GREENHECK
Energy Recovery Application
ERA/101-00

PRODUCT APPLICATION GUIDE

A technical bulletin for engineers, contractors and students in the air movement and control industry.

Energy Wheels vs. Plates

For commercial and institutional comfort ventilation applications, total energy heat wheels are far superior to plates in terms of total heat transfer. The reason is simple:

Wheels transfer latent energy (moisture), plates do not.

Both wheels and plates transfer sensible heat. But for metal plate exchangers, that's all you get. Total energy wheels transfer latent energy, or moisture, as well. The transfer of moisture is important because the latent portion of the outdoor air load exceeds 60% of the total load for many climates.

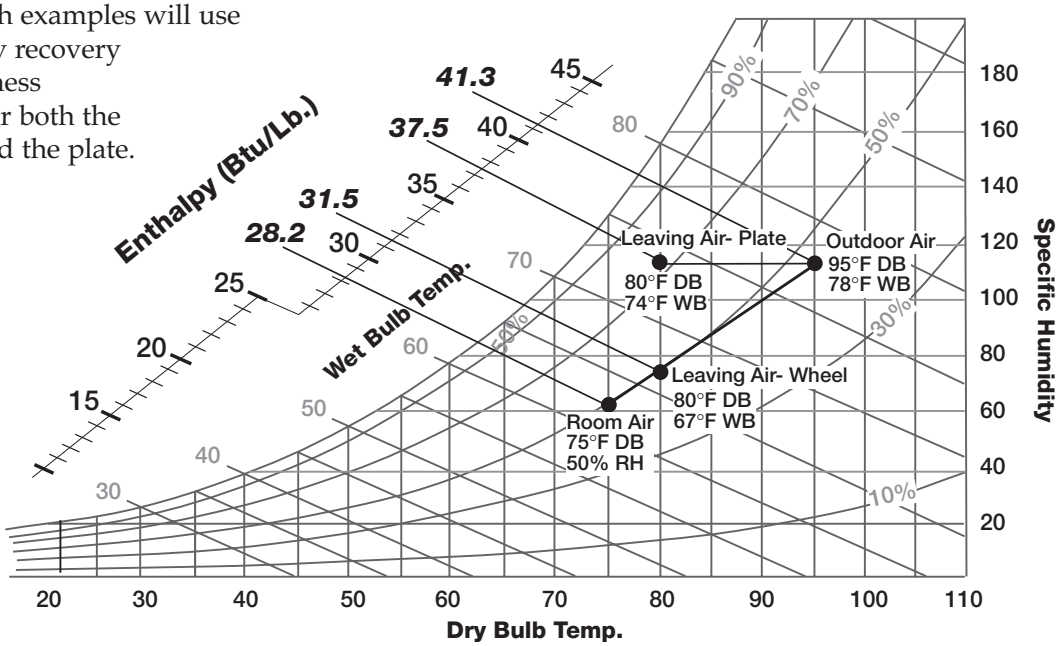
The best way to illustrate the impact of latent energy transfer is by examining cases for summer operation. One will be for summer full load conditions, where the outdoor temperature and humidity require maximum cooling. The other will be for summer part load conditions, where the cooling requirement is below maximum, but outdoor humidity is still high. Both examples will use an energy recovery effectiveness of 75% for both the wheel and the plate.

Load:

Analysis of energy recovery at full load determines the amount of air conditioning reduction that can be realized. For this example, outdoor air at full load is 95°F DB/78°F WB.

The psychrometric chart below shows the leaving air conditions for both devices. Notice that the process line for the plate is horizontal (no moisture transfer), while the process line for the wheel is directly toward room air conditions.

While both products are 75% effective, the total effectiveness of each is really determined by the transfer of total heat, or enthalpy. The maximum possible enthalpy transfer in this case is 13.1 Btu/lb of air, which is the difference between outdoor air and room air (41.3-28.2). The wheel transferred 9.8 Btu/lb (41.3-31.5), which translates into a total effectiveness of 75%. The plate, on the other hand, only transferred 3.8 Btu/lb (41.3-37.5), for a total effectiveness of 29%.



Full

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The total effectiveness of the plate is so low because it only transfers sensible heat. In this example, the total outdoor air load is 38% sensible and 62% latent. The plate is 75% effective on the sensible portion and 0% effective on the latent portion. As a result, the plate's total effectiveness is only 29% [(.38 x 75%)+(.62 x 0%)]. Equipment reduction is just 1.35 tons per 1,000 cfm of outdoor air.

The total effectiveness of the total energy wheel is 75% because the wheel transfers both sensible and latent energy with virtually identical efficiencies.

As a result, the wheel reduces the air conditioning load in this example by 3.7 tons for every 1,000 cfm of outdoor air.

Part Load

At part load conditions, the total energy wheel really shines. Consider the part load condition of 75 DB/72 WB, not uncommon for a summer morning. As the psychrometric chart below illustrates, the 75% effective wheel will create leaving air conditions that are three quarters of the distance between outdoor air and room air conditions. Even though the dry bulb temperature did not change, 75% of the total energy was transferred (the outdoor load is 0% sensible and 100% latent).

The plate heat exchanger would have an effectiveness of 0% in this case. Fan power would be spent pushing air through the plates, but no benefit would be realized.

Transferring the latent energy at part load is extremely important for maintaining proper indoor humidity levels. Keep in mind, systems operate at part load most of the time. If the outdoor air is not pre-conditioned by a total energy wheel, the indoor humidity levels would likely climb above 60% rh.

This is a real problem engineers face today. Humidity control is far more difficult than temperature control.

Summary

The ability of the total energy wheel to transfer latent energy translates into two key benefits that plates do not offer:

1. At full load, the wheel will reduce the outdoor air load by 2 1/2 times more than a plate will. For comparison, a wheel will reduce load by 3.7 tons per 1,000 cfm of outdoor air, where a plate will only reduce load by 1.35 tons.

2. At part load conditions, the wheel always pre-conditions the outdoor air to near room air conditions. This function is very important to maintaining indoor humidity at desired levels. Plates, on the other hand, have little effect if the outdoor dry bulb temperature is near (within 7°) room air dry bulb temperature.

Bonus

3. The wheel is constantly rotating, so it is always being cleaned by the counter-flowing air streams. Because the wheel is always dry, dust and other particles impinging on the surface during the first half cycle are automatically removed during the next half cycle. This cleaning process occurs with every wheel rotation, approximately 30 and 60 times per minute for standard and high air flow wheels, respectively.