Enthalpy Wheels Come of Age: Applying Energy Recovery Ventilation to Hospitality Venues in Hot, Humid Climates

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ABSTRACT

Energy recovery ventilation systems, including rotary heat exchangers or enthalpy wheels, utilize mature technologies that are routinely applied in commercial buildings. Energy recovery is particularly important in buildings with significant outdoor air intake requirements and has recently become widely accepted in applications such as schools and theatres. Hospitality applications including restaurants, bars, casinos and similar settings also stand to benefit from application of the technology, however, there is a lack of experience and therefore of accepted guidance in these applications. Furthermore, the unique challenges inherent in the variety of hospitality venues may limit appropriate use of the technology.

Applying energy recovery ventilation to hospitality venues in hot, humid climates need not be complex. This paper proposes guidelines that can facilitate application of the technology by specifiers or other construction professionals. These guidelines address evaluation of typical projects for the suitability of energy recovery, selection of appropriate energy recovery ventilation technology, and criteria for successful application of enthalpy wheels. Examples of applications developed for different mechanical systems and building types are provided. The literature describing the opportunities and limitations associated with enthalpy wheels is summarized and referenced. Installation, operation, and maintenance insights are presented, derived from the body of industry experience with enthalpy wheels.

INTRODUCTION

Recent changes in the public perception of smoking, a decrease in the percentage of smokers in the population, new prohibitions against smoking in many locales and buildings and the Surgeon General's determination that environmental tobacco smoke, ETS, constitutes a health hazard, have created a difficult challenge for the hospitality industry. Engineering solutions are needed that can allow both smoker and nonsmoker patrons of bars, restaurants, dance halls, casinos and bowling alleys to pursue their chosen recreation. At the same time, employees' needs for a reasonable work environment must be met as employers compete to attract and retain qualified individuals.

The primary means of addressing smoke and odor control in hospitality applications is through ventilation with outdoor air. Minimum rates for restaurants, bars and smoking lounges are given in the current ASHRAE Standard 62-1999, "Ventilation for Acceptable Indoor Air Quality"[1]. While these rates can be demonstrated to be successful, they impose significant energy, equipment cost and comfort penalties, particularly in hot humid climates. And, in some cases, higher rates may be preferred in order to achieve greater dilution or in order to manage pressure and internal airflows. Air cleaning or filtration, while important for reducing levels of some contaminants, is not a substitute for ventilation with outdoor air.

Energy recovery ventilation, in particular the use of enthalpy wheels to precondition outside air, has been shown in theory and practice to mitigate the energy, cost and performance impacts of these higher ventilation rates. The use of enthalpy wheels has become commonly accepted in schools and offices, however, the higher concentration of contaminants in the exhaust air has raised questions about their application in the hospitality environment. In addition, special design features for the management of airflow in smoking and non-smoking spaces, specific recommendations for equipment selection and maintenance requirements must be addressed to ensure successful application of the technology.

Enthalpy wheels have been applied to a variety of model applications, including hospitality. By identifying the best practices on these jobs and gathering information from manufacturers' experience in challenging smoking environments, we can assemble useful guidance for the designer, the mechanical contractor and the owner/operator.

ENERGY RECOVERY AND VENTILATION

Air-to-air energy recovery utilizes the properties of air to be exhausted from the building to pre-condition incoming outside air. Energy recovery technologies have been applied in the industrial sector since the early 1960's and before. In the 1970's they found their way increasingly into the commercial building sector as well as the residential market. The escalating cost of energy and the resulting focus on energy efficiency drove their application. They are routinely applied in Europe and particularly the Scandinavian countries where energy costs remain high. Controlled mechanical ventilation with energy recovery and tight construction together comprise a system to minimize the energy costs associated with outside air.

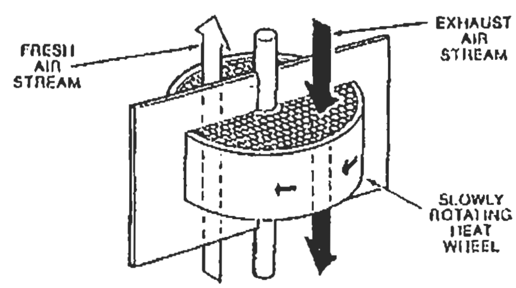
As the energy costs in North America sharply declined in the 1980's, the focus shifted from energy conservation to indoor air quality. It was recognized that improvements in building envelopes must be balanced with improvements in indoor air quality to maintain an acceptable indoor environment for human occupancy. The results of this debate were formalized in the ASHRAE/ANSI Standard 62-1989, Ventilation for Acceptable Indoor Air Quality[2]. This updated version of Standard 62, and its successor, ASHRAE Standard 62-1999, call for significantly higher ventilation rates than its predecessor version, ASHRAE Standard 62-1981[3]. These higher rates have been codified in all the major model codes in the U.S. including the International Mechanical Code[4]. The application of ASHRAE/ANSI Standard 62-1989 has been perceived as being too costly from a first cost as well as an operating cost perspective. One technology that addresses this perceived dilemma is energy recovery.

Energy recovery for ventilation purposes has grown from a custom niche in the early 1980's to a mature and widely applied product at the threshold of the 21st century. This maturity is reflected in the just updated ASHRAE/IESNA Standard 90.1-1999, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings[5]. This standard requires the use of energy recovery whenever the amount of outdoor air is greater than 70 percent as a percentage of total airflows over 5000 cfm. A minimum enthalpy recovery effectiveness of 50% is required. In hot, humid climates where the load is mostly water, only enthalpy exchangers will meet the standard.

Industry progress is further underscored by the formation in 1996 of the Air-to-Air Energy Recovery Ventilation Equipment Section within the Air-Conditioning & Refrigeration Institute. Over twenty manufacturers currently participate in this section. ARI is preparing a certification program for energy recovery components. The certification program is based on the test method of ASHRAE Standard 84[6] and the new ARI rating Standard, ARI 1060[7]. Both components and units containing these components will be eligible to bear the certified ratings label. Work is also progressing on a complete certification program for packaged equipment.

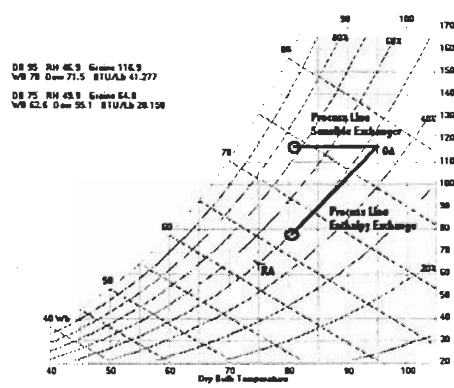
This discussion will focus on enthalpy exchangers, particularly enthalpy wheels because of their ability to handle both sensible and latent loads. The surfaces of the wheel are coated with a dry desiccant that sorbs and desorbs water with approximately the same effectiveness that it recovers temperature. Other important properties of the enthalpy wheel or rotary heat exchanger will be discussed under maintenance and cleaning below.

Figure 1. Enthalpy Wheel Heat Exchanger



The process lines for a typical sensible heat exchanger and a typical enthalpy wheel are illustrated in the psychrometric chart in figure 2.

Figure 2. Comparison of Process Lines for Sensible and Enthalpy Heat Exchangers



RESEARCH

Recent years have seen a significant increase in research supporting the application of energy recovery ventilation systems. The energy, humidity control and design benefits of enthalpy wheels systems have been demonstrated by a variety of studies. A DOE study of desiccant cooling systems found that the national energy benefits of enthalpy preconditioning can be 4 times greater than the active desiccant systems and total up to 0.4 quads of annual savings in the U.S.[8] A series of studies at the Florida Solar Energy Center have shown that enthalpy wheels coupled with conventional cooling systems can handle the outside air loads of ASHRAE 62-1999 while maintaining adequate control of indoor humidity control in large offices, small offices, schools and retail stores.[9, 10, 11, 12]

A 1998 modeling study of smoking rooms, bars and lounges by Irwin, Simonson, Saw and Besant found that enthalpy recovery provided superior load reductions in hot humid climates; Chiller capacity reductions of 13.4 tons were obtained for a 50 person capacity smoking lounge in St. Petersburg, FL.[13] Wellford and Hoagland found that cooling capacity reductions and associated payback considerations were remarkably consistent for most U.S. climates due to the similarity and significance of cooling loads at design.[14]

ENERGY RECOVERY ECONOMICS

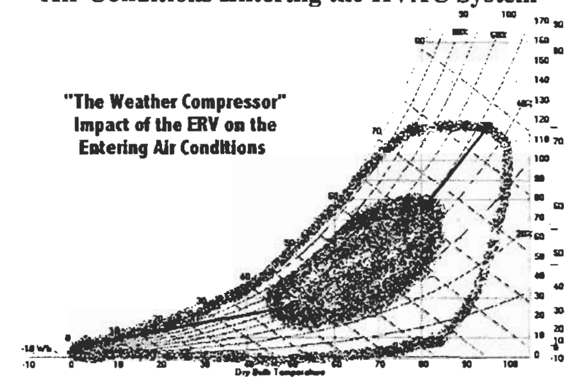
Historically, ERV systems have been sold on their energy savings benefits. While this is an important consideration, it is certainly not the most important driver, especially in hot humid climates. All of the following are significant to the successful building:

1. Design Load Reductions: The impact of the energy recovery on design loads for outdoor air ventilation is the key to most economic analyses. In hot humid climates it is not uncommon to save up to 4 tons of cooling capacity per 1000 cfm of outside air required. The savings on the cooling equipment alone can offset the cost of the energy recovery. The impact on design conditions can be visualized on the psychrometric chart as illustrated in figure 3. The process lines for enthalpy recovery are shown for both typical summer cooling and typical winter heating outdoor design conditions. The large shaded ring represents the range of outside air conditions that might be encountered in all of North America. The smaller oval represents the preconditioned air properties after passing through the ERV. Regardless of the climate extremes, including challenging part load conditions, the HVAC system receives outside air within a restricted range close to comfort conditions.

2. Indoor Environmental Control: Temperature, humidity and ventilation rate are critical to comfort and IAQ. The application of energy recovery is demonstrated to maintain target relative humidity within an acceptable range in a variety of applications, to moderate temperature swings and to permit the use of code required or additional outdoor air for dilution. Dehumidification of the outside air alone can make energy recovery cost effective if it allows the HVAC system to maintain acceptable conditions and minimize mold and mildew growth in a building that would otherwise have IAQ and maintenance problems. Comfort is perhaps the most important economic driver for the hospitality industry, where the comfort and enjoyment of the patron is central to the success of every establishment.

3. Operating Savings: Dollar savings accrue from both energy charges and demand charges. These savings can provide simple payback in temperate climates. In climates where the energy recovery does not add to first cost (due to offset load and equipment size) the energy savings may be viewed as contributing to revenue.

Figure 3. Impact of Enthalpy Recovery on Outside Air Conditions Entering the HVAC System



Most manufacturers of enthalpy recovery components, packaged energy recovery ventilation units and applied systems provide modeling software to allow the designer to predict the design load reductions, entering air conditions and operating savings. These programs are also utilized to select and design components and systems and should be part of the specifying engineers toolkit when applying enthalpy recovery in hot humid climates.

ENERGY RECOVERY APPLICATIONS

There is a large body of experience with energy recovery in schools, offices and industrial applications. While these may not be representative of all the challenges in the hospitality environment, there are useful similarities and innovative system designs that can inform any installation. A representative sample highlighting lessons learned follows:

* The J. C. Penney store in Baton Rouge, LA used an enthalpy wheel with other air handling components to achieve an internal rate of return of 11%. "The heat wheel option did not add a large amount of first cost even though the unit was lengthened and the heat wheel and exhaust fan are added"[15]

* The Alexander Elementary School in Houston's Alief ISD needed to increase per person ventilation rates from 5 cfm to a minimum of 15 cfm. Five roof-mounted ERV's were added to the system and integrated into the existing air handling system. The school was able to maintain comfort using the existing chillers despite a quadrupling of the outside air ventilation. The cost of the ERV's "was offset almost entirely by the avoided cost of purchasing additional air-conditioning capacity." [16]

* Fischer presented the positive IAQ results of ventilation retrofits in a series of schools located in hot humid climates. The combination of ventilation rates at ASHRAE 62 quantities of 15 cfm per person and moisture control afforded by preconditioning with energy recovery resolved IAQ problems and complaints in eight schools from the Carolinas and Georgia to Florida and Texas. [17]

GENERAL PRINCIPLES OF VENTILATION AND ENERGY RECOVERY APPLICATION

Energy recovery ventilation systems are ventilation systems first and foremost. Accepted and proven strategies for ventilating hospitality environments should be applied to the energy recovery system in order to achieve the best possible result. Indoor air quality can be enhanced by observing three general principles:

1. Dilution ventilation with outdoor air represents a starting point for addressing IAQ in terms of customer comfort. Guidance on minimum ventilation rates in hospitality applications, including bars, restaurants, casinos and smoking lounges is provided in ASHRAE Standard 62-1999, Ventilation for Acceptable Indoor Air Quality.

2. In addition to ventilation with outdoor air, filtration of both the outdoor air and recirculated air is recommended. Filtration of the outdoor air helps to preserve system cleanliness and can effectively minimize the introduction of pollen and other aeroallergens from the outdoor environment. Filtration of the indoor air can reduce particulate levels in recirculating systems, provide spot treatment of heavy smoking areas and assist in keeping ductwork and equipment clean.

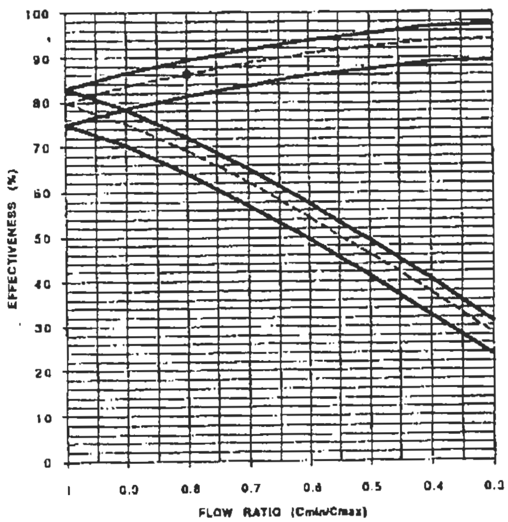
3. Within the conditioned facility, the direction of airflow should be carefully managed, particularly if both smokers and nonsmokers are to be accommodated. This means creating areas of differential pressure so that air is induced to flow from relatively "clean" areas to relatively "dirty" ones (also referred to as ventilation effectiveness). The type of system may be dictated by the requirements of the space. In some cases there will be both smoking and non-smoking areas. In others both smokers and non-smokers must be accommodated in the same space (such as bars and nightclubs).

Energy recovery ventilation addresses not only the first principle but also the third one. Because it necessarily involves both the supply and exhaust airstreams, energy recovery has the inherent capability to create pressure differences and directional airflows. A few key points to keep in mind:

✔ Air-to-air energy recovery systems require that the exhaust air be brought into physical proximity with the supply air; thus the application of energy recovery may impact whole building design and may require reevaluation of existing solutions.

✔ Maximum energy recovery is achieved with balanced supply and exhaust airflow. The system may be used to pressurize the building, however, only the unbalance required for pressurization should be used. See figure 4 for the impact of imbalance on energy recovery effectiveness on a typical enthalpy heat exchanger. Three sets of curves are shown representing balanced flow effectiveness of 75%, 80% and 83%. The top three curves illustrate the impact of unbalanced flow on recovery effectiveness of the smaller airstream (this is the classic definition of effectiveness). The bottom three curves show what happens to the total energy recovery relative to the amount of air moving in and out of the space.

Figure 4. Impact of Unbalanced Airflows on Energy Recovery Effectiveness



Recovery of energy from the exhaust air can increase on a percent available basis, however the system recovery is always reduced due to the reduced airflow in the exhaust. This is due to the fact that excess supply air leaves the building as exhaust or exfiltration with energy recovery effectiveness of 0%. A small imbalance (up to 10%) has a small impact on the effectiveness; however, a 2:1 ratio reduces a 70% effective heat exchanger application to 40% with respect to building system effectiveness.

- ✔ Ventilation effectiveness can be achieved in both the horizontal plane (useful for separating smoking and non-smoking areas) as well as the vertical direction (also referred to as displacement ventilation).

- ✔ The energy recovery must be integrated into the design along with other air handling equipment. This may or may not mean integration into the equipment itself. Recirculating systems, with some percentage outside air for dilution, may be appropriate for ventilation of a smoking area, for example. They are generally not suitable for ventilating or conditioning both a non-smoking and a smoking space using the same unit. In this case, 100% outside air systems are preferred and there are additional implications for operation and maintenance as discussed below.

- ✔ 100 % outside air systems can be designed to limit the leakage of exhaust air to supply air. It is not uncommon to achieve exhaust air transfer ratios of 1% or less using purge and fan arrangement/sizing. Purge is irrelevant in the recirculating system and only serves to increase fan energy use.

- ✔ Energy recovery is generally not suitable for kitchen exhaust hood applications due to the significant grease loading and related maintenance associated with the cooking environment. However, the impact of kitchen exhaust on the system and airflow patterns should be considered.

- ✔ Ensure that the energy recovery effectiveness is taken into account in the calculation of total cooling load. Otherwise, the cooling system can be significantly oversized. Research has demonstrated that oversized cooling systems cannot adequately control humidity due to short cycling and re-evaporation of water from the cooling coil. [18]

DESIGN GUIDELINES FOR THE HOSPITALITY APPLICATION

System design for hospitality applications is guided by a number of important factors:

1. **The amount of outdoor air to be provided to a hospitality design.**

When reviewing the required amount of outdoor air for different applications listed in ASHRAE Standard 62-1999 it is obvious that hospitality applications require higher per person ventilation rates when compared to other applications such as office buildings or educational facilities. In some applications it may be advisable to use the next higher minimum rate for an occupancy to improve dilution. For example, use the bar rate of 30 cfm for the smoking permitted area of a dining room or the smoking lounge rate of 60 cfm for a bar (legion halls, etc.) known to experience a higher than average smoking percentage or rate.

Table 1. Selected Outdoor Air Ventilation Rates from ASHRAE 62-1999

Application	Default Occupancy (persons / 1000 ft²)	Outdoor Air Requirement (cfm / person)	Outdoor Air Requirement (cfm / 1000 ft²)
Dining rooms	70	20	1,400
Bars, Cocktail Lounges	100	30	3,000
Assembly	120	15	1,500
Casinos	120	30	3,600
Smoking Lounge	70	60	4200
Offices	7	20	140
Classrooms	50	15	750
Auditoriums	150	15	2,250

2. **Existence of smoking areas and non-smoking areas within the facility.**

The second design consideration is whether the hospitality facility accommodates smokers and non-smokers. Two basic principles guide designs in hospitality environments where smokers and non-smokers are present: 1. Any return air where ETS is present can be exhausted instead of being recirculated, and 2. Airflows within the facility can be controlled to minimize any smoke drift from smoking to non-smoking areas. Field experience with these strategies has proven their utility in achieving occupant satisfaction.

A recent case study at Sam and Harry's, Harry's Tap Room in Washington, DC documented the use of supply and return air diffuser placement to control air flow and manage smoke drift.[19] A more detailed study of the positive benefits of increased ventilation effectiveness was conducted in an Applebee's restaurant in Greensboro, NC.[20] Modifications to the air distribution system resulted in improved environment and reduced drift of smoke to adjacent tables. In addition, a separate air-conditioning unit was used for the non-smoking area, providing an order of magnitude reduction in smoke concentration between the two areas. A more general discussion of the value and techniques of displacement ventilation in various building types is contained in an article by William A. Turner entitled Advanced Ventilation Design.[21] Many of Mr. Turners observations in school, office and industrial designs can also be applied to the hospitality application. Most significant, these systems, with 100% outdoor air, result in "less inter-zone pollutant transport". This should be the goal of successful hospitality design.

3. **Climate.**

As discussed above, due to the very high latent loads associated with outdoor air in hot humid climates and the higher ventilation rates required to achieve occupant satisfaction in hospitality venues, enthalpy recovery is recommended for pre-treatment of the outside air.

4. **Types of heating and cooling equipment and systems used.**

As discussed below under maintenance, recirculating systems exposed to environmental tobacco smoke (ETS) will require cleaning at intervals. Preference should be given to equipment that facilitates the cleaning procedure. Ducting should be cleanable as well. 100% outside air units are less sensitive to this requirement. If recirculating heating or cooling systems are installed, separate systems are suggested for smoking and non-smoking areas.

5. **Filtration or Air Cleaning**

In order to reduce cleaning requirements, increase maintenance intervals and reduce odor in recirculating systems, high efficiency filtration is recommended for returns in smoking environments.

ENERGY RECOVERY EQUIPMENT

The energy recovery ventilation equipment may take several forms including:

- Stand-alone or dedicated energy recovery ventilators are enthalpy wheels packaged with fans and controls
- Accessory units designed to be added to a packaged HVAC unit in the field, usually provided with separate fans for outside air and exhaust.

- Integrated package units are being provided by a few manufacturers. These products incorporate an enthalpy wheel with coils, controls, filters, fans, compressors and condensers.
- Air handling units with integrated enthalpy recovery are available for both indoor and outdoor application in standard and custom configurations.
- Custom-engineered site-built systems incorporating enthalpy wheels.

Any of these approaches may be used to allow for greater percentages of outside air in a given system or unit size. In retrofit applications of packaged systems, accessories may permit an increase from 10 or 15% outside air to as much as 50 or 60% outside air without increasing load or requiring modification of the original equipment. In new construction, smaller HVAC units, chillers and boilers may be selected based on the reduced load at design.

Stand-alone units are applied frequently to enhance ventilation and manipulate building pressure in an existing facility. The opportunity exists to increase local dilution and manage airflow without requiring changes to the existing plant. They may also be tied into existing HVAC systems through duct connection, typically supplying outside air into the system return while removing exhaust air from the space or, in some cases, directly from the return.

Purge may be specified to reduce leakage of exhaust air containing ETS into the supply air. In combination with fan placement and air pressure, purge can limit the transfer of exhaust air to supply air (through carry-over and seal leakage) to less than 1%. Such a requirement is valid for 100% outside air systems, particularly if they are designed to serve both smoking and non-smoking areas. On the other hand, purge is not required on systems that are already recirculating large percentages of return air. Note that, while exhaust air containing ETS is suitable for regeneration of enthalpy wheels, even those supplied with purge will eventually become an odor source and lose latent capacity as described below under maintenance.

Economizers are seldom useful in the hot humid climate application, however, in areas where both hot humid summer design conditions and cold winter design conditions prevail, it may be desirable to include economizer capability. Most manufacturers of stand-alone enthalpy recovery wheels incorporate economizer options into their offering. In the case of packaged equipment and applied air handlers, the integration of economizer function with energy recovery is widely available.

The recent growth of the market for enthalpy recovery means that regardless of system type or requirements, there will be energy recovery options with enthalpy wheels. Usually the designer will have several choices within a given category of product.

OPERATION

In general, the ventilation and energy recovery should operate whenever the space is occupied. In addition, the following may deserve consideration depending on the system design:

- ✔ Some benefit may be obtained from continuous operation of the system during unoccupied periods based on the reduction of contaminants deposited on surfaces both in the space and in the ductwork.
- ✔ In buildings with heavy smoking and ventilation shutdown during unoccupied periods, the system should be operated for a period of time prior to and after occupancy. Lead ventilation will assist in flushing concentrated odor (as discussed above under maintenance) from the HVAC system. Operation after occupancy provides an opportunity to reduce ambient concentrations of ETS constituents to near outdoor levels prior to shutdown, reducing deposition on indoor surfaces.
- ✔ Much of the literature and anecdotal evidence points to the benefits of higher than minimum rates for smoking applications. Unless occupancies vary in the extreme or very large amounts of outside air are being provided, the use of demand control to reduce ventilation rates may not be useful.

MAINTENANCE

As with any building systems and particularly air handling systems, proper maintenance will be essential to the successful function of the space. Nowhere is this more evident than in the hospitality environment where ETS is present. The need for maintenance should be considered in the system design and equipment selection.

A positive feature of all current enthalpy wheels is that they exhibit laminar flow within the heat and moisture exchange surface. (Packed bed and mesh type wheels exhibit turbulent flow and are not generally specified for comfort conditioning applications.) In addition, the transfer of water into and out of the desiccant surface occurs in the vapor phase; no wet surfaces are presented to the airstream. As a result, the wheel surfaces do not act as an impact filter and particulate matter small enough to enter the wheel will pass through. Larger particles (lint, etc.), which may impact on the wheel face, are generally removed by the counter flowing airstreams. This feature means that, with respect to accumulation of dry particulate matter, enthalpy wheels require less maintenance than other air handling components.

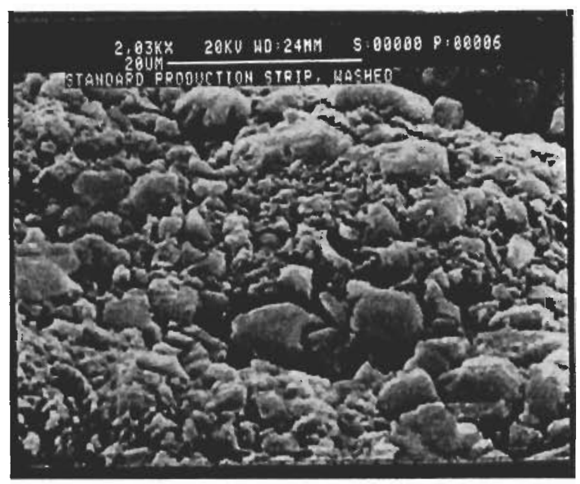
ETS is comprised of a variety of compounds, particles, gases and vapors including tars, phenols, and other substances[22] that condense out of the airstream and coat the surfaces of air handling equipment, including enthalpy wheels. This understanding has implications for system design and product selection as well as operation.

All the air handling ductwork and components serving a smoking area are exposed to semi-volatile components of ETS that condense on surfaces. Because they contain so much surface area, filters, coils and heat exchangers can become significant sources of odor as these compounds re-evaporate into the air. Thus enthalpy wheels, like permanent filters and coils, need to be cleaned on a schedule commensurate with the loading in a given environment. In addition, in the case of the enthalpy wheel, a coating of tar and other compounds will inhibit the transfer of water molecules on and off the desiccant coated heat exchange surface, reducing latent effectiveness. In order to recover and maintain latent effectiveness, the enthalpy wheel must be cleaned on a regular basis.

Electron micrograph photos of a suitable enthalpy wheel surface, before and after washing with soap and water, demonstrate that significant loss of desiccant and therefore of latent capacity do not occur.

Figure 5. Desiccant Surface Before Washing

Figure 6. Desiccant Surface After Washing



Our own extensive experience in the Japanese pachinko parlor market (pachinko parlors are well known for heavy smoking and the associated problems of high ventilation rates) and a local nightclub has demonstrated that cleanable, easy to access wheels resolve maintenance issues and restore the heat exchanger to near original latent capacity.

HOSPITALITY CASE STUDIES

There are numerous hospitality applications of energy recovery ventilation systems in operation today, confirming the utility of these systems in resolving equipment first cost and operating cost issues while addressing the ventilation performance and occupant comfort needs of the space. Several notable examples are referenced here:

* The Hitching Post food and beverage concession at the Richmond Airport sought to satisfy both smokers and non-smokers in order to maximize return from the airside location convenient to departure gates. Directional airflow, a conservative (higher) ventilation rate of 60 cfm per person (as for smoking lounges), enthalpy recovery and documented commissioning and maintenance procedures combined to produce a space that accommodates both smokers and non-smokers while maintaining humidity control. [23]

* The dining room and lounge at the Coral Reef Yacht Club in Coconut Grove, Florida used an enthalpy recovery ventilation accessory for a standard rooftop HVAC unit in conjunction with airflow distribution modifications to resolve a smoke and odor problem. Life cycle cost analysis of the system options showed that energy recovery saved 30% of the cost of a conventional system to upgrade the ventilation. Operating savings were estimated at between $3000 and $4000 annually. [24]

* The new Sunset Station Hotel and Casino in Las Vegas, Nevada utilizes a central station air handler with 100% outside air and heat recovery to make their smoking permitted casino smell and feel like a non-smoking facility. The system performance is enhanced with highly efficient filtration and plug flow (displacement) ventilation. This system utilizes a plate type heat exchanger due to the dry Las Vegas climate, but an enthalpy wheel would be substituted in a hot humid climate application. A building automation system continuously monitors outside air and pressurization by staging the air handler fans. [25]

CONCLUSIONS

Energy recovery ventilation, particularly enthalpy wheels deserve greater consideration in the design of ventilation systems for hospitality applications in hot humid climates. Properly selected and integrated with system design, stand alone energy recovery ventilators, packaged equipment with energy recovery options and integrated air handling systems with enthalpy wheel options have proven themselves in the challenging hospitality environment. The use of energy recovery allows for greater (more conservative) rates of dilution ventilation without compromising humidity control, comfort or cost objectives.

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