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Rotary heat exchangers

save energy and prevent a need for recirculation which contributes to the decrease the risk of COVID-19 transfer

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The benefits of good ventilation and indoor air quality for comfort, health and productivity in both places of work and homes is undisputed. According to WHO "poorly ventilated buildings affect air quality and can contribute to the spread of disease".

Other studies show that increasing the outdoor ventilation rate and minimising recirculation has a significant effect on reducing the spread of disease. By increasing the flow of well treated outdoor air we can dilute pollution in the room air. The room air distribution system needs to be effective in ensuring a proper ventilation of the whole space which also means effectively removing contaminants. This is influenced by the design of the room air devices and their positioning in the room. It is important to avoid short circuiting from supply air diffusers to extract valves.

It is also recommended that rooms can be additionally ventilated by opening windows but this, of course, depends on the weather, level of pollution and level of noise outside. Full fresh air ventilation systems with energy recovery provide a more reliable and comfortable solution.

Recirculation of air is to be avoided and this means we need to also avoid leakage of the extract air to the supply air in the ventilation unit.

The mechanism of transfer of the COVID-19 in air is still not clear although testing is being carried out now. It is then, possible that the virus can travel on aerosols with the ventilation air through the duct systems but to date, there is no evidence that virus can be transferred through a full fresh air ventilation system. A portion of that aerosol leaving the room will likely be caught by the surfaces of the ducts and duct components. Furthermore, ePM-filters will also catch a portion of the aerosol so by the time the extract air enters the ventilation unit the virus load will have been diluted.

Leakage of air in ventilation systems is, of course, wasteful but it can also affect the indoor air quality so we need to minimise leakage to both optimise the energy consumption and ensure the best possible air quality.

We differentiate between internal and external leakage. External leakage is the leakage through the unit casing between the inside and outside of the unit while internal leakage occurs between the dividing walls of the internal sections.

All types of air handling unit have a potential leakage of air past the filters which will have a negative impact on the air quality as well as dirty ducting with increased cleaning costs as a result.

Filter bypass leakage is classified according to the filter grade with the intention that the design of the filter frame and sealing is appropriate for the filtration required. Testing should be carried out in accordance with EN 1886. Eurovent certified air handling units are independently tested by third party laboratories and the results are published on the Eurovent home page.

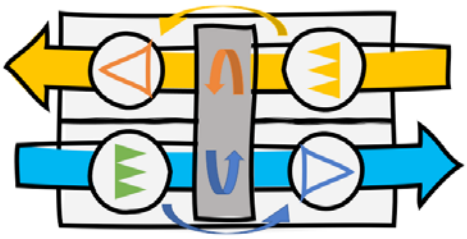
Heat exchangers for energy recovery are also potential sources for leakage. Plate heat exchangers should have small levels of leakage in themselves but a poor installation in the air handling unit can give rise to considerable leakage with energy losses and degraded air quality as a result. Well installed plate heat exchangers will have very low leakage but depending on the position of the fans and the construction of the unit there is a potential for leakage of extract air to supply air.

Rotary heat exchangers offer the advantage of a high efficiency with small space requirement and very little need for defrosting. But because they rotate, they are more difficult to seal effectively.

With rotary heat exchangers there are essentially four modes of leakage

1. Peripheral leakage

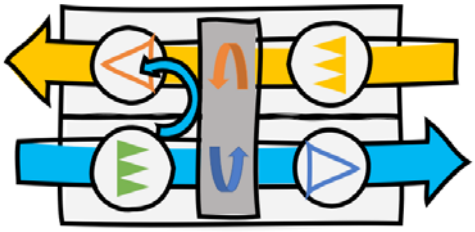
Leakage around the periphery of the rotor will have a direct effect on the overall heating power of the rotor. The reduction in temperature efficiency can be quite significant and Leakage past the periphery seals will also contribute significantly to the leakage between airflows so it is important that the periphery seal is effective.



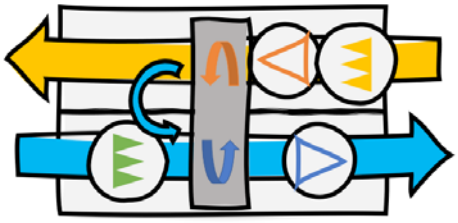
2. Leakage from the outdoor air side to the exhaust air side

Normally there will be a large pressure difference between the outdoor air side of the rotor and the exhaust side. This pressure drop drives a leakage from the supply to exhaust air side. Leakage in that direction will not affect the air quality but it will have an effect on the energy consumption. When we have the correct airflow at the supply air fan, we will have a higher airflow the fresh air filter and that means we will have a higher pressure drop there. We must also compensate on the exhaust side to

ensure that we get the correct extract airflow. This is quite a complex calculation to make requiring an iteration to arrive at the correct result but without it, the power consumption of the fans will not be correct and that means any annual energy calculation will also be wrong.



If the extract fan is placed on the extract side of the rotor then the leakage will be in the other direction:

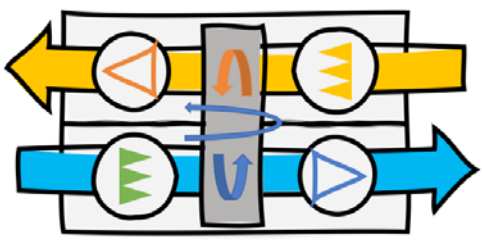


This will have a serious effect on the air quality and is not recommended at all.

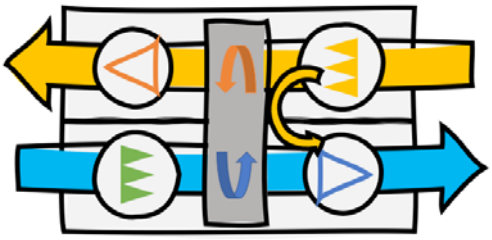
To be able to minimise the leakage of air between the airflows, the recommended arrangement of the fans is upstream of the rotor on both sides.

3. Carry over leakage

Rotary heat exchangers can carry extract air over to the supply air. This carry over leakage can be effectively eliminated by means of a purging sector. A small sector of the rotor is shielded off so that extract air cannot enter the rotor there and outdoor air is bled through the rotor in both directions to purge it of extract air. This purging function cleans the rotor of impurities and ensures a high quality of supply air. To drive this purging flow, we need a pressure difference; which must be created by the extract fan. The purging flow must also be added to the flow rate of the extract fan.



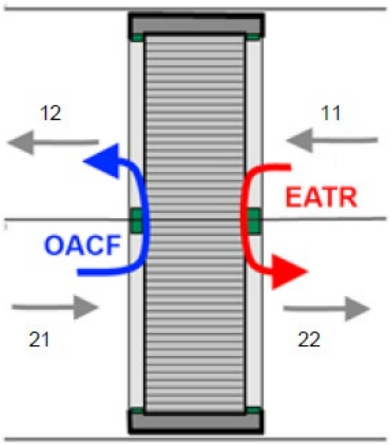
4. Leakage from extract to supply on the room side of the rotor



This leakage will depend on the pressure difference between the extract and the supply and if the fans are correctly positioned as shown, can be eliminated by throttling the extract air so that the pressure difference is in the right direction. This extra pressure drop must be included in the exhaust fan.

The leakages described in modes two to four above are defined in EN 16798-3:2018 [1] by two ratios: OACF and EATR.

Outdoor Air Correction Factor (OACF) and Exhaust Air Transfer Ratio (EATR)



OACF is the ratio of the outdoor air inlet and the supply air outlet flow:

From an air quality point of view, the OACF should be greater than 1 because that means the leakage is from supply to exhaust. If it is less than 1 then there is leakage from exhaust to supply and we want to avoid that.

EATR is the percentage of exhaust air recirculating to the supply air:

EATR is the leakage by the seal at the rotor on the room together with the carry-over leakage.

We need to consider these two leakage measures together. Both of them need to be kept within limits.

These definitions will also be found in the next version of EN 308 (heat exchangers - test procedures) but these standards do not give any limits. A new document to be published by Eurovent titled Eurovent REC 6/15-2020 effectively limits EATR to 1% and OACF to a range between 0.9 and 1.1

A proposal has been made for the inclusion of these leakages in the calculation of SFPint to the review study on the Ecodesign and Energy Regulations on ventilation units.

- **Note** that these definitions also apply to units with plate heat exchangers.
- **Note** also that it is not just the heat exchanger component that leak but take a holistic approach for the ventilation system.

Unfortunately, these internal leakages are today not part of Eurovent Certification programs so building ventilation designers need to understand them and request them of the ventilation unit manufacturers at design stage. In many cases, achieving an acceptable EATR requires that the extract air is throttled to achieve the correct pressure balance inside the unit. The pressure in the extract air upstream of the heat exchanger needs to be lower than that of the supply air downstream of the rotor.

Remember that to be able to calculate the EATR and OACF the manufacturer needs to know the actual pressure inside the unit and that means they need the pressure drop in all four of the ducts connected to the unit so it is important that information is provided.

What more can be done?

High efficiency filters placed after the supply air fans can provide additional security but they will also add cost to both the installation and operation so their use needs to be carefully evaluated in relation to use of the building.

Recommendations for the operation of existing ventilation systems during the COVID-19 epidemic are available (see https://www.rehva.eu/activities/covid-19-guidance/rehva-covid-19-guidance) and now we should consider how to build in the future. Well designed, installed, and maintained full fresh air ventilation systems with energy recovery provide a healthy and comfortable indoor air climate that will provide a reasonable level of protection and promote productivity. They can also be very energy efficient. ■

Reference

[1] EN 16798-3:2018 (Energy performance of buildings - Ventilation for buildings - Part 3: For non-residential buildings - Performance requirements for ventilation and room-conditioning systems