THERMOTECH ENTERPRISES, INC. Energy Recovery Wheel Systems

Purge Section

Technical Information

What the Purge Section Does

The Thermotech Heat Exchanger Rotor revolves between two counter-flow airstreams, maintaining a directional laminar flow pattern. During this rotation, small amounts of air can be trapped inside the rotor as the rotor element passes through the division between the two airstreams. Once that section of the rotor enters into the opposing airstream, the entrapped air inside the rotor element will be pushed into and mixed with the respective air volume. (See Figures 1 and 2). Therefore, a small amount of air is being transferred over the separating barrier between the two air ducts.

This phenomena is commonly referred to as carryover. If no effort is made to remedy this carryover effect, the rotating wheel will continue to transfer a percentage of entrapped air from one airstream to the other. In most applications such a mixture of exhaust air into the supply airstream should be avoided. However, mixing of supply air into the exhaust airstream can most always be tolerated. A purge section is specially designed to remedy this mixture of contaminated exhaust air into the supply air volume.

The purge section acts basically as an extension of the exhaust air duct into the supply air duct. In other words, that small fraction of contaminated air that is otherwise carried over to the supply air is now captured and rerouted back into the contaminated exhaust air volume. This thereby provides a supply airstream which is, for all intents and purposes, contaminant free.

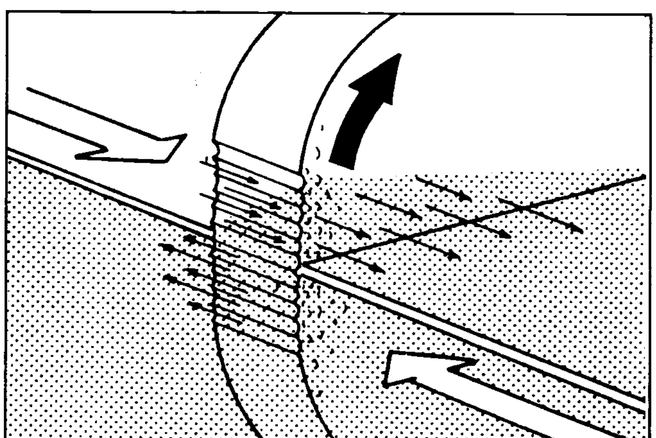

Figure 1 illustrates the carryover effect with no purge sector

How the Heat Exchanger Functions Without the Purging Section

At the time (TO) a section of the rotor has just entered into the supply airstream and contains a certain amount of exhaust air (shadowed area in Figure 2). For a short moment the air column is standing still before it begins to move in the reverse direction. At the time (T1) the exhaust air column is pushed back a little into the supply air duct by the entering outside air. At the time (Tn), all the exhaust air has been pushed out of the rotor into the supply air duct.

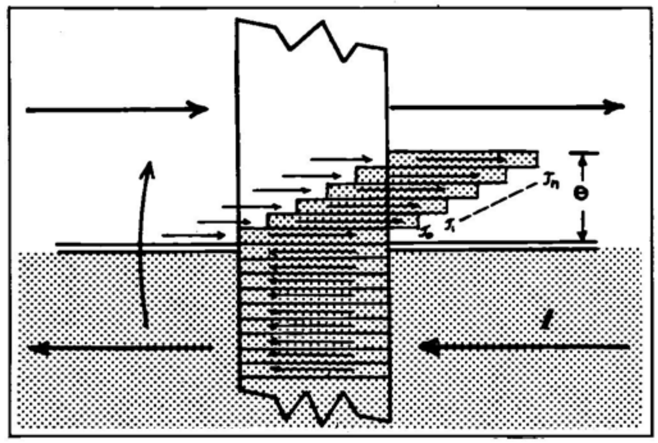

Figure 2 illustrates the carryover flow with respect to time.

The amount of air that is carried over this way is directly proportional to the rotational speed of the rotor and the volume of the wheel. The equation to express the mass flow of air being carried over in this fashion is best derived by dividing the rotor into small sections in the flow direction. The integration of this model gives:

$$Wt = S \bullet \pi \bullet R^2 \bullet L \bullet n$$

Where:

Wt = the mass flow of air (lb/min.)
S = the air density (lb/ cult)
R = the effective rotor radius (lt)
L = the depth of the rotor (lt)
n = RPM

Depending on the air velocity and the RPM, the relative carryover content can vary between 2% and 13% of the actual supply air volume.

How the Heat Exchanger Functions With a Purge Section

The Angle θ (as shown in Figure 4) is the angle through which the wheel rotates during the time period required for an air molecule to travel through the rotor media. This angle θ must therefore, be a function of the air velocity through the wheel and the rotational speed of the rotor. Integration of the rotational speed and the air velocity provides the following equation for θ in degrees:

$$\theta = \frac{6\text{-}n\text{-}L}{Vx} \qquad (2)$$

The Angle Ø (as seen in Figure 4) is the physical angle of the purge sector while θ is the theoretically required minimum purge angle to prevent carryover. The Angle θ can be calculated by using Equation 2. The air velocity is directly determined by the static pressure difference between the OA duct and the RA duct. The higher the static pressure difference, the higher the velocity of the air flowing from the OA duct through the wheel into the RA duct which in turn results in a small value on θ The difference between Ø and θ gives an indication of how much of the supply air is flowing into the exhaust airstream via the purge section. Considering all of this, it is possible to derive an equation that can be used to calculate the so called "purge volume" for the wide variety of varying conditions.

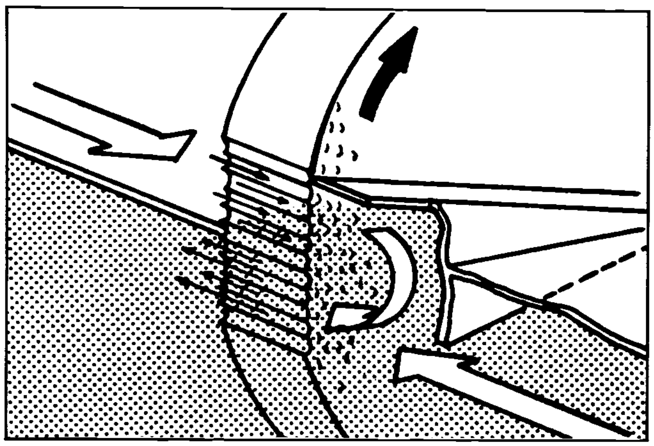

Figure 3 illustrates how the carryover is eliminated by the utilization of the purge.

It is practical to derive the equation so that we may get the actual purge volume in percent of the supply air volume (SA). By expressing the velocity (V x) as a function of the pressure difference across the purging airstreams (P_{OA} - P_{RA}) is known.

Adjustable Purge Angle

Thermotech Enterprises has the capability to compute the relative purge mass flow for any given set of condi-tions. When the rotary heat exchanger is installed into a large air conditioning system complex, the pressure in the OA duct and the RA duct is normally determined by the rest of the equipment in the system-blower location, etc. The supply air pressure drop P_{OA}-P_{SA} is actually a measure of the face velocity of the supply airstream, therefore, P_{OA} - P_{SA} is also set by design conditions. The RPM is determined by the respective operational climates, and thereby varies between 0 and the optimum RPM. This optimum RPM depends on the face velocity and the conditions under which the unit operates.

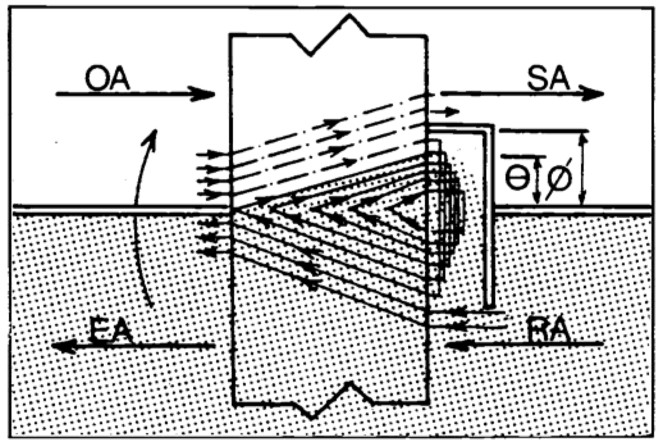

Figure 4 Illustrates the actual air flow pattern on an effective purge.

Note: The purge location shown here is not the only location for the purge. The purge will work fine in other configurations as well.

In order to adjust the purge mass flow, the only parameter remaining which can be varied is the angle of the purge section¢. Provided in Figures 10-13 are values of purge volumes as a function of P_{OA}-P_{RA} and the pressure loss through the rotor (P_{OA}-P_{SA}). Refer to Figures 10-13 in Principal Theory: Purge Angle Selection. These values are presented for three standard purge angles supplied factory set. Should a specific purge volume be necessary by field adjustment, this flexible purge angle will allow such an adjustment to be easily performed.