PRODUCT APPLICATION

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

Energy Recovery Technologies

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 the ASHRAE 90.1 standard dictates 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 wheels are the most efficient energy recovery device widely 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 include a desiccant that gives them the capability to transfer latent energy, but the application of the desiccant significantly varies between the two types of wheel. 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. Embedding the desiccant into the polymer material gives the desiccant roots in the material as indicated in Figure 1.

Total Energy Wheel

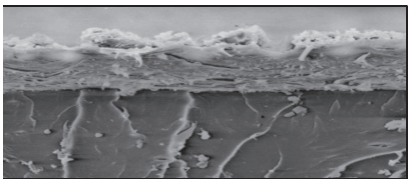


Figure 1. Silica gel desiccant "rooted" into polymer wheel

Due to these roots, the embedded desiccant will not wear over time and the unit will continue to perform with an 80 percent total effectiveness. While effective, the sprayed-on molecular sieve on the aluminum wheel may 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 than the aluminum wheel, as well as being a more affordable option.

Maintenance

Total energy wheels require some maintenance compared to the core, which has no moving parts. 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 wheel as needed to remove any particles or oils that may have accumulated. However, because both aluminum and polymer wheels are constantly rotating, they are 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.

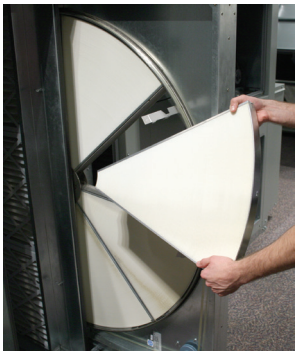


Figure 2. Segmented polymer wheel

Applications

A primary advantage of using the total 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 increases as the airflow application increases because multiple 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, energy wheels are quite common in high-airflow applications above 2,500 cfm.

The total energy wheel is extremely effective, but only when rotating. The rotation is powered by a belt and motor. Dedicated Outdoor Air Systems (DOAS) come equipped with rotation sensors that provide an alert if the wheel has stopped rotating. Energy recovery ventilators (ERVs) have this optional capability as well.

Because the energy wheel can lead to significant energy savings, it is commonly used in applications that require high percentages of outdoor air, such as office buildings, hotels, schools, dormitories and locker rooms. Additionally, energy recovery wheels can be applied to recover energy from restroom exhaust. ASHRAE Standard 62.1 dictates that energy recovery devices rated for less than 10 percent cross-leakage can return restroom exhaust through the technology to maximize energy saved. Because the cross-leakage through the energy wheel is below 10 percent, it is approved for these types of applications.

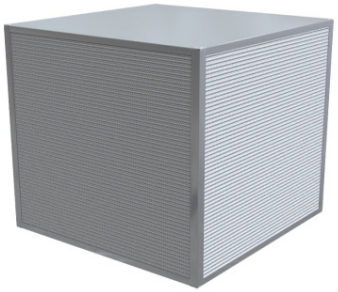
Total Energy Core

Construction and Performance

Similar to a total energy wheel, a total energy core transfers both sensible and latent energy. It has a lower energy recovery effectiveness of 50 to 65 percent, which still meets or exceeds the 50 percent standard set by ASHRAE 90.1. The energy core is manufactured as a corrugated and layered fiber 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

With no moving parts, maintenance is relatively low for energy cores. However, 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 fiber core, which can be damaged by water. The polymer core is washable with low-pressure water and a soap detergent.



Total Energy Core

Applications

Although the cores have a lower total effectiveness than wheel technology, they are popular in low-airflow applications (below 2,500 cfm) because they have no belts or motors to maintain and can be a cost-effective, simple solution. The core technology is most commonly found in commercial applications with limited maintenance staff such as schools, dormitories, offices, and nursing homes. It is also recommended for restroom exhaust applications due to its very low cross-leakage rating (less than 1%).

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 used 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 regions such as the southwestern portion of the United States.

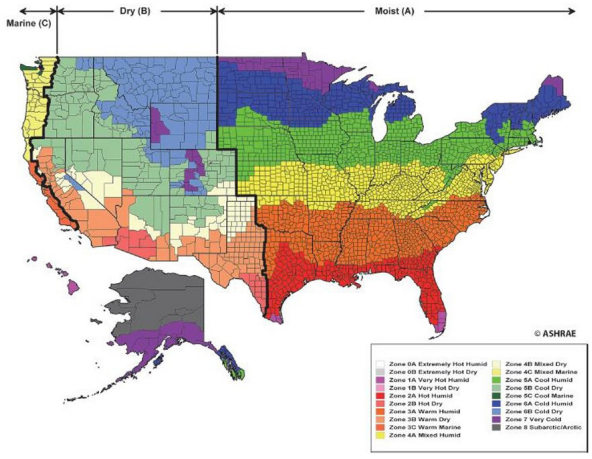


Figure 1. United States Climate Zone Map

Standards, Codes, and Certifications

Energy recovery applications are highly driven by the ASHRAE 90.1 standard. The 2022 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. These requirements are also in the 2021 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 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.

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	NR	NR
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

Figure 3. ASHRAE 90.1-2022 Climate Zone Map & Requirements

Fan Power

Fan power is an important consideration for energy recovery. It is governed by the fan power limit, which is a requirement found in ASHRAE 90.1-2022 that sets fan power allowances for different fan system features. Each air system component in the fan system, such as heat exchangers for energy recovery, is given fan power allowances in watts/CFM (cubic feet per minute). Then the engineer needs to demonstrate that the fan system uses fewer watts than the full calculation shows.

Keeping fan power as low as possible by using the fan power limit is crucial for reducing the overall energy consumed by HVAC equipment that uses energy recovery. This includes energy recovery ventilators and DOAS.

Summary

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

Total Energy Wheel: With a total effectiveness of 80 percent and a self-cleaning feature, a polymer total energy wheel has a long lifespan and the highest energy transfer in the market.

Total Energy Core: Great for lower-airflow applications as it is a simple and low-maintenance solution for total energy transfer.

Aluminum Plate: Only transfers sensible energy, making it a good technology for applications in dry regions.

Energy Recovery Technology Comparisons

	Total Energy Wheel	Total Energy Core	Sensible Plate
Energy Transfer	Sensible & Latent	Sensible & Latent	Sensible
Total Effectiveness	80%	50–65%	30%
Media	Polymer or Aluminum	Polymer or Fiber	Aluminum
Desiccant	Molecular Sieve or Silica Gel	–	–
Applications	Commercial	Commercial	Commercial & Light Industrial
Benefits	• Highest total effectiveness • Segmented construction (segments can be washed) • Often used in high-airflow applications • Recommended for restroom exhaust	• No moving parts • Extremely low cross-leakage • Popular in low-airflow applications • Recommended for restroom exhaust	• No moving parts • Can be used in light industrial applications

P.O. Box 410 • Schofield, WI 54476
Phone: 715.359.6171 • greenheck.com