Service contractors selecting an energy-recovery ventilator (ERV) desiccant wheel replacement purely on high efficiency and capital cost, without regard to static pressure, may defeat their building owner client’s attempt to maximize long-term energy savings and return-on-investment (ROI).

Instead, a wheel-replacement selection should be reviewed for its recovery-efficiency ratio (RER), according to the Air-Conditioning, Heating and Refrigeration Institute’s (AHRI) Guideline V “Calculating the Efficiency of Energy Recovery Ventilators and Its Effect on Efficiency and Sizing of Building HVAC Systems.” The RER takes into consideration the efficiency and the static pressure of a desiccant-wheel replacement. Not calculating the RER could result in tens of thousands of dollars in lost energy savings over the course of the desiccant wheel's lifecycle.

Intended for service contractors, engineers and building owners, Guideline V provides a means for calculating the impact of applied energy-recovery equipment on the energy efficiency of the HVAC system at a single selected operating condition.

Simply, the calculations comprehensively take a host of factors into consideration, such as geographical climate, fan/motor efficiency, exhaust-air transfer ratio (EATR), pressure drop, energy-recovery methodology and many other parameters. Guideline V also allows service contractors (or manufacturer representatives) to compare ERV wheels and arrive at a comprehensive savings for heating and cooling, rather than just a wheel manufacturer's efficiency rating that does not consider all variables.

Figures 1 and 2 show the cost savings difference between polymer and aluminum wheels based on the effectiveness and parasitic fan losses due to the static pressures. The result is that the wheel with the 0.28-in.-wc pressure drop advantage saves approximately $400 per year more than its competitor. The results were based on the weather data, and utility costs for Atlanta, GA, during the time of the study.

Generally, the savings when choosing a wheel that delivers less static pressure is approximately $500 for the 5,000-cfm illustration. While $500 does not seem like much of a difference, that sum can rise significantly to the $20,000 range, for example, when considering a 200,000-cfm building ventilation system, depending on the geographic location, climate and other variables.

Both Figures 1 and 2 demonstrate it is really not just efficiency, but both efficiency and static pressure combined that will provide the greatest ROI.

The ASHRAE-sponsored educational session, “Air-to-Air Energy Recovery Applications: Best Practices,” presented during the 2014 AHR Expo also suggested that high efficiency and high static pressure might not be the best combination. Revealing statistics of a study using eight U.S. geographical regions' energy costs and climate, the study found that seven regions benefitted most from medium-efficiency/medium static pressure gain, versus high-efficiency/high static efficiency gain. One region, which had the highest energy costs, surprisingly benefitted most from a low-efficiency/low static pressure gain.
Another overlooked variable is sensible/latent loads. In northern parts of Europe, except for coastal areas, there is not much relative humidity compared to the U.S., so Europeans are more concerned with sensible loads, especially with their comparatively higher energy prices. Here in the U.S., both sensible and latent loads must be considered, especially in the Southeast and summertime operation in many of the nation's regions. Even the dry Western states should be concerned with latent loads because occupants and other factors create indoor moisture loads that can both be recovered and used to raise the indoor RH. There's no advantage in dry regions to bring in arid air and not help raise its RH by transferring the moisture from the exhaust airstream. It's more efficient to transfer the moisture to the incoming air to attempt a more comfortable RH between 40% and 60%.

A disadvantage in the polymer (plastic and fiber composite) wheels is the tendency to increase static pressure, due to their impeding air-flow construction. Additionally, the closely knit layers of polymer also tend to retain dust, insects and other debris. This raises maintenance costs for periodic cleaning or replacement and subsequently lowers the ROI. Unmaintained polymer wheels have split apart from increased static pressures caused by lodged particulate accumulations.

ERV wheels must be kept clean of particulates, which can build up over time. A clogged wheel can affect static pressure and lessen the energy efficiency of the system.

Certain aluminum wheels are designed with larger flute-size openings, which create a non-turbulent laminar flow that allows particles to pass through without accumulating within the wheel media. The aluminum media can also have an anti-stick surface coating applied to both sides of the wheel to further prevent particles from accumulating and plugging the wheel in highly polluted airstreams.

Although all energy-recovery wheels have different static pressure losses, there are some wheels that, when compared to others, may have up to 1/2-in.-we difference. While this difference appears fairly minimal, converting it to fan power can make a significant energy-savings difference over the wheel's lifecycle.
For example, Figures 3 and 4 show a 25-ton, 5,000-cfm unitary layout of a rooftop outdoor air unit and the static pressure differences between basic polymer and aluminum wheels. Replacing a polymer wheel with the same diameter aluminum wheel can result in a substantial reduction in wheel pressure drop. Furthermore, the system also needs less brake horsepower for the supply and exhaust fan motors. It also lowers connected amps as well as the cost of the electrical package.

Another polymer-wheel static pressure concern is their inherent clogging with debris. If not periodically cleaned of debris, static pressure increases even more, as less air flows through a dirty wheel. This drives energy costs well beyond the inherent static-pressure shortcomings of a polymer wheel. Contrarily, aluminum wheels need considerably fewer cleanings, if any at all, because of their fluted design. A case in point is casinos, which are one of the most difficult desiccant-wheel applications because of cigarette smoke. There are many examples where aluminum wheels have a better track record over polymer wheels for casino applications, simply because of the predominance of airborne particulates and the potential for clogging the wheel.

An aluminum-substrate wheel combined with molecular-sieve desiccant material creates a heavy-duty, 4- to 10-in.-deep aluminum wheel that never needs regeneration or replacement and requires little maintenance. The wheels transfer sensible heat through passing the aluminum media between the two airstreams and the latent energy via the desiccant material that adheres onto the aluminum surface.

Given the shorter lifecycle of polymer wheels, ERV manufacturers have outfitted them with a rack to easily slide out for cleaning or replacement. When a replacement was needed, there were not many choices other than another polymer wheel. Recently, however, aluminum-wheel manufacturers have innovated replacements for polymer wheels consisting of a matching wheel diameter and thickness packaged within an easily installed slide-in cassette format. Typically, wheels come in diameters of 30, 36, 41, 46, 58, 64, 68 and 74 in. It is also advisable to replace the motor and the drive belt, which most times come as part of the entire wheel assembly in an ERV.

Disregarding rusted bolts and other unforeseen service-call obstacles, a replacement should require less than 30 minutes of time for sliding in the new wheel cassette and securing a mounting plate with four to eight bolts.

Other optional considerations when specifying a new or retrofit desiccant wheel include:

→ Temperature—Polymer wheels have a maximum temperature capacity of 130°F, whereas aluminum models can withstand up to 180°F.

→ Coatings—Aluminum wheels can easily include surface coatings for special applications. For example, a chemical-processing plant may opt for an anti-corrosive coating or a hospital may require an anti-microbial coating.

→ Lifecycle—Dependent on the application, aluminum wheels typically have a longer expected lifecycle than polymer.

→ Filters—Polymer wheels require filters with a higher MERV rating, which can also add to static pressure.

→ Maintenance—A building owner without a trained maintenance staff or a meager maintenance budget may opt for an aluminum wheel, which requires only recommended checks for particle buildup. Any buildup can easily be blown out without removing the wheel. Contrarily, polymer wheels, which typically are pieced together in triangular pie shapes, must be disassembled, removed and washed separately.

→ Desiccant type—Silica gel, which is one of the more popular desiccant medias, can degrade from 10% to 35% over a period of time, according to the study “Impact of Desiccant Degradation on Desiccant Cooling System Performance,” funded by the U.S. Department of Energy, Solar Cooling program. To offset this degradation, the system owner must realize disadvantages, such as premature wheel replacement and increased maintenance considerations of frequent cleaning of the media.

→ Air leakage—Seals around the wheel are critical to prevent the potential of energy-recovery cross contamination, which is the incident of exhaust air and its contaminants inadvertently mixing with the supply air via air bypass around a wheel with faulty seals.

→ NEPA rating—The aluminum wheel has an NFPA 92A rating of <25 and 50 for the smoke and flame certification. In order for the polymer wheel to be accepted under the
NFPA standard, it had to be certified under the UL 900 testing, which is also lumped into the category of “throw-away filters.” Additionally, polymer materials may release toxic off-gassing during a fire that could affect occupants.

The majority of unitary equipment manufacturers’ ERV models specified for the new construction market in the last 20 to 30 years have an OEM-polymer type of wheel. Polymer-based wheels were preferred because of their lower cost at the time, but recently wheels with aluminum and other substrate materials have become competitively priced. Therefore, with the recent findings on RER and its significant effect on ROI, all wheel types should be calculated first. RER should be calculated by service contractors and consulting engineers for desiccant-wheel replacements and as OEM options in new unitary equipment specifications, respectively.

Not calculating various desiccant wheels’ RER and their potential for maximizing ROI is a disservice to building-owner clients that could unknowingly cost them thousands in lost energy savings.

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