Limiting internal air leakages across the rotary heat exchanger

To date, there has not been a well-documented SARS-CoV-2 outbreak traced to aerosol transmission through ventilation or air-conditioning system[1]. In this context, the spread of infections due to the air leakage across Rotary Heat Exchanger (RHE) is very unlikely. Furthermore, the use of the RHE is important to maintain the condition (temperature and humidity) in the building ensuring fresh air supply, and the stop of the rotor will not remove leakages. However, as health experts continue to study the transmission of the virus through particles suspended in the air, precautionary measures to reduce internal air leakage in ventilation systems may be taken.

The main indicator of internal leakage of contaminated air leaving the room to supply air through the exchanger is expressed by Exhaust Air Transfer Ratio (EATR) in %. As illustrated in *Figure 1*, EATR is a function of the pressure difference between supply air side downstream exchanger (p22) and the extract air side upstream the exchanger (p11), and its value depends on the type of sealing and conditions. But also, the rotor speed and purge sector have an impact on EATR. The main target is to keep over pressure on the supply air side, and in this way, ensure the possible leakage from supply to exhaust air (i.e. EATR = 0%). In well-equipped air handling units (AHUs), pressure taps to measure p11 and p22 are normally available.

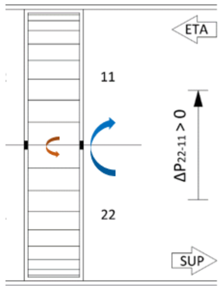


Figure 1. $\Delta P_{22\text{-}11}$ in AHU

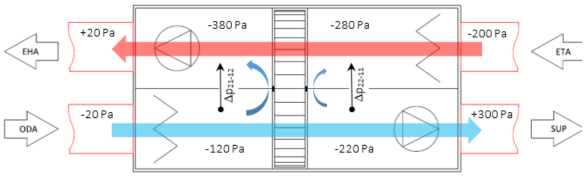
For a correctly designed, set-up and maintained rotary heat exchanger, the leakage of potentially contaminated by pathogens extract air to supply air stream is typically very low and in practice negligible. Nevertheless, in case of improper layout of AHU fans or lack of correct pressure balance setting, the leakage may be significantly higher.

Measures to keep the exhaust air leakage low

The air leakage across rotary exchanger depends on a number of factors described below. The facility management staff normally has no impact on the location of fans, but other measures to eliminate or minimise leakage should be taken during commissioning, inspection and maintenance.

Correct position of fans
A prerequisite for maintaining internal leakages low is the correct positioning of fans. The available fans' position configurations are shown on Figures 2-5. The most recommended configuration includes both fans located downstream the exchanger (see Figure 2). In this configuration, with correctly balanced pressures (p22-11 > 0) and properly set-up purge sector, EATR is usually below 1%. In contrast, the most adverse configuration in terms of leakage includes both fans on the building side (see Figure 3). In the worst case, for this configuration EATR can amount up to 10 - 20%[2].

[1]https://www.hopkinsguides.com/hopkins/view/Johns_Hopkins_ABX_Guide/540747/all/Coronavirus_COVID_19__SARS_CoV_2_?q=aerosol+covid-9
[2] Eurovent Recommendation 6-15. Estimation based on Eurovent Certified data.



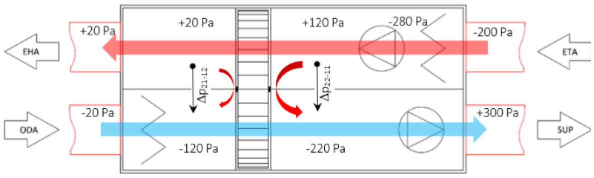


Figure 2. Best configuration. Both fans after the rotorFigure 3. Both fans on building side

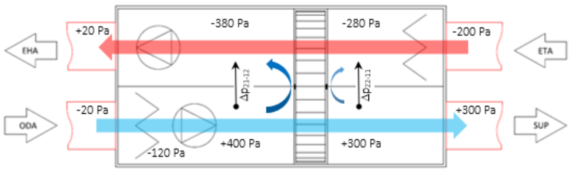


Figure 4 Both fans on the outdoor side

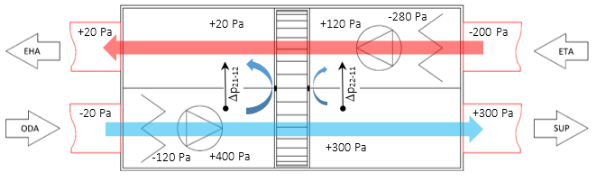


Figure 5 . Both fans upstream the exchanger.

Balance pressure difference

Next step to eliminate a leakage is to set the correct relation between pressures p_{22} and p_{11}. Pressure p_{11} shall be at least 20 Pa less than the pressure p_{22}. Depending on the configuration of fans, this can be done by throttling as follows:

- Both fans after the rotor (Figure 2): adjust the throttle in the extract air so p_{11} will become at least p_{22} – 20 Pa. If the throttling device (e.g. damper) is not available in an AHU, it should be installed in the ductwork.
- Both fans on the building side (Figure 3): There is no possibility to use throttling in this case.
- Both fans on the outdoor side (Figure 4): There is no need to use throttling in this case.
- Both fans upstream the rotor (Figure 5): adjust the throttle in the supply air so p_{11} will become at least p_{22} – 20 Pa. If the throttling device (e.g. damper) is not available in an AHU, it should be installed in the ductwork.

Correct application of purge sector - Position and setting

The purge sector is a device that can practically eliminate the leakage resulting from the rotation of wheel (carry-over). Its location and setting (angle) must be arranged according to manufacturer guidance depending on the configuration of fans and pressure relations.

Effective seal of the rotor

Perimeter and middle beam sealing prevent air leakage from supply side to exhaust side. Seals are subject to wear and their performance deteriorates with time. The condition of the seals should be checked during periodic inspection and, if necessary, restored to its original state in accordance with the manufacturer's instructions.

Method to estimate leakage (EATR) for on-site tests

The precise test of internal air leakage must be carried out at the laboratory. However, a draft of a new upcoming standard (prEN 308) provides a simple method for the estimation of EATR by temperature measurement that can be performed on-site. The test procedure includes measurements of temperatures t_{11}, t_{21} and t_{22} in steady-state conditions with deactivated function of heat transfer (stopped rotor). Next, EATR is calculated as:

$$EATR = \frac{t_{22} - t_{21}}{t_{11} - t_{21}}$$

Where,

t_{11} is temperature exhaust air inlet;

t_{21} is temperature supply air inlet;

t_{22} is temperature supply air outlet.

The part of leakage related to the rotation of wheel (carry-over) cannot be determined by this method.

Colophon
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