Select Aire Heat Recovery System

INTRODUCTION

This technical bulletin reviews the largest heat loss/heat gain source in a pool enclosure: ventilation air. It describes a simple method for recovering a significant portion of the exhaust air's energy without a large capital expenditure and with no increase in operational costs. This method also allows the system to be considerably more efficient than an economizer.

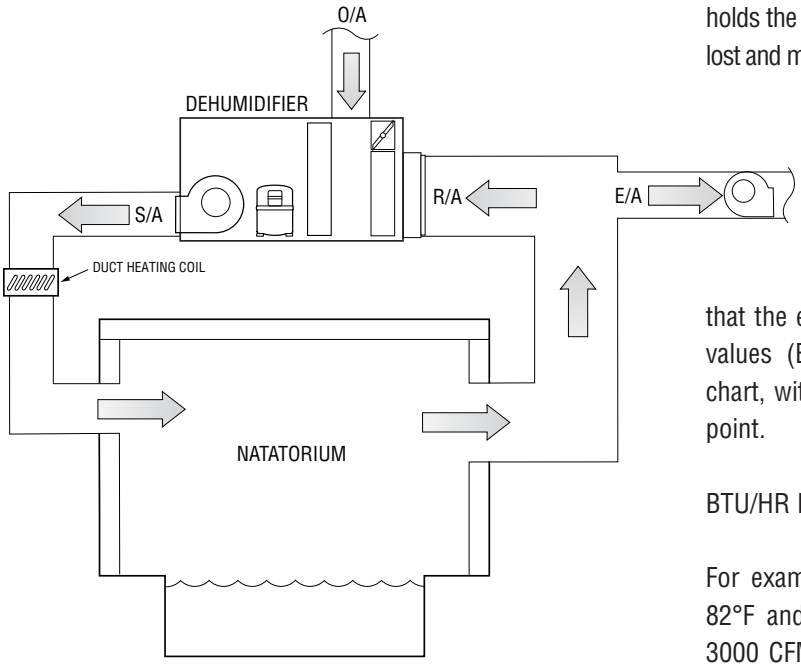

Figure 1 - Typical Exhaust System

VENTILATION AIR

According to building code, a public swimming pool must introduce fresh outdoor air to the enclosure. (ASHRAE standards call for 0.5 cfm/ft^2 of pool and deck, and 15 cfm per person. Refer to Desert Aire's *Technical Bulletin No. 5: Ventilation Air for Indoor Pools*, for details on the codes). Heat loss during the heating season is the single largest expenditure in operating costs. The actual loss comes from two components: sensible heat and latent heat.

The sensible component is a function of the difference between inside air temperature and outside air temperature. During the winter heating season, if 82°F room air is discharged and cold air is brought in to replace it, energy must be added to heat the fresh air. The greater the difference between inside and outdoor temperatures, the greater the heat loss.

The latent component is the loss of pool water heat in the form of moisture. Continuous evaporation is caused because heat is added to the pool water to maintain the water temperature. This energy is consumed by the process of changing water from a liquid to a vapor. Once the vapor is airborne, it still holds the energy content. If the vapor is exhausted, the energy is lost and must be made up in the form of additional pool water heat.

The combination of the latent and sensible components can be viewed on a psychrometric chart as the total enthalpy of the exhaust air. (See Figure 2 below.) The formula below can be used to calculate just how much energy is lost every hour that the exhaust/make-up system is operating. The enthalpy values (BTU/lb.) must be obtained from a psychrometric chart, with the outdoor air temperature measured at its dew point.

BTU/HR loss = (ventilation CFM) x (4.5) x (Δ H)

For example, a pool enclosure with an inside condition of 82°F and 50% relative humidity and a ventilation code of 3000 CFM would lose 283,500 BTUH when the outdoor air temperature is 32°F. At a gas cost of $0.50/therm, the fuel cost for the month to reheat the air and add energy back to the water to maintain temperature would be $1,275.

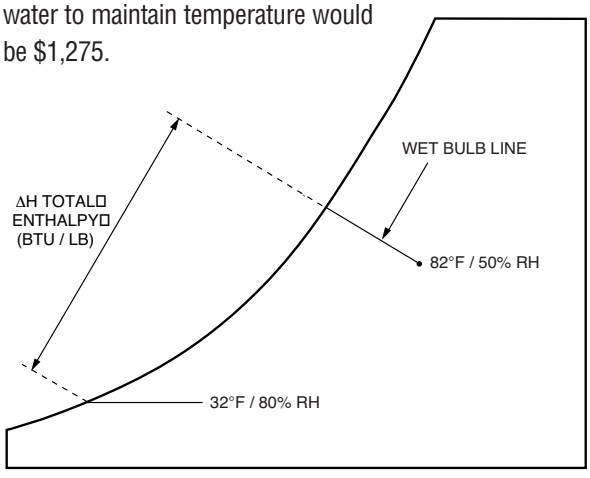

Figure 2 - Total Enthalpy Psychrometric Chart

SELECT AIRE HEAT RECOVERY SYSTEM

Every pool enclosure requires a dehumidification system for environmental control year round. The Select Aire dehumidifier acts as a heat pump to recover energy for use by the air and water reheat condensers. This heat pump action can be used to recover exhaust air energy also. (Refer to Figure 4, Heating Mode Schematic, Occupied.) The Select Aire system is an option on Desert Aire natatorium dehumidifiers. It provides both exhaust and make-up air as an integral part of the unit. In addition, the exhaust air can be taken from either the return air or the evaporator leaving air.

Cold exhaust would be employed during cold weather when it is desirable to retain as much heat as possible inside the building. The refrigeration system functions mainly as a heat pump system that recovers heat from the exhaust air and transfers it to the make-up air or pool water.

Warm exhaust would be employed during warm weather when it is desirable to remove as much heat as possible from the building. The refrigeration system serves to dehumidify and/or air condition the building, as required.

In a Select Aire system, exhaust is achieved by means of a centrifugal blower installed in a plenum along with a damper assembly. The blower is sized for the maximum desired exhaust. The plenum is mounted on top of the unit.

Make-up air is brought in through a plenum which is actually part of the exhaust plenum but is isolated from the exhaust air. It includes air filters and a motorized damper.

It is important to properly balance the airflow through a refrigerated dehumidifier. Improper airflow can damage compressors or reduce the moisture removal capacity of the equipment. Exact amounts of outdoor air must be brought in so that building codes are not violated. However, airflow balancing is more complicated in a dehumidifier with multiple blowers, dampers, and airstreams.

An effective control system, such as the one used in the Select Aire (covered in U.S. Patent # 5,682,754), will simplify air balancing while maintaining the correct proportions of return air, supply air, exhaust air, and make-up (outdoor) air. The Select Aire system works by monitoring the static pressure difference across three major components. The pressure difference is directly related to the quantity of airflow through each of the components. The control system then modulates several dampers in response to the pressure readings.

One pressure sensor measures the air pressure drop across the evaporator coil. A bypass damper above (or below) the evaporator modulates to maintain the correct pressure drop.

The second pressure sensor measures the pressure difference across the exhaust blower. The amount of air delivered by a blower is a function of its rotational speed and the pressure differential between its inlet and outlet. Since we use a single-speed motor, we can control the amount of exhaust air simply by varying the inlet static pressure (by opening and closing the warm or cold exhaust dampers).

The third pressure sensor in a Select Aire system measures the pressure difference across the reheat condensor. This reading is a measure of total (or supply) airflow, which is the quantity of air actually delivered to the pool room. The airflow is maintained by modulating the outdoor air damper. If the sensor determines that the supply airflow is too low, the outdoor air damper opens wider until the correct amount of air is delivered.

After initial setup, the Select Aire system is self balancing. The control system will compensate for standard filter loading or other disturbances which would alter the airflow of a conventional dehumidifier. Once the airflow is balanced, the control system functions to maintain proper humidity, room air temperature and pool water temperature.

Pressure Sensor	Control Damper
Reheat coil	Outdoor air damper
Evaporator coil	Evaporator damper controls face velocity
Exhaust blower	Warm and cold exhaust dampers control exhaust air volume

Table 1 - Damper Control Summary

UNOCCUPIED

During unoccupied time periods, the ventilation codes allow the closing of the outdoor air dampers, thus providing a significant savings in energy. The Select Aire system includes a time clock to allow programming of the occupied / unoccupied cycles. (Refer to Figure 3.)

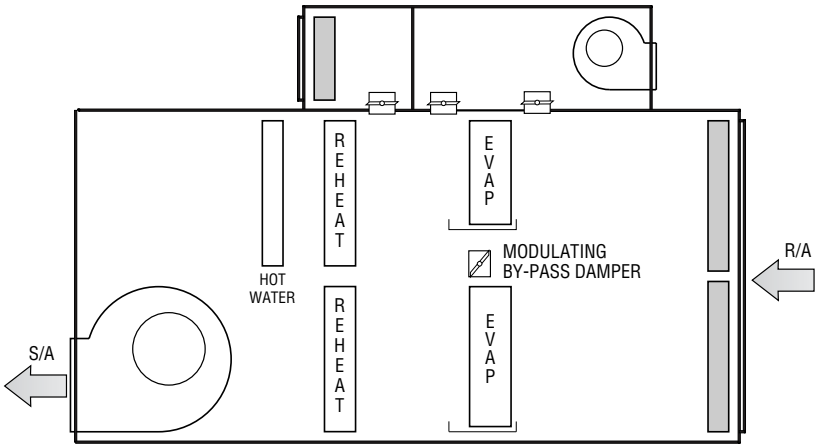

Figure 3 - Select Aire Schematic, Unoccupied Time

HEATING MODE, OCCUPIED

The Select Aire heat recovery system operates on the basic principles of thermodynamics. Warm, moist return air passes over the evaporator coil and is cooled from approximately 82°F/50% RH to approximately 50°F/95% RH. In the process, both sensible and latent heat are recovered and added to the refrigerant. The total enthalpy formula can be used to calculate the unit's recovered energy content. This energy can then be used to heat the make-up air or the pool water.

The dehumidifier is acting as a heat pump in this process. As part of the refrigerant cycle, the compressor contributes energy from the heat of compression. This energy is also added to the recovered sensible and latent energy. In this mode, the system operates at COP's of 4.5 to 5.0. Therefore, it is possible to recover more energy than has been exhausted. (Refer to Figure 4.)

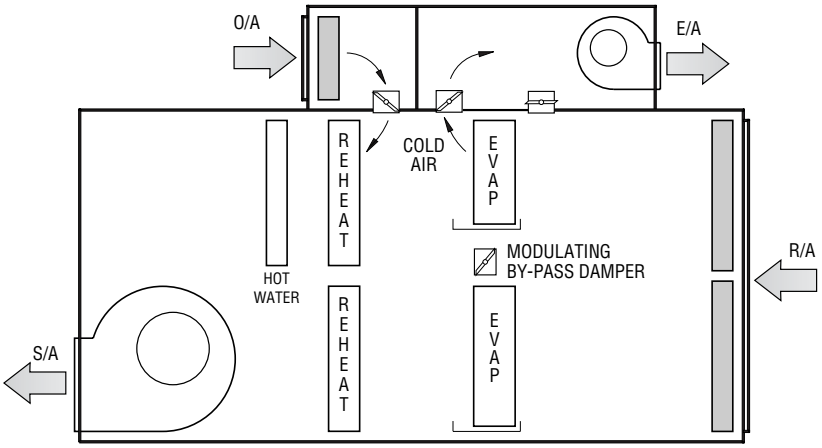

Figure 4 - Heating Mode Schematic, Occupied

COOLING MODE, OCCUPIED

During the cooling season, the air that has been cooled by the evaporator should not be exhausted because that would waste energy. By exhausting the warm air before the evaporator coil, the highest enthalpy air is removed from the system. The modulating bypass damper readjusts the airflow across the evaporators to maintain peak coil efficiency. (Refer to Figure 5.)

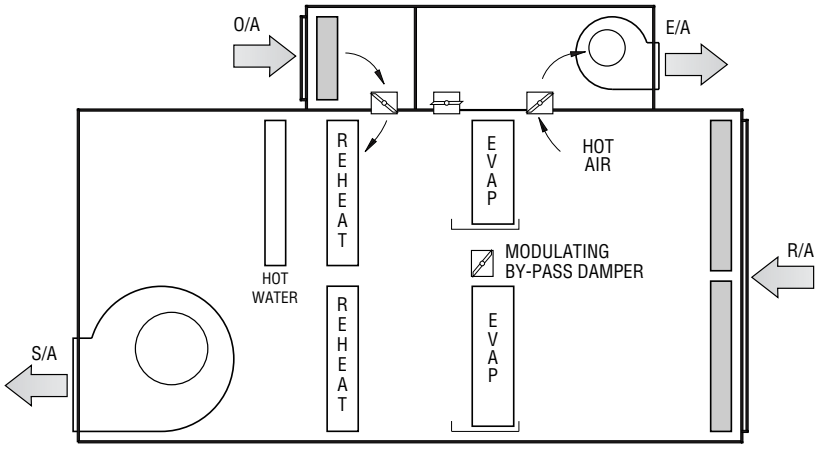

Figure 5 - Cooling Mode Schematic, Occupied

SPECIAL EVENTS CONDITIONS

Throughout the year, many aquatic facilities will hold special events which will have spectators seated in the bleacher sections. ASHRAE 62 requires that additional outdoor air be introduced during these spectator events. If necessary, the Select Aire system can increase the amount of exhaust and fresh air by rebalancing all of the dampers. The maximum amount of fresh air that can be introduced is 25 to 40 percent of the total supply airflow.

Some design engineers want a slightly cooler air temperature (1° to 2°F less) to flush over spectators. The best way to achieve this is to employ a dedicated outdoor air system (DOAS) that can handle the spectator air volume. This would be activated only during special events, thereby optimizing the energy costs and providing independent control of temperature and duct placement. The SA pool dehumidifier operates independently in its standard mode and takes care of the ventilation code air for the pool.

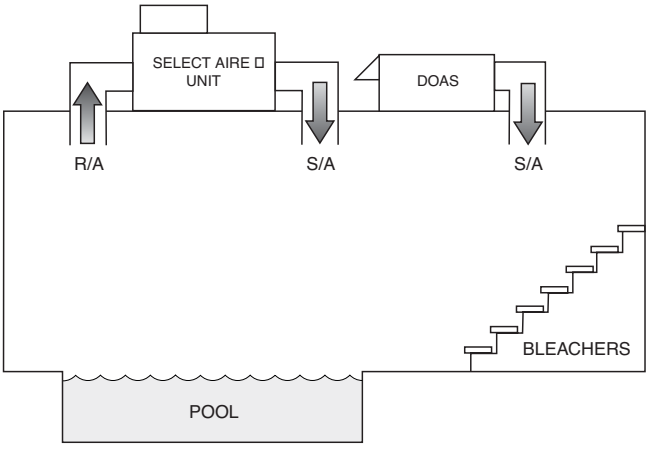

Figure 6 - DOAS System for Spectators

PURGE

More facilities are being designed with the pool dehumidifier providing a purge capability. This special dehumidification mode is activated each time the water is shocked (super-chlorinated) to break down the combined chlorine. After a pool is shocked, the pool dehumidifier introduces 100% outdoor air for 30 minutes to an hour. This helps speed up the chemical process in the pool water.

The Select Aire system runs in its normal mode 99% of the time. When the purge mode is energized, the return air damper is closed and the special outdoor air purge damper is opened. At the same time, the Select Aire system is disengaged so that no compressors or coils are active. A field supplied exhaust fan is then activated and the natatorium is purged.

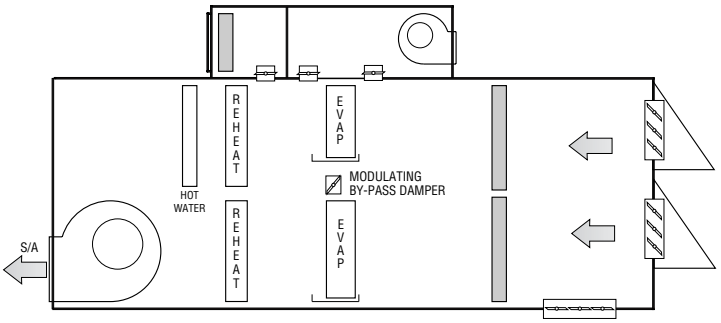

Figure 7 - Select Aire Schematic, Purge Mode

CONCLUSION

The Select Aire system provides benefits during the heating season by recovering a portion of the exhaust air's energy and in the cooling season by rejecting the warmest air from the building. Since the dehumidifier provides all of the necessary equipment, the initial capital outlay is minimal. The extra operating costs are also minimized, since the dehumidifier must run to control humidity anyway.

The Select Aire system optimizes the choice of where and when to exhaust air. The decision is determined by the thermostat's heating and cooling setpoints. The control sequence is simple and basic. While 100 percent of the heating season exhaust energy cannot always be recovered, the Select-Aire system provides significantly higher recovery values than do other heat recovery methods, while guaranteeing the humidity level year round.

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