Energy Recovery Technologies

July 31st, 2015

Energy recovery is a common solution to provide comfort ventilation for commercial and institutional applications. Due to the large variety of technologies, there is a need to differentiate the advantages of each. Three of the most common technologies in the energy recovery market are:

1. Total Energy Wheel
2. Total Energy Core
3. Sensible Aluminum Plate

Although ASHRAE 90.1 drives when energy recovery should be applied, understanding the composition, design and total efficiency of these technologies can add to an educated decision on which technology will be the best for an application.

Total Energy Wheel

Construction and Performance

Total Energy Wheel

Total energy wheels are the most efficient energy recovery device currently available in the market, with the capability to transfer both sensible and latent energy. Wheel technologies have a total effectiveness up to 80 percent when the supply and exhaust airflows are balanced. There are two predominate types of total energy wheel media: aluminum wheels and polymer wheels. Both of these wheels have the capability of transferring latent energy by applying a desiccant to the wheel, but the application of the desiccant significantly varies between the two types of wheel. Although desiccants can be applied in different ways to the wheel media, the aluminum wheel most commonly uses a molecular sieve desiccant that is sprayed onto the surface of the wheel, whereas a polymer wheel uses a silica gel desiccant that is embedded into the polymer material by a solvent. By embedding the desiccant into the polymer material, the desiccant has roots in the material as indicated in Figure 1.

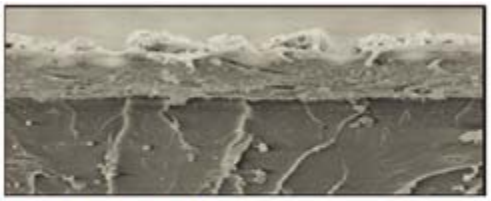

Figure 1. Silica gel desiccant "rooted" into polymer wheel

Due to these roots, the desiccant embedded into the polymer material will not wear over time and the unit will continue to perform with an 80 percent total effectiveness. Unlike the desiccant on the polymer wheel, the sprayed-on molecular sieve on the aluminum wheel tends to wear and flake off over time, which has the potential to decrease the latent energy transfer of the aluminum wheel. As a result, the polymer wheel has a longer latent energy lifespan compared to that of the aluminum wheel.

Maintenance

Figure 2. Segmented polymer wheel

The polymer energy wheel is composed of pie-shaped wheel segments as indicated in Figure 2, while the aluminum wheel is designed as one solid wheel. A segmented wheel is beneficial because each segment can be removed and physically washed. Polymer wheel manufacturers recommend washing the polymer wheel every two years to remove any particles or oils that may have accumulated on the wheel. However, because the wheel is constantly rotating, it is always being cleaned by the counter-flowing

air streams. Because all of the energy transfer occurs in the vapor stage, the wheel is always dry. Thus, if particles deposit on the surface of the wheel, they will be displaced when the wheel rotates because of the counterflow airstreams. This cleaning process occurs with every wheel rotation, approximately 30 to 60 times per minute.

Applications

Another advantage of using the polymer energy wheel in high airflow applications is the unit footprint compared to other energy recovery methods. With other technologies, such as a total energy core, the unit footprint significantly increases as the airflow application increases because several cores will need to be stacked in series. With an energy wheel, the additional airflow can be accounted for by increasing the diameter of the wheel by up to three inches. This small increase will not significantly impact the overall size of the energy recovery unit. Due to the smaller footprint impact, polymer energy wheels are quite common in high airflow applications above 2,500 cfm.

Because the energy wheel is extremely effective and can lead to high energy savings, it is commonly used in many applications that require high percentages of outdoor air. Some applications that use total energy wheels are office buildings, hotels, schools, dormitories and locker rooms. Additionally, energy recovery wheels can be applied to recover energy from bathroom exhaust. The ASHRAE Standard 62.1 dictates that energy recovery devices rated for less than 10 percent cross leakage can return rest room exhaust through the technology to maximize energy saved. Because the cross leakage through the polymer energy wheel is below 10 percent, it is approved for these types of applications.

Total Energy Core

Total Energy Core

Construction and Performance

Similar to a total energy wheel, a total energy core transfers both sensible and latent energy, but has a lower total effectiveness of 60 percent. The energy core is manufactured as a corrugated and layered hydroscopic resin or polymer material. The supply and exhaust airstreams travel through the corrugated pathways and the energy transfer occurs through the material. This results in an extremely low cross leakage rating between the supply and exhaust airstreams.

Maintenance

Maintenance of the core is different compared to that of the total energy wheel. Because the core does not rotate between the two airstreams, it is recommended to vacuum off the core's surfaces to ensure that debris does not accumulate and block the airstreams. It is not recommended to wash the core because water will damage the hydroscopic resin which makes up the core technology.

Applications

With no belts or moving parts, the total energy core is a simple technology. Although the cores have a lower total effectiveness when compared to wheel technology, they are popular in low airflow applications (below 2,500 cfm) because the footprint of the unit is relatively small and there are no belts or motors to maintain on the transfer device. The core technology is most commonly found in commercial applications such as schools, dormitories, offices, nursing homes and locker rooms. In addition, with extremely low cross leakage ratings, the core technology is recommended for bathroom exhaust applications as well.

Aluminum Plate

Construction and Performance

The sensible-only aluminum plate has the lowest total effectiveness of the three energy recovery technologies discussed because it transfers only sensible energy. The plate is 75 percent effective when transferring sensible energy, but does not transfer any latent energy, which results in a total effectiveness of 30 percent (summer conditions).

Applications
Similar to the core technology, the aluminum plate is stationary and does not rotate between two airstreams, resulting in minimal cross-contamination. This feature, along with its aluminum construction, allows the technology to be applied in light industrial applications, as well as commercial and institutional comfort applications. In addition, since the aluminum plate only transfers sensible energy, it is most commonly applied in dry applications such as the southwestern portion of the United States.

Standards, Codes, and Certifications

Energy recovery applications are highly driven by the ASHRAE 90.1 standard. The 2010 version of the standard requires the use of energy recovery based upon a unit's supply airflow, outdoor air percentage, and geographic location as indicated in Figure 3 below. This language is adopted by the 2012 International Energy Conservation Code.

The standard mandates that the total effectiveness of the energy recovery technologies be a minimum of 50%. This value is determined based on the test procedure outlined in the Air-Conditioning, Heating, and Refrigeration Institution (AHRI) Standard 1060.

In addition to outlining testing procedures, AHRI also facilitates third-party performance certification for energy recovery technologies. To ensure that the performance data provided by manufacturers is accurate, AHRI will post all energy recovery manufacturers' performance data on the AHRI Directory online (https://www.ahridirectory.org) and facilitate third-party testing with an accredited laboratory. For additional information on the AHRI Standard 1060, please reference the application article ERA/109-02.

Summary

Understanding the differences between the total energy wheel, total energy core, and aluminum plate will help to apply the best energy recovery technology to a specific application. The primary benefits of each technology include:

• Total Energy Wheel: With a total effectiveness of 80 percent and the capability to clean the technology, polymer total energy wheels have the highest energy transfer in the market with ensured longevity.

• Total Energy Core: Great for applications below 2,500 cfm as they are low maintenance and provide a small footprint.

• Aluminum Plate: Only transfer sensible energy, making it a great technology for applications in dry regions.
See the following page to view a comparison of energy recovery technologies. Zone

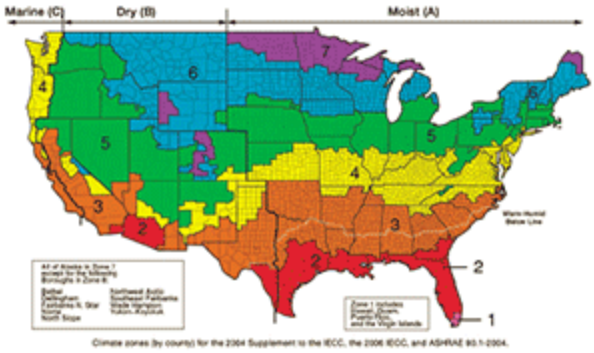

Figure 3. ASHRAE 90.1-2010 Climate Zone Map & Requirements

Zone	Percentage of Outdoor Air at Full Design Airflow Rate (cfm)					
	30% ≤ 40%	40% ≤ 50%	50% ≤ 60%	60% ≤ 70%	70% ≤ 80%	≥ 80%
	Design Supply Fan Airflow Rate (cfm)					
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	≥ 5,000	≥ 5,000
1B, 2B, 5C	NR	NR	≥ 26,000	≥ 12,000	≥ 5,000	≥ 4,000
6B	≥ 11,000	≥ 5,500	≥ 4,500	≥ 3,500	≥ 2,500	≥ 1,500
1A, 2A, 3A, 4A, 5A, 6A	≥ 5,500	≥ 4,500	≥ 3,500	≥ 2,000	≥ 1,000	≥ 0
7, 8	≥ 2,500	≥ 1,000	≥ 0	≥ 0	≥ 0	≥ 0

NR = Not recommended

Energy Recovery Technology Comparisons			
	Total Energy Wheel	Total Energy Core	Sensible Plate
Energy Transfer	Sensible & Latent	Sensible & Latent	Sensible
Total Effectiveness	80%	60%	30%
Media	Polymer or Aluminum	Hydroscopic Resin	Aluminum
Desiccant	Molecular Sieve or Silica Gel	–	–
Applications	Commercial	Commercial	Commercial & Light Industrial
Benefits	• Highest total effectiveness • Segmented construction • Segments can be washed • Recommended for bathroom exhaust	• No moving parts • Extremely low cross leakage • Popular in low airflow applications due to small footprint and low maintenance • Recommended for bathroom exhaust	• No moving parts • Can be applied in light industrial applications