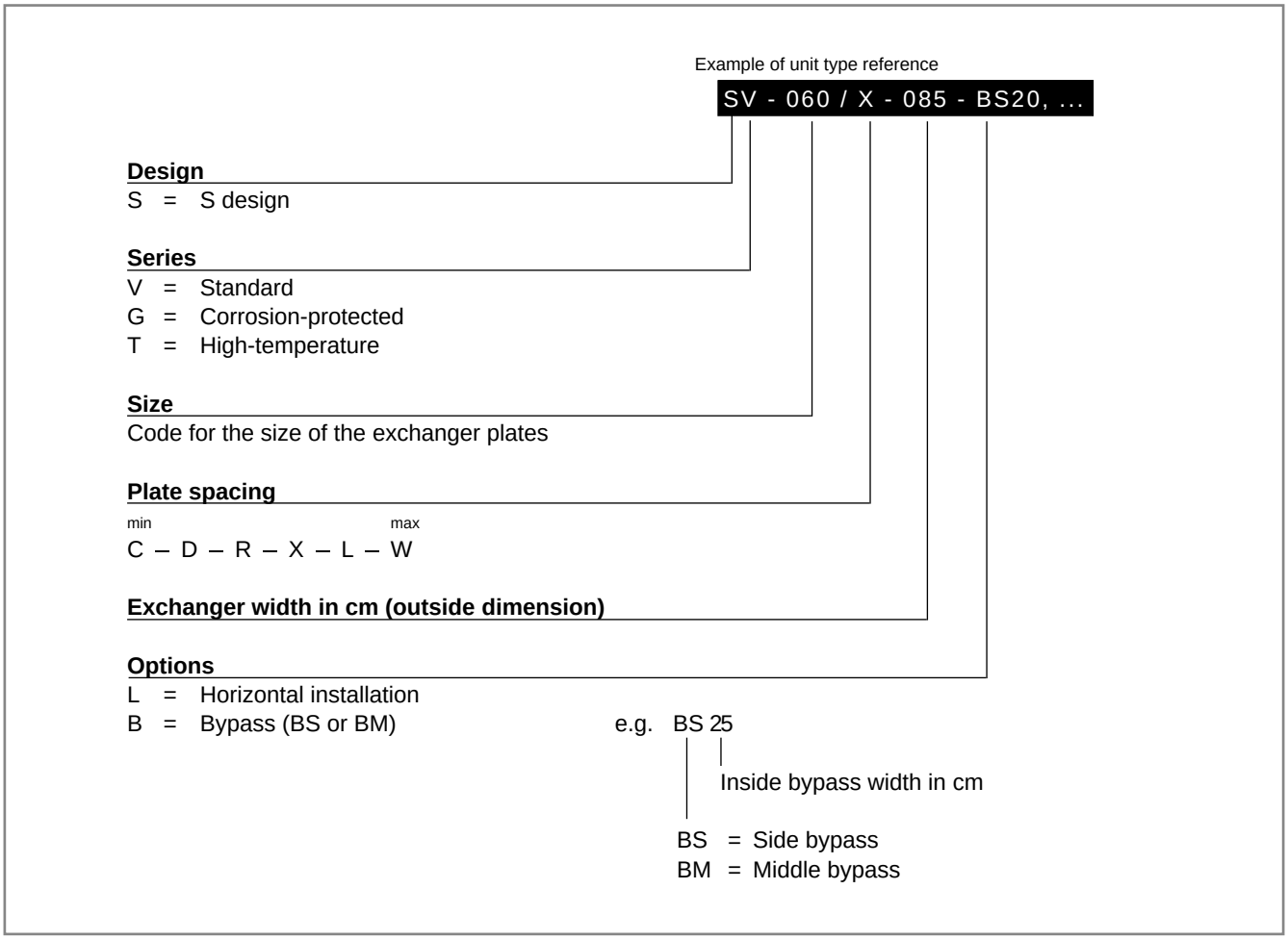
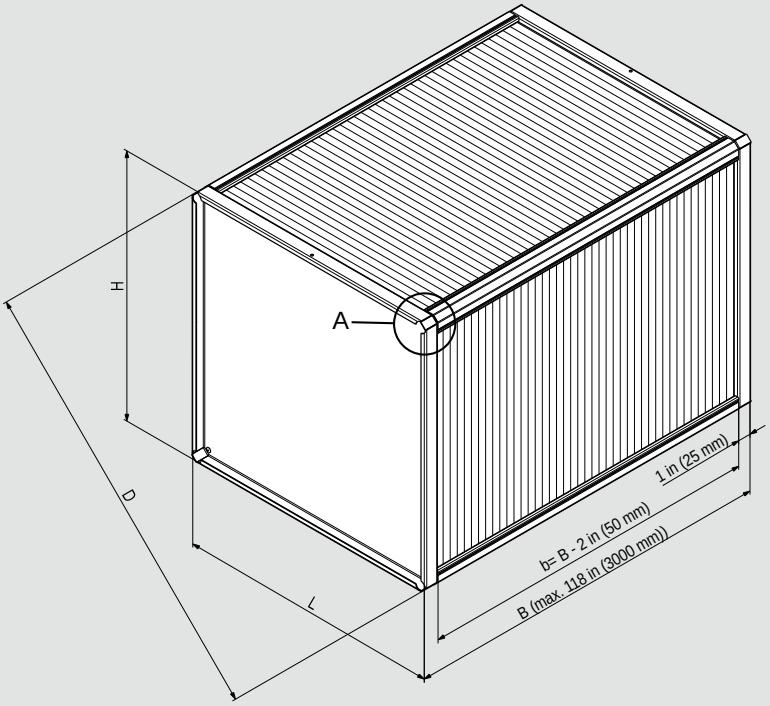


Fig. 17: Unit type reference for Hoval plate heat exchangers

		S design								
Exchanger size			**060**	**070**	**085**	**100**	**120**	**140**	**170**	**200**
Height, length	**H = L**	in	23.6	27.6	33.5	39.4	47.2	55.1	66.9	78.7
		mm	(600)	(700)	(850)	(1000)	(1200)	(1400)	(1700)	(2000)
Diagonal	**D**	in	32.6	38.2	46.6	54.9	66.0	77.2	93.9	110.6
		mm	(829)	(970)	1182	(1394)	(1677)	(1960)	(2384)	(2808)



Detail A

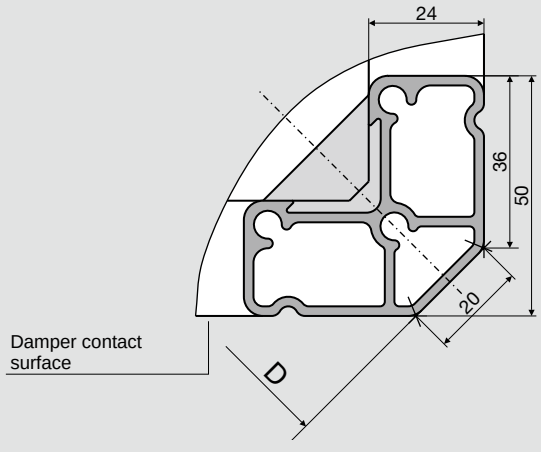
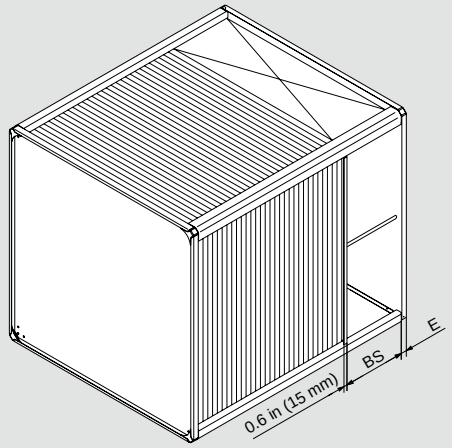
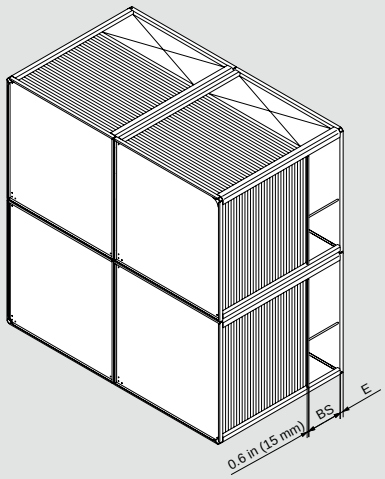


Table 5: Dimensions of exchangers without bypass, S design (in mm)

Side bypass BS				
E = 1 in (25 mm)	060	070	085	100
				
E = 1 in (25 mm)	120			
				

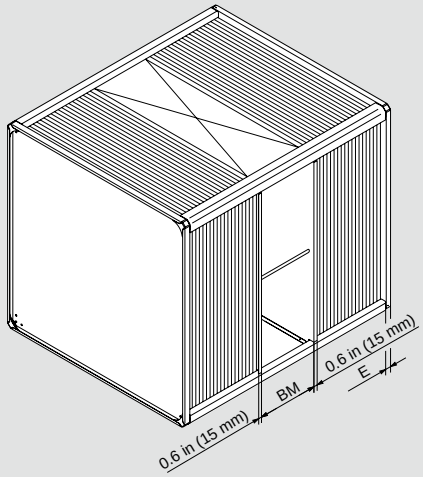
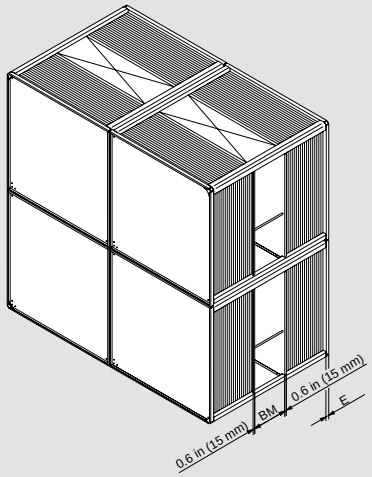
Middle bypass BM				
E = 1 in (25 mm)	060	070	085	100
				
E = 1 in (25 mm)	120			
				

Table 6: Dimensional drawings for exchangers with bypass

9 Design Guidelines

9.1 Innergy tech Winnergy PRO selection software

The design of Hoval plate heat exchangers is easy and quick with the Winnergy PRO selection software. It runs under Microsoft® Windows and offers the following:

- Reliable design data thanks to our AHRI certification
- Exact calculation of a specific Hoval plate heat exchanger
- Calculation of all appropriate plate heat exchangers for a specific project

Notice
The Innergy tech Winnergy PRO selection software is available for download on our homepage (www.innergytech.com).

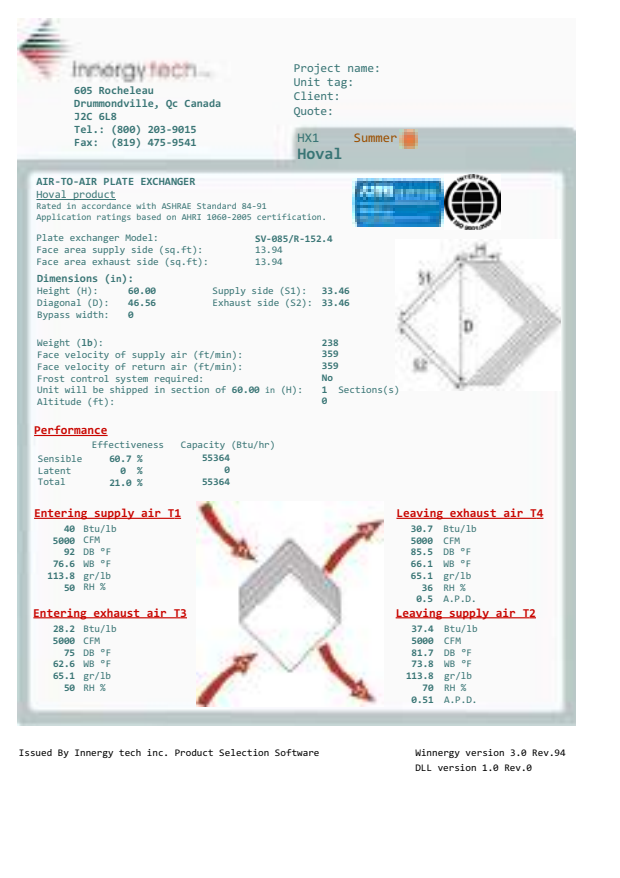


Fig. 18: The design of Hoval plate heat exchangers is easy and quick with the Winnergy Pro selection software.

9.2 Design data

When designing, correct data is essential to achieve the desired values. This is often particularly difficult in air handling installations because the specific density and specific heat are dependent on temperature. Also the water vapour contained in the air is very important for the design. For an exact calculation of a plate heat exchanger the air conditions at entry to the exchanger are required.

Extract air	Air flowrate at exchanger entry	CFM	[m³/s]
	Rel. humidity at exchanger entry	[%]	[%]
	Temperature at exchanger entry	[°F]	[°C]
	Max. pressure drop	in w.g.	[Pa]
Fresh air	Air flowrate at exchanger entry	CFM	[m³/s]
	Temperature at exchanger entry	[°F]	[°C]
	Max. pressure drop	in w.g.	[Pa]

Table 7: Design data for plate heat exchangers (When cooling the data is reversed, i.e. swap extract air for fresh air – corresponding to 'heat releasing' and 'heat absorbing'.)

The following errors should be avoided when collecting the data:

- Volume flow is not equal to mass flow. For an accurate design the mass flows of fresh and extract air should be known.
- For winter operation the moisture in the air is often estimated too high. (Where does the moisture come from?)
- Are the temperatures (fresh air, extract air) really as stated in practice (or are they wishful thinking)?

9.3 Rules and guidelines

Ascertain before designing which rules and guidelines apply. For instance, for some applications (e.g. hospitals) some heat recovery systems are not suitable or can only be allowed after appropriate proving.

9.4 Positioning of unit and system layout

- Where should the heat recovery unit be positioned?
- Which is the optimum air path?
- Which dimensions are allowed?

These questions are important when selecting a plate heat exchanger and should be thoroughly examined in advance. Little general recommendation can be given for positioning and air path. Only take care that condensate, if present, can drain freely and does not remain inside the exchanger, thus causing a higher pressure drop. This is always guaranteed with a downward extract air flow. Yet, in practice all possible airflows and positions are used without any problems. Section 5.4 gives special tips for horizontal installation.

9.5 Cost-effective design

Select the most economical type, regarding efficiency and/or plate spacing. The following rules apply:

- Long periods of operation (e.g. 3 operating shifts)
  → high effectiveness
- Long life span of unit
  → high effectiveness
- High extract air humidity and thus improved effectiveness through condensation
  → medium, large or very large plate spacing
- High dirt hazard
  → large or very large plate spacing

When using plate heat exchangers in process technology, ascertain whether the heat recovery figure is limited due to supply air temperature.
The optimum plate heat exchanger selection can only be based on an economic calculation.

9.6 Twin exchangers

If a particularly high effectiveness is required it is possible to connect 2 or even more plate heat exchangers in series. The total effectiveness is calculated as follows:

$$\Phi_{2total} = \Phi_{2A} + \Phi_{2B} - (1 + \mu) \frac{\Phi_{2A} \; \Phi_{2B}}{1 - \mu \; \Phi_{2A} \; \Phi_{2B}}$$

Various arrangements are possible; the important thing is that the two air streams pass each other in cross flow.

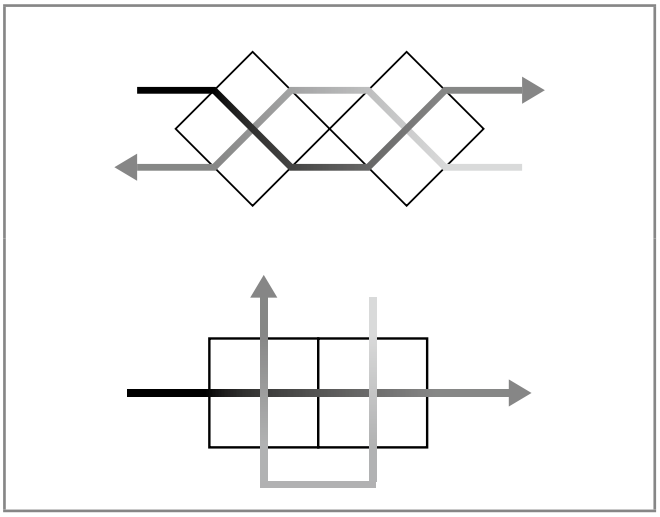


Fig. 19: Twin exchangers offer interesting connection possibilities and highest heat recovery values.

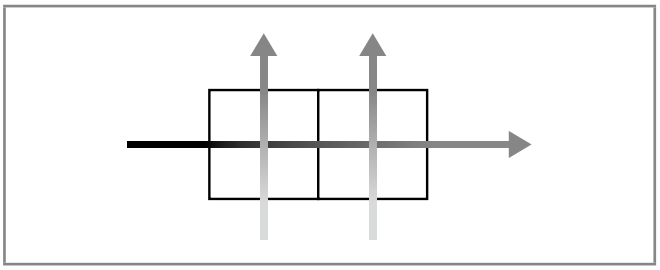


Fig. 20: For unequal mass flow rates check parallel flow or counter flow arrangements.

9.7 Performance control

Check which internal heat sources are available in the hall. If the extract air temperature is expected to be clearly higher than the desired temperature, a performance control of the plate heat exchanger should be considered (see section 2).

9.8 Recirculation bypass

If the air handling installation allows for recirculation operation as well (e.g. during the night) this can also be achieved with a recirculation bypass in the plate heat exchanger. If recirculation is also possible during fresh air operation, reasonable control priorities (recirculation/heat recovery) must be defined.

9.9 Sound attenuation

Plate heat exchangers have a sound-dampening effect. The performance depends on the plate size and spacing. More details based on various tests and theoretical considerations are available upon request.

9.10 Corrosion

Series V of Hoval plate heat exchangers has proved satisfactory for installation into air handling equipment. If corrosion is expected – e.g. in swimming pools, kitchens, and certain industrial applications – series G (corrosion-protected) is used. In special cases series P (stainless steel) is recommended. The Innergy tech technical department will advise which series is suitable for specific applications.

9.11 Application limits

Prior to selecting a plate heat exchanger, check if any application limits have been exceeded (temperature, pressure difference). See also section 6.

9.12 Dirt build-up

In 'normal' air handling equipment the air streams are cleaned mostly by coarse dust filters. Therefore there is no dirt hazard for the plate heat exchanger, but if this is expected, in specific applications, consider the following:

- Position the exchanger in such a way that it can be cleaned easily or
- install in such a way that it can easily be removed for cleaning.
- Fit inspection ports before and after the plate heat exchanger.
- If possible, filter the air streams so that dirt built-up is minimised or cleaning intervals are longer.

It was found in practice that dirt built-up is far less than expected. The Innergy tech technical department will advise if special precautions should be taken based on your application characteristics.

9.13 Condensation in the warm air stream

Plate heat exchangers are not 100 % leakproof unless special measures are taken (see section 1.2 and 1.4). Therefore, if condensation is expected install condensate drip trays on the supply and extract air side. Position the fans in such a way that the pressure gradient and thus leakage is from the supply to the extract air. In addition, the option 'Added full edges seal' is recommended (see section 5.4).
When large amounts of condensate are present in the extract air and the air velocity is higher than 2.5 m/s, condensate drops can be carried along with the airflow and enter ducts or other ventilation components downstream of the heat exchanger. To avoid this and thus uncontrolled condensate escape, we recommend that a drop eliminator is installed after the plate heat exchanger.
In addition, check the following and arrange for appropriate measures:

- How is the condensate drained away?
- Is icing-up hazard expected (see section 1.6)?

9.14 Solvent resistance

Plate heat exchangers may sometimes be used in applications where solvents (e.g. acetone, methanol, toluol, xylol, propanol and MEK) are contained in the extract air stream. These may attack the sealing compound used for the corner sections. The Innergy tech technical department will advise.
For such applications please also consider:

- Control dampers must be installed in the (clean) fresh air stream.
- A pressure gradient from the supply air to the extract air side should be provided, avoiding the transmission of solvents to the supply air. (In addition, a leakage test is recommended.)
- Check if the other materials (aluminium, galvanized steel, etc.) are resistant to the solvent.

9.15 Operation and function reliability

Hoval plate heat exchangers do not require power drive, have no moving parts and thus are 100 % reliable in operation.
Therefore it is possible, at the planning stage, to take recovered heat into consideration. The heat generation and distribution required (boilers, heaters, flues) can therefore be dimensioned and selected on a smaller scale. Thus cost savings are already in evidence at the installation stage.

10 Transport and Installation

Hoval plate heat exchangers have no moving parts. Therefore they are easy to install and totally reliable in operation. The following should be checked before installation:

- Has the plate heat exchanger been damaged during transport (visual check of casing and plate package)?
- Has the correct type been delivered (design, series, size, plate spacing, options)?
- How is the plate heat exchanger to be positioned (installation position)?

10.1 Transport

- The plates should always be vertical during transport.
- The exchangers may be lifted at the side walls, yet to avoid damage the tensile direction must be vertical (parallel to the side wall). Also lifting facilities (hooks, loops, etc.) may be bolted to the returned edge of the side wall for transportation.
- The reinforcing sections on the side walls may also be used for lifting when present.
- Do not lift the exchanger at the aluminium corner section because this might cause damage to the corner sealing (leakage).
- Do not lift the exchanger at the reinforcing bar spacers of the bypass.
- In general: Do not suspend the exchanger in one point but always over a crane beam (Fig. 28).

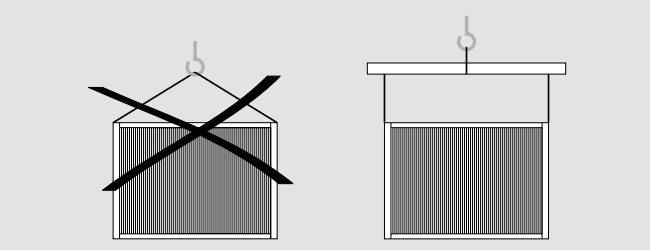


Fig. 21: Do not suspend the exchanger in one point!

10.2 Mechanical installation

The Hoval construction offers particular advantages for installation into air handling units or connection to ducts or other ventilation equipment:

- The corner sections of aluminium are hollow. They can be bolted or riveted without damaging the exchanger.
- Also the flange of the side walls can be used for bolting and riveting.
- The returned edge of the side wall allows easy installation of a sealing all round. It can also be used for side fastening (bolting, riveting).

The examples below show some possibilities for the installation of Hoval plate heat exchangers into air handling units:

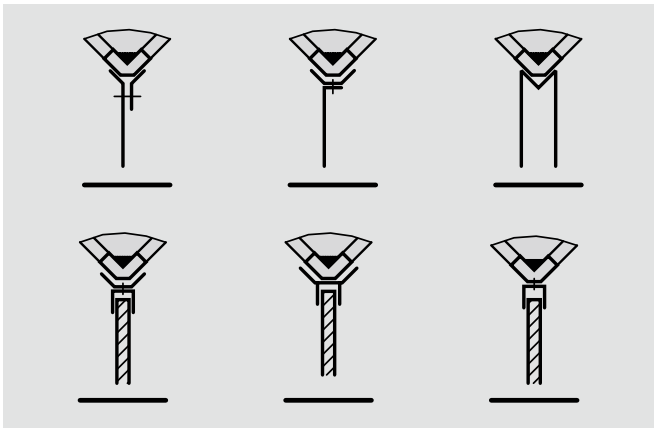


Fig. 22: Installation possibilities

10.3 Condensate drain connection

If condensation is expected make sure that this can drain away freely. We recommend condensate drip trays on both sides, i.e. for both air streams. The expected amount of condensate is calculated with the Innergy tech Winnergy PRO selection software. Correspondingly sized condensate drains should be installed.

10.4 Fitting of sensors and other detectors

If for example temperature sensors are required in the plate heat exchanger, make sure that the exchanger package is not damaged by their installation.

10.5 Assembly on site

Depending on local conditions (particularly for retro-fitting) it may be necessary to deliver the plate heat exchanger in several parts. These must then be assembled on site by bolting and riveting. There are various possibilities for break-down of the exchanger:

- In the width, sections can be manufactured as desired.
- In the height and length, only compound exchangers can be divided. In this case the individual exchanger blocks can be supplied.

11 Commissioning and Maintenance

11.1 Commissioning

Before commissioning, ensure that the air streams can flow freely through the plate heat exchanger.
Furthermore, check if installation has been carried out correctly and make sure that the application limits (temperature, pressure difference, material, etc.) cannot be exceeded.

11.2 Maintenance

Only periodic visual checks are necessary.
Based on long experience, dirt build-up inside the plate heat exchangers installed in air handling equipment is not expected. Yet should dirt enter the plate heat exchanger when used for special applications, e.g. welding shops, paint shops, kitchen extracts, etc., the exchanger package can be cleaned as follows:

- Remove dust and fibres with a soft brush or with a vacuum cleaner. Take care when cleaning with compressed air that the exchanger package is not damaged. Keep at a distance!
- Oils, solvents, etc. can be removed with hot water or grease solvents, by washing or immersing. Cleaning with high-pressure devices is possible if:
  – a flat nozzle 40° is used (type WEG40/04)
  – the maximum water pressure is 1450 psi (100 bar)

Attention
When cleaning take care that the exchanger is not damaged, neither mechanically nor chemically:
→ Choose harmless cleansing agents.
→ Clean carefully.

12 Specification Text

12.1 Hoval S series by Innergy tech

Hoval cross-flow plate heat exchanger for heat recovery, consisting of exchanger package and casing:
The exchanger package consists of aluminium plates with pressed-in spacers; condensate drainage is possible in every direction.
The plates are connected by a fold, which gives a severalfold material thickness at air entry and exit.
The corners of the exchanger package are sealed into especially rigid aluminium extrusions in the casing with a sealing compound. The side walls of galvanized steel are bolted tightly to these extrusions.
All performance data is AHRI-certified.
A hygiene certificate of ILH Berlin (institution of air hygiene) confirms the exchangers suitability for use in general air handling systems as well as in hospitals.

Series V (standard):
Aluminium plates, extruded aluminium sections and galvanized sheet steel; silicone-free; resistant to temperatures up to 194 °F (90 °C).

Series G (corrosion-protected):
All components (aluminium plates, extruded aluminium sections and galvanized sheet steel) coated; silicone-free; resistant to temperatures up to 194 °F (90 °C)

Series T (high-temperature):
Aluminium plates, extruded aluminium sections and galvanized sheet steel; special sealing agent, resistant to temperatures up to 392 °F (200 °C).

Technical data				
Type				
Weight			lbs	kg
Height x width x length			inch	mm
Warm air	Air flowrate at exchanger entry	V_{11}	CFM	m^3/s
	Temperature at exchanger entry	t_{11}	°F	°C
	Rel. humidity at exchanger entry	RH_{11}	%	%
	Temperature at exchanger exit	t_{12}	°F	°C
	Pressure drop (with condensation)	Δp_1	in w.g.	Pa
Cold air	Air flowrate at exchanger entry	V_{21}	CFM	m^3/s
	Temperature at exchanger entry	t_{21}	°F	°C
	Rel. humidity at exchanger entry	RH_{21}	%	%
	Temperature at exchanger exit	t_{22}	°F	°C
	Pressure drop	Δp_2	in w.g.	Pa
Mass flow ratio		m_2/m_1		

Symbol	Unit		Term
A	pi^2	m^2	Exchanger surface area
b	in or ft	mm or m	Width of the exchanger package
d	in	mm	Plate thickness
h	Btu/lb	kJ/kg	Enthalpy
k	Btu/(ft² hr °F)	W/m^2K	Heat transmission
m	lb/h	kg/h	Mass flow = V ρ
Δp	in w.g.	Pa	Pressure drop
Q	Btu	kW	Heat performance
t	K or °F	K or °C	Temperature
V	CFM	m^3/h	Volume flow
α	Btu/(ft² hr °F)	W/m^2K	Heat transfer rate
Φ	%	%	Heat recovery efficiency $\Phi_1 = \frac{t_{11} - t_{12}}{t_{11} - t_{21}} 100$ $\Phi_2 = \frac{t_{22} - t_{21}}{t_{11} - t_{21}} 100$
RH	%	%	Relative humidity
ρ	lb/pi^3	kg/m^3	Specific density
μ	–	–	Mass flow ratio $\mu = \frac{m_2}{m_1}$
λ	Btu/(ft hr °F)	W/mK	Heat conductivity
ζ	–	–	Drag coefficient
First index			1 ..... Heat releasing medium 2 ..... Heat absorbing medium
Second index			1 ..... Plate heat exchanger entry 2 ..... Plate heat exchanger exit

Collar

ABOUT INNERGY TECH

For more than 20 years, Innergy tech has been providing state-of-the-art, air-to-air heat and energy recovery products to the HVAC industry. With over 1 million residential and commercial products sold in more than 20 countries around the globe, Innergy tech is recognized as a world market leader in the heat and energy recovery industry. Our company is known for the quality of its products, its highly skilled technical services and for its ability to meet its commitments to its customers.

Founded in 1995, Innergy tech has already moved 3 times to larger facilities in response to the increasing worldwide demand and is now operating in a 41,000 sq. feet modern facility. With the help of state-of-the-art manufacturing equipment, all the latest lean manufacturing concepts have been implemented and are supported by a comprehensive quality management system certified under the ISO 9001 standards. Visitors are always welcome to see for themselves how Innergy tech can help bring their company to new levels.

Innergytech factory (Drummondville, Canada)

Innergy tech expertise

Research and development of new products at the leading edge of technology has always been our strength. It is the reason why we are now offering, and constantly improving, the most complete product line in the heat and energy recovery industry. If you are looking for Energy Recovery Wheels (Heat Wheels), Heat Pipes, Sensible or Enthalpy Plates Exchangers we can fill your needs.

Certified performance at Innergy tech

At Innergy tech, we strongly believe in third party certified performances as the only way to insure quality products that will perform as designed. Based on this belief, we have been part of the AHRI1060 certification program from its very beginning as well as being an active AHRI (Air-Conditioning, Heating & Refrigeration Institute) member. This continuous effort resulted in a well-established industry certification program, which is now making the life of our customers far easier since they no longer have to accept self-certified products. This certification will give you peace of mind.

setting the standard
for energy recovery

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HEAT PIPES • PLATES
WHEELS • CORES

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