Pool Dehumidification Basics

When energy costs were low, many pool owners considered only first cost when choosing how to dehumidify their pool rooms and went with an exhaust-air fan plus heater for the outdoor air. But even when energy was cheap, outside-air systems were a false economy, because they often left pool rooms with humidity levels that were either (depending on outside air conditions) too high or too low—making swimmers uncomfortable and often causing structural damage to the pool enclosure.

With today's high energy prices and the emphasis on a low carbon footprint, pool operators are looking for systems that can dehumidify the space, maintain swimmer comfort, and save energy. Pool owners now realize that proper dehumidification of a pool room is not only essential for maintenance of the pool structure and swimmer comfort, but it can dramatically affect their operating and maintenance costs.

This paper explains what to consider when designing a pool dehumidification system:

- Maintaining optimum air and water temps for swimmer comfort
- Airflow
- Ductwork and grilles
- Minimum outside air requirements
- Heat recovery options
- Saving energy with latent heat recovery
- Free energy analysis

Maintaining optimum air and water temps for swimmer comfort

A common complaint pool operators get is that the pool water is too cold. Paradoxically, the usual reason for this complaint is that the air temperature being maintained in the pool room is too low rather than the water temperature is too low.

The pool water evaporates more rapidly as the air temperature decreases relative to the pool water temperature. Water evaporates off swimmers' skin just as it evaporates off the pool surface. This creates an effect called evaporative cooling. The higher the water temperature relative to the air temperature, the faster water evaporates off swimmers' skins, and the cooler they feel. To lessen the evaporation rate and optimize swimmer comfort, pool-room air temperature should be maintained at two degrees above the temperature of the pool if at all possible

A well-designed and installed dehumidification system controls both temperature and humidity levels. A typical residential or commercial pool will minimize complaints about room and pool conditions when:

- The water temperature is set at 82˚ to 84˚.
- The air temperature is set at two degrees above the pool water temperature.
- The relative humidity is maintained between 50% and 60%.

Swimming pools that cater to the elderly are often kept at 86˚ to 88˚ degrees, while therapy pools are kept in the low to mid 90's. In these cases, the room air temperature should still be set in the mid 80's, because a temperature higher than the mid 80's can by itself cause discomfort. To compensate for the increased evaporation levels due to the higher water temperature, the dehumidifier should be sized to keep the room's relative humidity in the mid-50% range. A dehumidification system that is designed for these conditions will have no problem keeping the pool room properly dehumidified.

Messing with the settings. Many dehumidification systems that were correctly designed (water temperature 82˚ to 84˚, air temperature two degrees above water temperature, and relative humidity between 50% and 60%) have been readjusted to the point that the pool room has a high water temperature, a room air temperature set below the pool water temperature, and high humidity in the pool room. Swimmers and maintenance people complain, and the dehumidifier gets the blame, when in fact the problem was caused by the pool operator messing with the settings.

For example, evaporation off the pool surface will increase over 43% if the water temperature is raised from 82˚ to 86˚ and the air temperature is reduced from 84˚ to 80˚. A dehumidification system that was designed to handle the 84˚air/82˚water load will not be nearly large enough to handle the 80˚air/86˚water load.

In order for a dehumidification system to keep the pool room between 50% to 60% relative humidity, decide on the pool and water temperatures before designing the dehumidification system and then keep the temperatures in the pool room at the design conditions.

Airflow

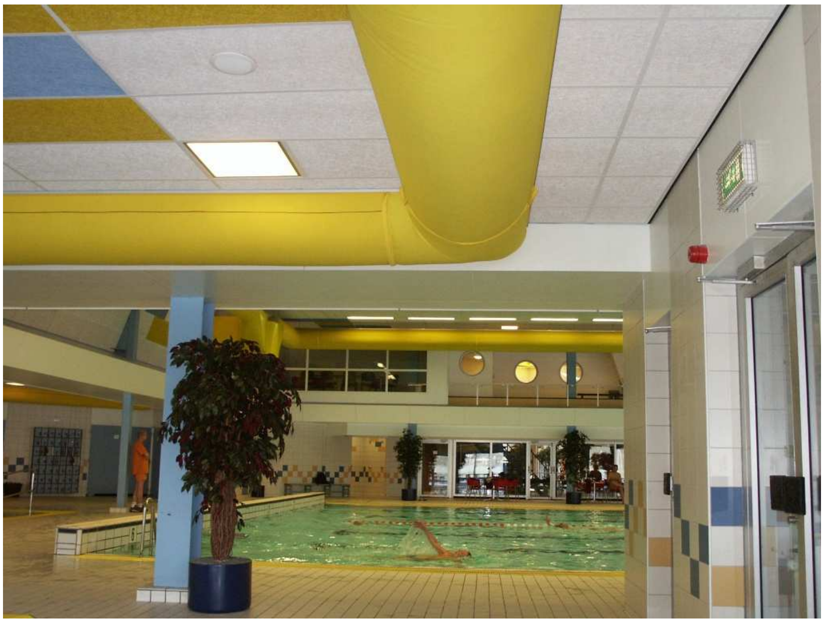
The American Society of Heating, Refrigeration and Air conditioning Engineers (ASHRAE) recommends airflow for pool rooms of between four to eight air changes per hour. The code requires that the supply air to the pool room not be recirculated unless the air is dehumidified to maintain relative humidity at 60% or less.

Airflow should be continuous over all glass surfaces (including skylights) and exterior walls to prevent condensation. If ducting cannot be placed to ensure airflow over the surface of skylights, use fans to blow air up to prevent condensation.

Use minimal supply airflow over the surface of the pool water, because airflow over the pool surface increases the evaporation rate of the pool. However, a low return of no more than 30% of the total airflow is recommended to help pull the evaporated chloramines off the air that is slightly above the pool surface. If a low return is used, there should also be a high return to prevent moisture from accumulating at the roofline.

Ductwork and grilles

Ductwork, grilles, etc., must be resistant to corrosion from the chemicals in the pool room. The ductwork can be painted aluminum, stainless steel, or fabric duct. The best choice for grilles and diffusers is anodized aluminum. Never use fiberglass duct liner in a pool room because of the high humidity load.


Fabric duct

Fabric duct is becoming a common sight in pool rooms, because it eliminates concerns about condensation and corrosion issues with ductwork. Proper consideration of the velocities and static pressure in the fabric duct is important. Wescor personnel can assist the pool-room designer with the proper sizing of fabric duct.

Because it is handling chemically laden air, the pool room’s duct system should be totally separate from the ductwork into any other area not related to the pool. The first choice in ducting is underground blowing up, but when this is not feasible, the second choice is overhead blowing down.

Minimum outside air requirements

ASHRAE Standard 62 is the industry-accepted standard for indoor air quality and was adopted to protect the health of swimmers and to enhance energy conservation in commercial pools. The standard assumes that an automatic chemical-feed system and a dehumidifier are installed and operational.

The most recent standard defines the recommended minimum outside air requirement for commercial pools as .48 cfm of outside air per square foot of the pool surface and deck. The deck is defined as the square footage of the pool room less the pool and seating areas. If there are spectator areas, there must be additional outside air. The ASHRAE formula for the additional outside air is:

spectator area ft^2 x 0.06 cfm/ft^2 + [# of people x 7.5 cfm]

Some states maintain the earlier International Mechanical Code requirement of .5 cfm of outside air per square foot of deck area and 15 cfm per spectator.

Controlling outside air dampers for spectator events can be handled in one of three ways:

- A manual switch.
- A timer with a spectator event manual override.
- Using a carbon dioxide monitor. A CO_2 monitor has been accepted by ASHRAE as an indicator of indoor air quality.

The outside air requirement is only for the time period that the pool is open. There is no requirement for outside air during non-occupied hours as long as the dehumidification system can maintain the relative humidity at or below 60%.

The fact that outside air is not required during unoccupied times can be a major consideration in choosing a dehumidification system. A system that uses outside air to dehumidify the space, such as a wheel or a plate heat exchanger, must bring in outside air even during unoccupied times to maintain relative humidity at 60% or below. This will necessarily mean an increase in energy costs as compared to a refrigerant-based dehumidifier, because outside air must be heated during winter months.

When designing the outside air system, also consider that the pool room should be negatively pressured. Thus the exhaust air should be sized to be slightly higher than the outside air brought into the building. This is very important, because a positively pressured environment can push hot, humid, and corrosive pool-room air into interstitial spaces, where it will condense and cause moisture and structural damage.

The dynamics of the pool enclosure are unique when considering placement of the outside air duct into a refrigerant-based dehumidifier. Most other applications can accept outside air upstream of the air handler without affecting the system's performance, but not in the case of a dehumidifier. Problems can occur during the heating season when outside air is introduced into the return air duct. Condensation forms in the ductwork when cold outside air meets warm humid return air. This condensation causes the mixed air temperature that is returned to the dehumidifier to be lower than the pool-room air and decreases the moisture removal capacity of the dehumidifier. The best location to bring in outside air is between the dehumidifier's evaporator and reheat coils.

Heat recovery options

Two forms of energy can be recovered from air as it is exhausted from a pool:

- ***Sensible energy*** is thermal energy (heat). It is the heat that is measured by a thermometer.
- ***Latent energy,*** or latent heat, is the energy that is in the water vapor created by the water evaporating into the air from the pool surface. The pool heater creates the initial energy that is needed to speed up the molecular motion of the water causing it to evaporate. This energy is available to be recaptured when the water condenses. Latent energy is generally recognized as the humidity we feel.

Air-to-air heat exchangers do just half the job. Most state mechanical codes require that some kind of energy recovery must occur when using outside air to dehumidify a commercial pool room. One choice is to use an outside air system with an air-to-air heat exchanger for heat recovery. An air-to-air heat exchanger recovers sensible energy and pre-heats outside air with the energy recovered but recovers only a fraction of the latent energy.

Also be aware that at low ambient outside temperatures, the make-up air must be pre-heated or by-passed in order to not freeze the heat exchanger. This can significantly reduce the effectiveness of the heat exchanger in cold weather. Thus when the heat exchanger is most needed it has the least amount of recovery efficiency. In warm weather, when there is no requirement to heat the building, there is no heat recovery at all from the exhaust air stream. If the building temperature is to be maintained during the summer months, a separate air conditioning system must be installed.

An air-to-air heat exchanger system must use outside air 24 hours a day/365 days a year to keep the pool room dehumidified. The pool room environment can be out of control during times of the year when the specific enthalpy (the measurement of the combination of the dry air and the water vapor in the air) of the outside air is greater than that required to maintain the indoor conditions. In any case, an enthalpy controller and modulating dampers must be used to control the relative humidity of the indoor air if a 100% outside air system with heat recovery is used.

In the western United States a “100% outside air system” is a misnomer. Because most outside air systems control humidity in the pool room based on the enthalpy of outside air, the dampers are open far less than 100% for most of the year. This is because the outside air is dehumidifying the pool room. A system bringing in 100% outside air would over-dehumidify the pool room. As mentioned previously, these systems need to bring in outside air even during unoccupied periods in order to dehumidify the space, so often the only “benefit” to an outside air system is higher energy bills.

Dehumidifiers do it all. The most energy-efficient choice for pool-room energy recovery is a packaged dehumidifier. These systems recover both sensible and latent energy and return the energy to the air, to the water, or to both. Because latent energy has been recovered, the relative humidity in the pool room can be maintained without using any more outside air than is required by code. Thus the combined energy savings with a dehumidifier are much greater than an outside air system with heat recovery.

Saving energy with latent heat recovery

A motel pool of 700 square feet will evaporate approximately 18 pounds of water per hour. This is over 17,000 BTUs/hr of latent energy. If this energy is not captured through heat recovery, it must be expelled from the pool room to keep relative humidity in the room at 60% or less. Energy that is not captured and returned to the pool room means that over 416,000 BTUs per day must be exhausted from the pool room without being recovered—a very wasteful use of energy.

A typical athletic club pool is five times the size of a motel pool. Its latent energy exhausted from the pool room will be over two million BTUs per day unless a dehumidifier is used to capture the latent energy.

In addition to latent energy, water is also lost to evaporation. When latent energy is recovered from the air by a dehumidifier, the vapor condenses to water that can be returned to the pool. In an athletic club pool of 3500 square feet, that equals more than 107,000 gallons of water reclaimed in one year.

Free energy analysis

Wescor has over 25 years of pool dehumidification experience that adds up to more than 500 pool dehumidifiers sold, with Wescor sizing most of the pools' dehumidification systems. We will perform a free energy analysis for any pool in the Pacific Northwest and provide the contractor or engineer with a written analysis showing:

- The evaporation rate off the pool surface.
- The amount of outside air required by code.
- The proper size dehumidifier to install for that particular pool.
- An energy analysis comparing all methods of dehumidification that can be used for that pool, with a yearly energy usage and annual energy cost for each method.

Contact Wescor on your next pool job, and let us show you how you can save energy.

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