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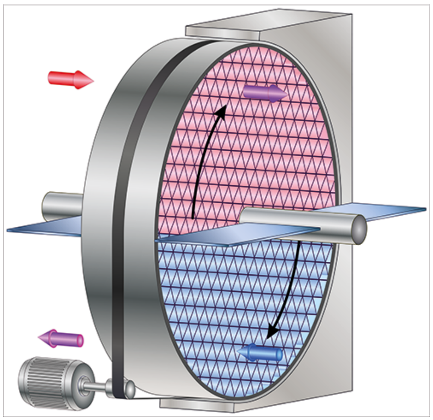
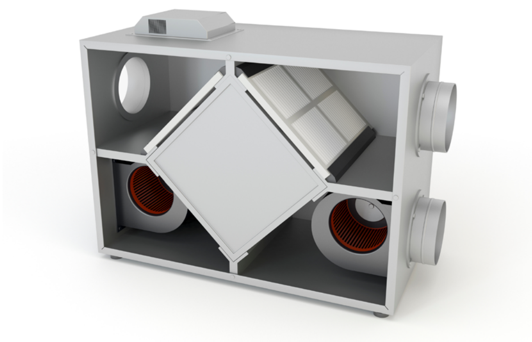
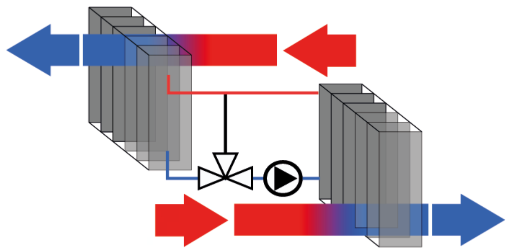
AIR-TO-AIR ENERGY RECOVERY EQUIPMENT







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"Air-to-air energy recovery is often the best solution for a significant reduction in energy needs but also in installed heating or cooling capacity."

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Summary

Air-to-air energy recovery provides an energy exchange between two air streams at different temperatures and humidities. The energy content of the air can be split into a sensible and a latent fraction. When the energy recovery involves only a temperature difference, the heat exchange is indicated as sensible. If both temperature and humidity differences are involved, the heat exchange is indicated as total, i.e. sensible and latent.

Air-to-air energy recovery is particularly useful in building ventilation, where it can provide fresh air preheating in winter and pre-cooling in summer, with the potential to significantly reduce the energy and financial costs of ventilation.

Many technologies are available for heat recovery ventilation. Heat exchangers can be recuperative (a solid wall separates the two fluids) and regenerative (heat exchange is operated through a solid, permeable material or liquid intermediate system). The heat exchange can be only sensible or total (sensible and latent).

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Introduction

Decreasing energy consumption in the various sectors has become a major concern in many countries and particularly in the EU states. The building sector offers significant opportunities for energy savings, as it is responsible for up to 40% of the total energy demand. At the same time, total energy consumption can be strongly reduced in a building with relatively simple measures such as better insulation, elimination of thermal bridges and increasing the air tightness of the envelope. Reducing the infiltration of outside air makes it compulsory to set up appropriate ventilation rates. Moreover increasing air quality requirements with corresponding higher ventilation rates result in high energy costs, especially in climates with a greater difference in air enthalpy between outside and inside. Air-to-air energy recovery is often the best solution for a significant reduction not only in energy needs but also in installed heating or cooling capacity. The energy recovery is achieved by air-to-air heat exchangers where two air streams circulate: one stream reduces its enthalpy or temperature while the other stream increases it. When only a temperature variation is involved, the energy exchange is said to be sensible. When both temperature and humidity variations are involved, the energy exchange is said to be total, or sensible and latent. Sensible heat exchange devices are by far the most widespread. There are also enthalpy exchangers, capable of transferring both heat and moisture, also referred to as total heat exchangers, and although they are more expensive, they may be preferable in some situations to the sensible energy exchange only.

Air-to-air energy recovery equipment also has applications in industry whenever gas streams exhausts from furnaces, ovens, driers or similar processes involving hot air, can be used for preheating fresh air prior to the process, or for other plant heating purposes. In industrial use, the correct definition is gas-to-gas energy recovery [1][2]. In fact, some of the above applications involve combustion exhaust or smokes, not just air. The chemical industry operates with many other different gases. The equipment is often very similar to the heat exchangers used in buildings: the main difference regards the materials, which must operate at much higher temperatures and sometimes in a corrosive environment. Industrial applications are beyond the scope of this Informatory Note, which will only deal with civil applications.

In cold weather, the energy recovery device takes energy from the exhaust air stream by increasing the temperature and moisture of the ventilation air with an enthalpy heat exchanger and only temperature for a sensible heat exchanger. The opposite operation takes place in warm weather with a decrease in enthalpy (temperature and moisture) or only in the temperature of the ventilation air. Heat recovery ventilation is not always profitable, e.g. in mid-season, when it might prevent possible free-cooling[1]. Therefore, it is strongly recommended to use equipment allowing for easily overridden recovery (a feature that will be mentioned when available in the description of the various equipment in the following) or a suitable by-pass that can exclude the heat exchanger [3][4]. The provision of a by-pass in the circuit is also beneficial in reducing parasitic energy of the fans when heat recovery is not desired.

When assessing the performance of a heat recovery system, the enthalpy of the air should be the primary consideration.

Air enthalpy

The enthalpy of a gas mixture can be calculated by adding the enthalpies of its components. Humid air is a mixture of dry air and water vapour. The enthalpy of this mixture is usually expressed in terms of the *unit mass of the dry air*. In this way, the total mass of the mixture includes the mass of the dry air plus the corresponding water vapour. The total mass is therefore 1+x mass unit, where x is the specific humidity of the air or humidity ratio ($kg_v kg_a^{-1}$). The specific enthalpy h of the air is then given by:

$$h = h_a + x h_v$$

Equation (1)

Where:
h_a = dry air enthalpy ($kJkg^{-1}$),
h_v = water vapour enthalpy ($kJkg^{-1}$).

An acceptable approximation in SI units of measure is given by (t is the air temperature in Celsius degrees):

$$h = 1.005t + x(2501 + 1.9t) \quad kJkg_a^{-1}$$

Equation (2)

Air enthalpy, according to equation (2), can be split with a good approximation into a sensible fraction ($1.005t+1.9tx$) and a latent fraction ($2501x$). A temperature variation gives rise to a variation in dry air enthalpy and a much smaller variation in water vapour enthalpy. A variation in humidity implies a variation in the latent fraction of the air enthalpy and a modest variation in the sensible fraction. This is because the air humidity is in the small range of 0.01-0.02 $kg_v kg_a^{-1}$ at ambient conditions. Table 1 gives air enthalpy for certain air conditions (temperature and relative humidity) and the fractions of sensible and latent energy content. The order of magnitude illustrates the possible advantages of total or only sensible heat recovery.

[1] Free cooling in ventilation is the possibility of cooling with simple outside air input, possible when its temperature is lower than indoor temperature

Table 1

Specific humidity *x*, enthalpy *h*, sensible and latent fractions at certain air temperature and relative humidity (RH)

Temperature	RH %	x (gkg$_a^{-1}$)	h (kJkg^{-1})	$h_{sensible}$ (%)	h_{latent} (%)
0°C	50%	1.9	4.8	0.0%	100.0%
	100%	3.8	9.5	0.0%	100.0%
5°C	50%	2.7	11.8	42.8%	57.2%
	100%	5.4	18.6	27.3%	72.7%
10°C	50%	3.8	19.6	51.6%	48.4%
	100%	7.6	29.2	34.9%	65.1%
15°C	50%	5.4	28.7	53.0%	47.0%
	100%	10.7	42.1	36.5%	63.5%
20°C	50%	7.3	38.6	52.7%	47.3%
	100%	14.7	57.4	36.0%	64.0%
25°C	50%	9.9	50.3	50.8%	49.2%
	100%	20.1	76.3	34.1%	65.9%
30°C	50%	13.2	63.9	48.3%	51.7%
	100%	26.5	97.9	32.3%	67.7%

Definitions and concepts

Some definitions and concepts are necessary to describe air-to-air heat exchanger performance [5]:

- Heat exchanger effectiveness
- Flow configuration
- *NTU*, Number of Transfer Units
- Pressure drop
- Compactness

HEAT EXCHANGER EFFECTIVENESS

As mentioned above, heat exchangers are capable of recovering both sensible and latent heat from the air, operating what is known as total heat or only sensible heat recovery. Effectiveness is defined for both types:

$$\varepsilon_t = \frac{W_{ex}(h_i - h_u)}{W_{\min}(h_i - h_e)} = \frac{W_{in}(h_{in} - h_e)}{W_{\min}(h_i - h_e)} \qquad \varepsilon_s = \frac{W_{ex}(t_i - t_u)}{W_{\min}(t_i - t_e)} = \frac{W_{in}(t_{in} - t_e)}{W_{\min}(t_i - t_e)}$$

Equation (3)

Where:

ε_t = total effectiveness
ε_s = sensible effectiveness
W_{ex} = exhaust air mass flow rate
W_{in} = fresh air mass flow rate
W_{min} = minimum value of the two flow rates
h_i, t_i = room enthalpy/temperature
h_e, t_e = outside air enthalpy/temperature
h_{in}, t_{in} = supply enthalpy/temperature after the heat exchanger
h_u, t_u = heat exchanger exhaust enthalpy/temperature

The exhaust airflow rate is usually lower than that of fresh air, especially to achieve a slight inside overpressure, which eliminates uncontrolled air and dust infiltration. The fraction is normally about 90%. Even if the effectiveness of an air-to-air heat exchanger can approach 95%, the most common values are between 50% and 70%.

FLOW CONFIGURATION

The most common configurations of the air streams inside the heat exchanger are as follows:

- Counter-flow (the two air streams move in opposite directions in the heat exchanger);
- Parallel flow (the two air streams move in the same direction);
- Cross-flow (the two air streams cross each other inside the heat exchanger).

Although the most efficient configuration is usually counter-flow, the most common is cross-flow as it allows for easier installation of the ducts.

NTU, NUMBER OF TRANSFER UNITS

The Number of Transfer Units, *NTU*, is defined as follows:

$$NTU = \frac{UA}{C_{\min}}$$

Equation (4)

Where:
U= overall heat transfer coefficient ($kWm^{-2}K^{-1}$)
A= heat transfer area of the exchanger (m^2)
C_{min}= minimum thermal capacity rate, for only sensible exchange $c_p W_{min}$ (c_p moist air specific heat, $kJkg^{-1}K^{-1}$).

The other air stream is designated as C_{max}.

The overall heat transfer coefficient depends mainly on the characteristics of the heat exchanger surfaces and on air velocity.

The sensible effectiveness variation for a given flow configuration can be expressed, when the ratio C_{min}/C_{max} is fixed, as a function of *NTU* (figure 1).

PRESSURE DROP

The heat exchanger introduces a pressure drop on both airstreams. Consequently, two fans must be provided. The required fan power P can be estimated by:

$$P = \frac{Q\Delta p}{\eta}$$

Equation (5)

Where:

P= fan power (W)
Q= volume flow rate (m^3s^{-1})
Δp= pressure drop (Pa)
η= overall efficiency of fan

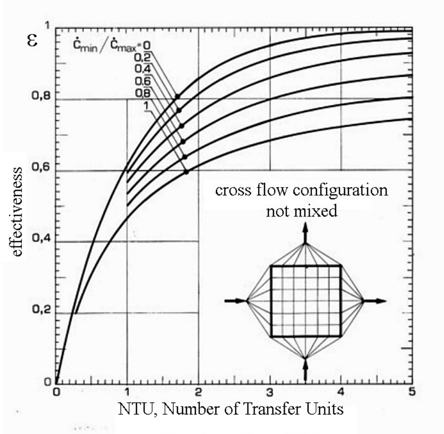

Figure 1

Sensible effectiveness as a function of *NTU* for different C_{min}/C_{max} ratios in an unmixed cross flow

The pressure drop is usually in the order of a few hundred Pa, while the effectiveness of the fan depends strongly on the design, type and size with a value that can be generally between 25% and 50%.

The energy cost of these fans should be considered carefully as pressure drop is always present, even if heat exchange is not required (neither in cold nor in warm weather). As already mentioned, when possible, the heat exchanger should be by-passed whenever its operation is not useful.

COMPACTNESS

The volume of a heat exchanger should be considered in relation to the space it requires, as space is not always easily available in a building. A good heat exchange capacity is a welcome feature. It can be expressed as the heat exchange unitary capacity ($Wm^{-3}K^{-1}$), which is the rate of heat exchanged by one cubic meter of the heat exchanger for 1 K of temperature difference between the two streams.

Air-to-air sensible heat exchangers

Heat exchangers can be either recuperative (a wall of solid or permeable material separates the two fluids) or regenerative (the heat exchange is operated through an intermediate solid or liquid system) [6] [7] [8].

The most common recuperative heat exchangers are:

- Fixed plate heat exchangers
- Heat pipe heat exchangers
- Thermosiphon heat exchangers
- Run-around coil heat exchangers

The most common regenerative heat exchangers are:

- Alternate flow heat exchangers
- Rotary heat exchangers

FIXED PLATE HEAT EXCHANGERS

The most widespread air-to-air heat exchanger is the fixed plate. Multiple thin plates are stacked together to form channels where the two air streams flow through each other. The most common configuration is the cross-flow (Figure 2).

The plates are usually made of aluminium and can be smooth or corrugated. Smooth plates result in a lower pressure drop which increases with corrugation. Corrugation allows for better heat transfer coefficients. Plate thickness ranges from 0.25 to 0.40 mm. The effectiveness, which concerns only the sensible fraction, can reach 80%. Typical values are 50% to 70%. The heat exchange unitary capacity is in the order of 4,000 $Wm^{-3}K^{-1}$. Figure 3 reports the pressure drop of a fixed plate heat exchanger as a function of air velocity. Typical pressure drops are between 100 and 200 Pa and are strongly influenced by the air velocity. Figure 3 also gives the effectiveness. The reduction in effectiveness may be surprising because a higher velocity allows higher heat transfer coefficients. The fact is that NTU has a slight reduction for higher flow rates, because the heat transfer coefficient U increases with an exponent that can be of the order of 0.8, but the flow rate in the denominator of NTU increases with unitary exponent.

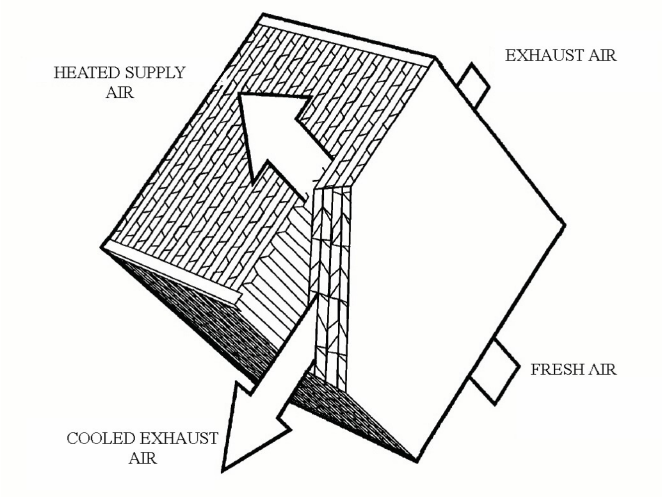

Figure 2

Fixed plate heat exchanger in cross-flow configuration

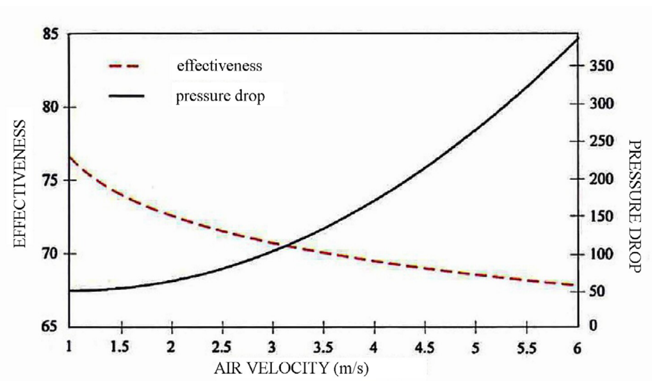

Figure 3

Sensible effectiveness and pressure drop of a fixed plate heat exchanger as a function of air velocity

Fixed plate heat exchangers are available in a very wide range of sizes from flow rates as low as 0.01 m^3s^{-1} suitable for single room ventilation, up to 50 m^3s^{-1} for large halls or shopping centres.

HEAT PIPE HEAT EXCHANGERS

A heat pipe is a sealed tube containing a substance, which, in the operative temperature field, changes state from liquid to vapour. Heating a section vaporises the liquid; the vapour moves toward the other section where it condenses with the heat transfer. Figure 4 illustrates the operation with the inner surface wicked so that the liquid returns to the evaporation section by capillary action with a horizontal position or even with some degree of adverse slope. Of course the liquid can return by gravity for a tilted position with the evaporator down.

Heat transfer in a heat pipe requires a modest temperature difference between the warm and cold streams, even as low as 1°C.

The heat exchanger consists of several parallel heat pipes that form a battery where the cold and warm sections are separated by a partition that is sometimes double-walled to prevent cross-contamination with total reliability (Figure 5). The partition can be fitted between 25% and 75% of the pipe length depending on the relative flow rates. The heat exchange unitary capacity is very high at around 7,000 $Wm^{-3}K^{-1}$.

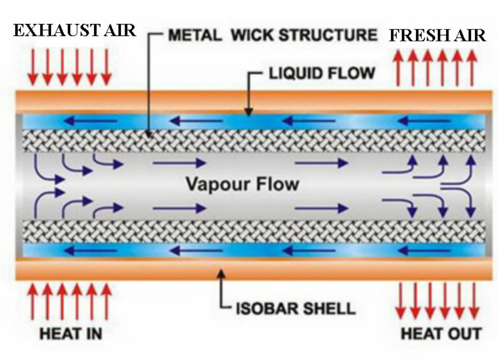

Figure 4

Section of a heat pipe

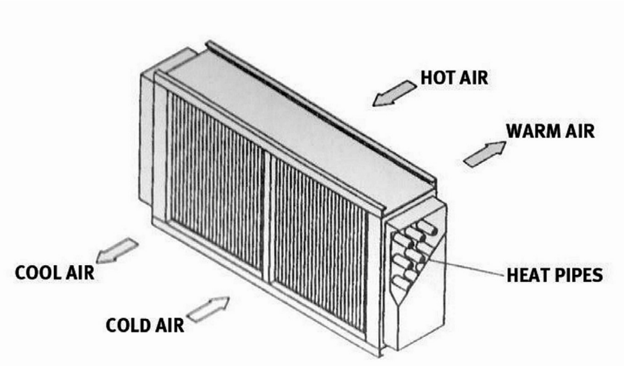

Figure 5

A heat pipe heat exchanger

The effectiveness is strongly dependent on the slope of the pipes: at an adverse slope with evaporator up of only a few tens of mm, the effectiveness quickly drops to zero. Then when a tilt controller is provided, the heat exchanger can be easily excluded from the heat exchange, e.g. when free cooling is possible, avoiding preheating of fresh air.

The effectiveness depends mainly on the number of pipes rows and can approach 80% with a modest influence of the air front velocity (Figure 6). Experiments have been conducted with promising results using flat micro heat pipes [9]. The heat transfer capacity of a heat pipe is almost proportional to the square of the pipe diameter and does not depend on its length. The pipe surface must be properly finned to allow acceptable heat transfer between the air streams and the pipe.

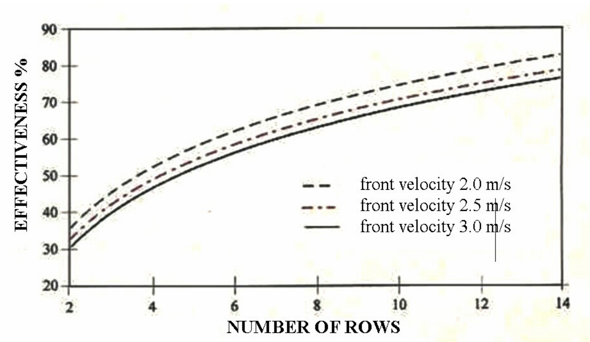

Figure 6

Sensible effectiveness of a heat pipe heat exchanger as a function of the number of rows for three different front velocities

THERMOSIPHON HEAT EXCHANGERS

Thermosiphon heat exchangers rely on a similar phase change as heat pipes. They are sealed systems consisting of a condenser, an evaporator and interconnecting pipes. The intermediate substance inside the system evaporates when the evaporator coil is heated by warm air, and then condenses at the condenser coil transferring heat to the other air stream. In a typical configuration, the condensate returns to the evaporator by gravity, with the condenser located above the evaporator, as in figure 7. A configuration with the condenser and evaporator at the same level is possible but less efficient. The advantage is that this configuration can be bidirectional.

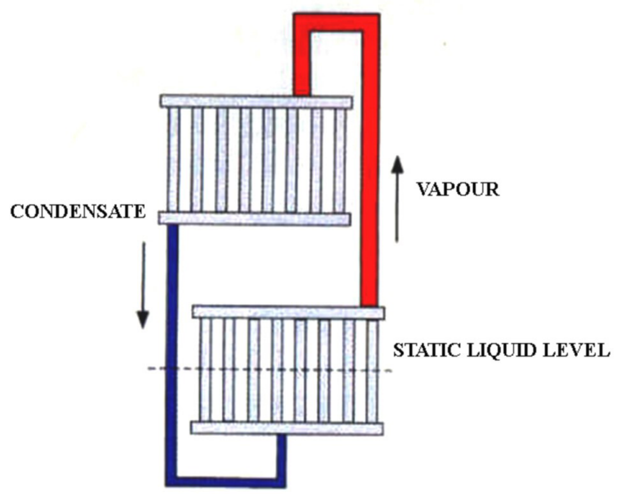

Figure 7

Thermosiphon heat exchanger loop

RUN-AROUND COIL HEAT EXCHANGERS

A run-around coil heat exchanger is a system that consists of two coils connected by a hydronic circuit where water or an antifreeze water solution (sometimes diathermic oil) is circulated by a pump. The hydronic circuit is equipped with an expansion tank to allow the liquid expansion). One coil is located in the duct where fresh air flows and the other in the exhaust air stream. The circulating liquid transfers heat from one air stream to the other (Figure 8).

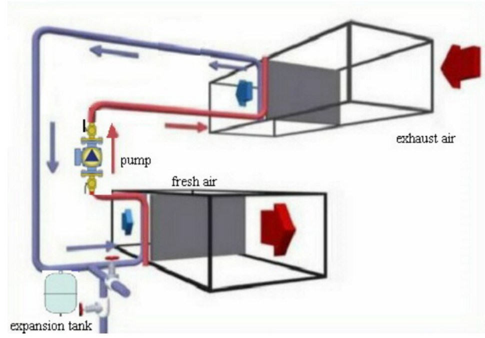

Figure 8

Run-around coil system layout

As heat transfer requires two steps, from one air stream to the liquid and then from the liquid to the other air stream, the usual effectiveness range is rather low, from 40% to 60%, rarely reaching 70%. The heat exchange unitary capacity is about 4,700 $Wm^{-3}K^{-1}$. This rather low effectiveness is compensated by a series of advantages. The main advantage is the flexibility in connecting the two air streams. This operation usually requires an expensive ductwork, while the interconnecting pipe in this system requires little space and little labour. At the same time the exhaust and inlet air ducts can be located several meters apart, a really welcome feature in case of retrofit.

This heat exchanger can be excluded from the heat transfer, simply by switching off the pump, to allow possible free cooling. No cross-contamination is possible between the two air streams.

ALTERNATE FLOW HEAT EXCHANGERS

Whereas in run-around coils, a liquid transfers energy from one air stream to the other, in alternate flow heat exchanger, the role is played by a solid in the form of a matrix, often metallic, through which the exhaust air or fresh air alternate (Figure 9). The hot flow increases the internal energy of the matrix, which can then release energy to the cold flow. Of course, the heat recovery is alternating. To overcome this unfavourable feature, a double matrix can be provided, alternating the flows according to a control that suitably drives a series of dampers. The resulting system is bulky and complex, however, it achieves the highest effectiveness of any air-to-air heat exchanger, even reaching 95%.

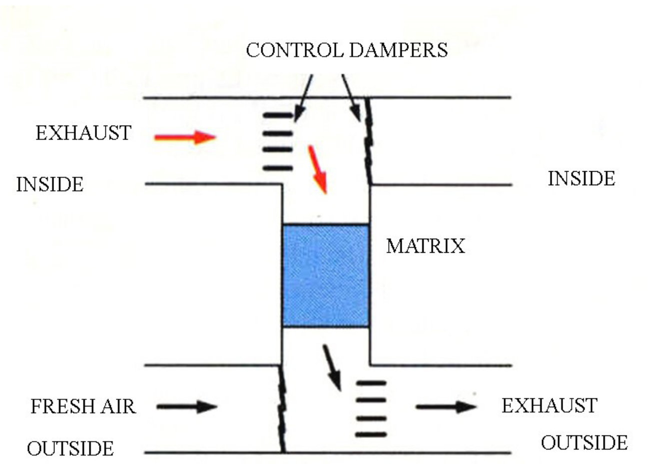

Figure 9

Alternate flow heat exchanger

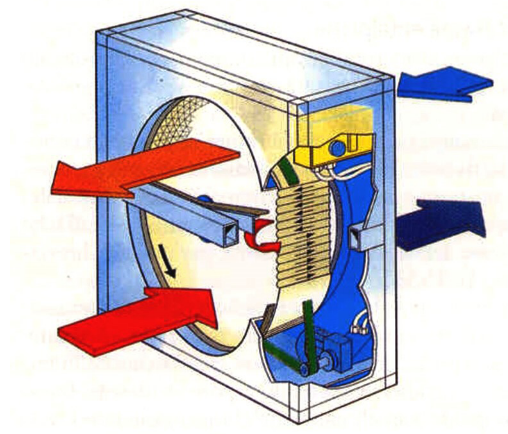

Figure 11

Rotary heat exchanger (Source ABB Econovent-Munters)

ROTARY HEAT EXCHANGERS

An easier solution to overcome intermittent heat recovery from the alternate flow heat exchanger is the rotary heat exchanger. A wheel made up of a suitable matrix of a knitted aluminium or steel wire, but more often consisting of corrugated sheets (Figure 10), spans two adjacent ducts carrying exhaust and fresh air (Figure 11). The matrix absorbs heat from the hot gas passing through it and transfers heat to the other flow by rotating.

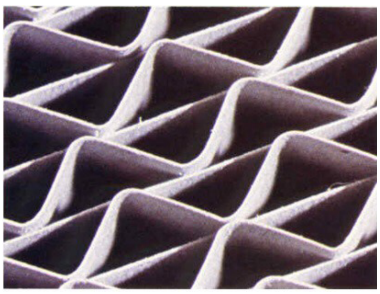

Figure 10

Corrugated sheets matrix

The effectiveness for a given matrix is highly dependent on both the air velocity, as previously considered for other heat exchangers, and on the rotor speed with a value that increases rapidly up to a rotational speed of 6-10 rounds per minute as shown in Figure 12. The effectiveness can then reach up to 80%. The heat exchange unitary capacity is about 5,400 $Wm^{-3}K^{-1}$. When the wheel is stopped, the heat exchanger is excluded from the heat transfer, to allow for possible free cooling. Appropriate control, implemented in the most advanced models, lowers the rotational speed for reduced heat load duties.

The main drawbacks of rotary heat exchangers are their cost (it is usually the most expensive equipment for a given duty) and the cross-contamination of the two air streams. The contamination is due to seal leakage at the circumferential and central gaskets, but mainly to the carryover. Theoretically the air content of the matrix is transferred from one air stream to the other at each wheel revolution. Then the carryover increases with the rotational speed, the depth of the wheel and the void volume of the matrix (usually in the range of 75-95%) and it can easily exceed 5% of the air flow. eSome manufacturers incorporate a purge section to limit contamination: a fraction of the supply air is used to scavenge the matrix just after the exhaust duct as shown in Figure 11. The carryover can thus be reduced to less than 0.1%, which however reduces the effectiveness.

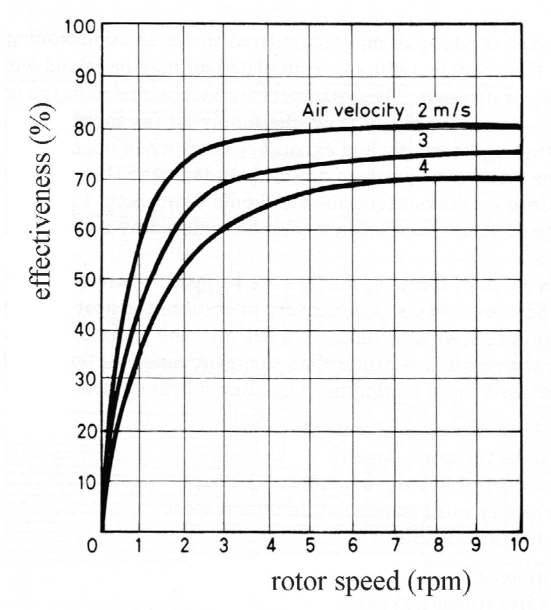

Figure 12

Sensible effectiveness of a rotary heat exchanger for three different air velocities as a function of the rotational speed

FROSTING

Although the above considered heat exchangers rely on sensible heat recovery, condensation can occur in the exhaust duct in case of low outside temperatures or very humid exhaust air. Drainage of condensate must then be provided. In severe climates, frost can form on the heat exchanger's surface, reducing cross sectional area of the exhaust flow with the possibility of blocking the flow completely. A frost control is therefore recommended in very cold climates. Various methods are used to prevent frosting. Preheating the supply air is one possibility (of course less energy efficient). Another method is the reduction of the heat exchanger effectiveness, by bypassing some of the supply air or by taking special measures according to the heat exchanger type, such as tilting the heat pipes, reducing the heat wheel rotation or bypassing part of the liquid in the run-around coils system.

Air-to-air total heat exchangers

The most common total heat exchangers are:

- Membrane plate exchangers
- Rotary enthalpy heat exchangers
- Twin tower enthalpy recovery system

MEMBRANE PLATE HEAT EXCHANGERS

The plate heat exchanger can be made with paper plates treated with a hygroscopic substance or with microporous permeable polymer membranes, both of which are capable of transferring moisture from one air stream to another. The typical sensible effectiveness of these heat exchangers ranges from 55 to 75%, while the latent effectiveness can be between 25 and 60%. Careful air filtration is strongly recommended to prevent membrane fouling or the washout of the hygroscopic salt from the treated paper. This technology is not widespread, as there are few manufacturers.

ROTARY ENTHALPY HEAT EXCHANGERS

Rotary enthalpy heat exchangers are outwardly quite similar to the rotary sensible heat exchangers described above. The main difference is the matrix, the sheets of which are coated with a hygroscopic substance like alumina (aluminium oxide) or are made of a special paper impregnated with a concentrated aqueous solution of LiCl. The matrix absorbs heat and moisture from the hot and humid stream, which are then transferred to the other stream. In winter, the fresh air is preheated and humidified, while in summer it is precooled and dehumidified. In industrial processes, a similar device is the dehumidification wheel, which operates between a process air stream to be deeply dried and a high temperature (above 80°C) regeneration air. It should be noted that the rotational speed of enthalpy wheels differs significantly from that of sensible wheels. The typical rotation speed of sensible wheels is 10 rounds per minute, while that of enthalpy wheels is 10 rounds per hour [8].

Total effectiveness can reach 80%, while sensible effectiveness is in the range of 65-80% and latent effectiveness between 50 and 80%.

To better appreciate these performances, consider that summer outside air at 35°C and 15.7 gkg^{-1} specific humidity (44% relative humidity) might be pre-cooled to 27.2°C, reducing the specific humidity to 11.6 gkg^{-1}. For winter operations, outside air at 0°C and 2.9 gkg^{-1} might be preheated to 15°C and humidified up to 5.5 gkg^{-1} (room conditions 22°C, 6.6 gkg^{-1} with a relative humidity of 40%). The possible humidification of the air in winter, as just evaluated, may be not be acceptable in the presence of high latent internal loads (swimming pools, kitchens, showrooms, and crowded rooms), as emphasised in another Informatory Note [3]. A careful analysis of the climate and internal loads should therefore be carried out whenever the use of an enthalpy heat exchanger is considered.

TWIN-TOWER ENTHALPY RECOVERY SYSTEM

A twin-tower enthalpy system consists of two packed towers where a hygroscopic aqueous solution (often an aqueous solution of LiCl or $CaCl_2$) is sprayed onto the packing material such as Raschig rings, to provide a large surface area within the volume of the tower (Figure 13). The solution circulates continuously between the two towers. One tower is crossed by the exhaust air stream (exhaust unit), the other by the supply air (supply unit).

In winter operation, the sorbent takes heat and moisture from the exhaust stream, transferring them to the supply air. In summer the sorbent cools and dehumidifies the supply air, transferring heat and moisture to the exhaust air. The solution in the exhaust unit is generally hot enough to allow regeneration. Adequate heating of the solution may be required to achieve the required regeneration, hence the heat exchanger on the top left of the figure, supplied by hot water. At the same time, proper cooling of the sorbent may be required before it is sprayed into the supply unit. This is achieved by the heat exchanger at the top right of the figure, supplied by chilled water. The two different temperatures in the exhaust and supply units justify the presence of a solution heat exchanger as shown on the bottom of the figure.

This system is applied to large all-air systems. Cross-contamination is very low and depends on the solubility of the air in the solution. It should be noted that desiccants are bactericidal. Correct tuning of the plant is fundamental with appropriate technical support from the manufacturers.

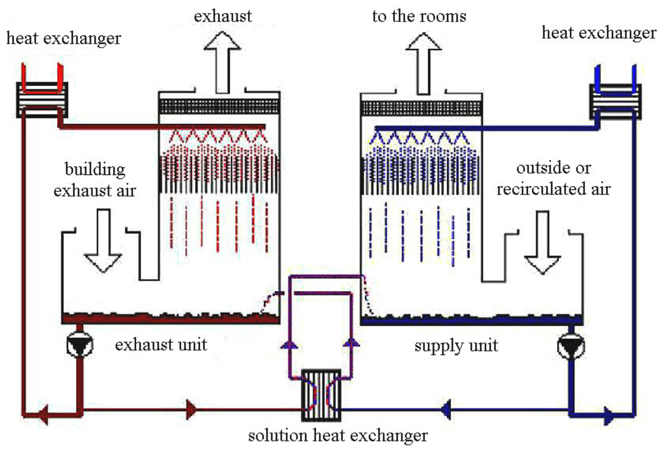

Figure 13

Typical twin-tower enthalpy recovery system

CONCLUSION

Air-to-air energy recovery can be achieved by a great variety of devices, which differ in terms of effectiveness, pressure drop, ability to exclude heat exchange and whether they allow only sensible or total heat recovery. And, of course, they also differ in terms of cost. The best equipment application requires the designer to have a thorough knowledge not only of the equipment behaviour, but also of the characteristics of the system to be served: temperature, humidity, flow rates, thermal loads and outside climatic conditions.

It is strongly recommended to install an appropriate control on the heat recovery system whenever possible, in order to allow for eventual free cooling, by stopping heat recovery. As mentioned above, this action is easily achievable in some heat exchangers such as heat pipes (suitable tilting of the pipes), or run-around coils (stopping the pump) or rotary heat exchangers (stopping the rotation of the wheel). For the other typologies, the best solution is to provide a bypass of the heat exchanger, also eliminating the corresponding pressure drop, whenever heat recovery is not profitable. In any case, the designer should carefully evaluate the pressure drop of the heat exchanger in order to limit the parasitic energy cost of the fans.

Energy benefits of heat recovery can be really valuable in both building ventilation and various process applications, with a reduction in energy cost that can exceed 70%.

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IIR recommendations

Heat recovery in mechanical ventilation systems requires appropriate equipment selection. Therefore, the IIR stresses the need to:

- Develop strong worldwide campaigns on the characteristics, performance and cost of available air-to-air energy recovery equipment to raise awareness among potential users, engineers and architects.
- Organise specific courses for designers and installers on the appropriate choice and installation of heat recovery equipment according to the climate and building requirements, making the best possible use of the performance of available devices.
- Set up incentive schemes and guidelines to promote the most efficient utilisation of air-to-air heat recovery equipment both in building ventilation systems and in various industrial process applications.

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