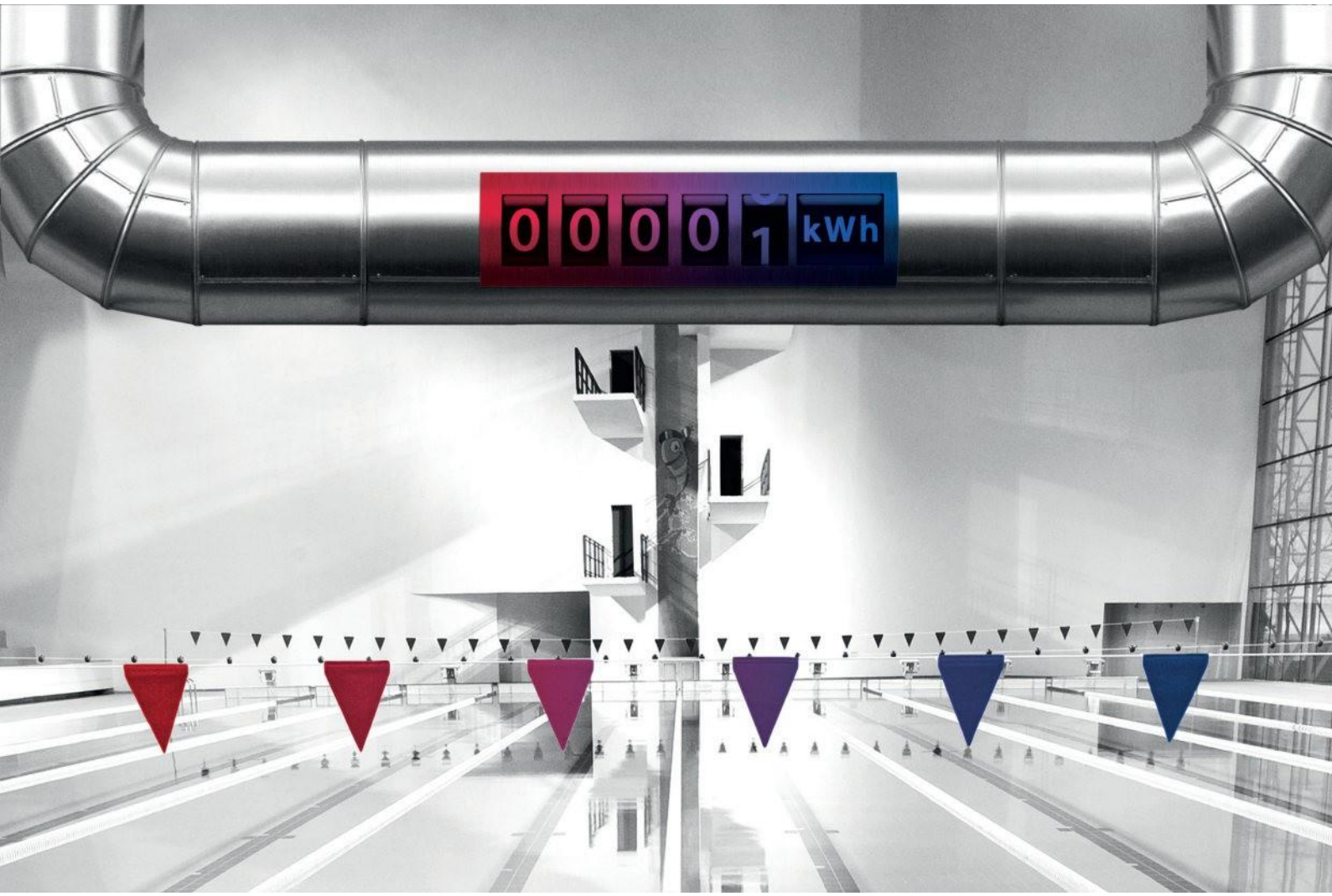
POINTS FOR DESIGNING VENTILATION OF SWIMMING POOLS



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Points for designing ventilation of swimming pools

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1. Introduction

A swimming pool is a complex system that places heavy demands on many disciplines. Both that they have the necessary expertise in their specialty, and the ability to cooperate.

The main challenge is water and health. Open water surfaces create structural challenges in itself. Moreover sanitary reasons will require systems for water treatment, which in many cases can cause corrosive environments. To create an attractive indoor climate in a swimming pool certain minimum temperatures are required, which stand in contrast to a winter climate.
Big temperature differences inside and outside creates large pressure differences, and moist air cooling down on its way out of the building construction will create condensation during the winter.

Many disciplines must be involved in a successful swimming pool project:

- Structural Engineering
- Building Physics
- Water Treatment Technology
- Ventilation systems
- Automatic controls

To achieve a successful outcome, all these functions must work properly. Dantherm Air Handling A/S are specialists in indoor air quality and ventilation. We will therefore concentrate on air conditioning.

What characterizes a swimming pool?

A swimming pool is a room with:

- High indoor temperature
- High relative humidity
- Open water surface
- Periods with active people
- Corrosive environment

Further, a swimming pool meets the needs of many user groups:

- Disabled people may need special access opportunities to the water
- Children's pool / paddling pool should be shallow, and have high water temperature
- Therapy pool will have a high temperature
- The swimming pool room must provide the opportunity for, and encourage play and fun in water
- The swimming pool room must encourage everybody to train and do exercise
- Competitive Swimmers must have good training opportunities and 'low' water temperature

When we see these different needs all new swimming pool halls should be equipped with several pools. Evaporation increases dramatically with the water temperature so that hot pools should have a small surface, while training pools should have a large surface. Evaporation is calculated for each pool, and added together. The air temperature is maintained at a fixed level throughout the hall, unless it is separated in separate rooms (glass wall).

2. Small mistakes can have major consequences

Structural consequences

The combination of high temperature and high humidity provides challenges in engineering. Traditional indoor air in the swimming pool is 30°C and 55% RH. This results in a dew point of about 20°C. Cold bridges, diffusion, and leaks can cause major structural consequences, such as mould, fungus, rot and at worst collapse due to large accumulations of water in the ceiling and roof.

Energy consequences

Warm moist air has a very high energy level. Traditional dehumidification with the use of fresh air gives large energy costs. Air conditioning thus requires well thought out energy solutions in corrosion resistant materials. Dehumidification and ventilation is a combination of process and comfort technology.

Air handling units must cover the swimming hall's needs for:

- Fresh air
- Dehumidification
- Heating
- Air Movement

Human consequences

Water treatment requires significant amounts of chlorine and in some cases other chemicals. Trichloramines evaporates from water to air. High temperature and humidity creates a humid working environment for the staff, whereas the wet bathers want high temperatures.

Asthma is a problem among athletes, especially cross-country skiers and swimmers are exposed. It is estimated that cross-country skier's asthma problems are caused partly to great efforts for a long time in cold climates. For swimmers great training doses of high intensity are common, but the temperature is not low.

Trichloramines is a theme that has come into the picture in recent years. This is a subject that we do not know much about, but it is believed today that a bigger amount of fresh air can help to remedy the problem. The main cause of the problem is presumed to be the hygiene of the users (insufficient showers routines) and water chemistry, but human behaviour is difficult to change.

3. Evaporation

Water will normally evaporate to the air from a water surface. If we imagine a closed room with a pool, and the same temperature everywhere, the air will soon become saturated with water vapour. Evaporation will then stop. If the air is replaced, the humidity will be lower. Evaporation increases with increasing temperature and decreasing humidity.

It also increases with increasing air movement by splashing / water in motion, and by increased surface (walking areas).

In a swimming pool there will be a constant evaporation from the pool. This is the very point of the indoor climate issue in swimming pools. The air humidity is not allowed to get over a certain level - usually 50 to 60% RH. If this level is exceeded the risk of serious structural damage increases drastically. Because evaporation takes place all day - all year - very large amounts of energy are involved. Limiting evaporation and removing moisture in an economic way are therefore crucial for the swimming hall's financial results.

The heat required for evaporation is taken from the environment, ie, partly from the water and partly from the air (depending on water and air temperature, humidity, air speed, etc.) No matter where the heat is taken from, the amount of energy to the evaporation is the same. Assuming that most of the evaporation heat is taken from the water, a corresponding amount of energy must be

supplied to the pool water heating system. To this should be added the pool's remaining losses (heat conduction through the walls / floor etc.).

In order to minimize evaporation, the following will have positive impact:

- Lowest possible water temperature
- Highest possible air temperature
- Highest possible relative humidity
- Lowest possible air speed above the surface
- Lowest possible floor temperature
- Minimum splashing / slides / Jacuzzi / wet people
- Use of a pool cover when pool is not in use
- The most uniform running conditions throughout the week

You will quickly understand that the request for low evaporation is in contradiction to other requests, such as a dry building, many satisfied users/bathing guest and good conditions for operating the system.

4. The function of the air handling unit

The many tasks of the air handling unit:

- To ensure a good air quality for users
- To secure air movement (warm wet swimming pool air must not remain close to thermal bridges and where it will be cooled)
- To cover the dehumidification requirements
- To cover the heating requirements (In a swimming pool hall it is nearly always warmer than in the outdoor environment)
- To ensure an efficient energy utilization

In addition, the unit must be designed for corrosive atmospheres and long life. An air handling unit for a swimming pool will be in operation all the time!
All these requirements are covered by a Dantherm DanX air handling unit.

The principle is "simple"

Evaporation of water from an open water surface requires energy, about 0.7 kWh per liter of water. This energy is taken from the environment which is primarily water but also air. The warmer water compared to air the greater the evaporation, so it is recommended to keep an air temperature which is at least 2°C higher than the water temperature, but this is incompatible with water temperatures above 30°C. When the air is dehumidified the same amount of energy is returned, which is used for:

1. Keeping the air temperature in the hall (transmission loss, infiltration loss and ventilation loss).
2. Any excess heat is returned to the water.

When water-cooled and air-cooled condensers are connected in series, heat can be emitted to both at the same time.

The combination of the heat exchanger and heat pump ensures an efficient and energy friendly dehumidification. When the compressor is operating the energy loss from the swimming pool hall is the lowest. (The energy content of the exhaust air is reduced over the evaporator). The compressor will therefore have a long life, and will operate when there is a demand for heat in the hall!

The relationship between water and air temperature and water surface area determines the dehumidification requirements. The volume of the swimming pool hall determines the airflow requirement.

As for offices, we recommend that for a swimming pool hall with people, the minimum fresh air requirements is determined by the total area (10 m^3 / h per m^2 of water surface + 5 m^3 / h per m^2 of other surfaces) and the requirement for RH and temperature should provide forced fresh air supply in case of great activity. CO 2 is a bad indicator because the hall's volume is large compared to the number of people. RH is a bad indicator as well because over dimensioning the dehumidification unit will never result in a demand for fresh air.

Conclusion: Ensuring good air quality for the users!

The minimum amount of fresh air during opening hours based on the area and forced fresh air amount at increased activity.

Ensure air movement

(Warm wet swimming pool air must not remain close to thermal bridges and get cooled down there).

The amount of circulated air is defined on basis of the hall's volume and water and air temperatures. The air should normally be supplied from a position below the windows. Objective:

max turbulence in the hall, and a minimum of turbulence just above the water surface. As a rule of thumb we count with 4 to 8 air changes per hour in relation to the hall's internal height and temperature. Low height and high temperature, high circulating airflow.

Cover the dehumidification requirements

Evaporation is calculated on basis of air and water temperature and water surface, and you select a unit that covers this requirement at night operation with 100% recirculation.

Cover the heating requirements

Calculate the building transmission and select a re-heating coil together with heat pump to cover the heating requirements.

Efficient use of energy: water-cooled condenser

A water-cooled condenser (preferably in series) with an air cooled condenser ensures distribution of "excess heat" from the dehumidification process to where it is needed. Air should be first priority, then water. You can also use this energy for preheating of tap water, water-based low temperature systems etc.

5. Important to remember

- No common intake / exhaust with other systems because: Varying amounts of air for the air handling unit.
- A pool cover is not appropriate for large halls with high activity level.
- Water-cooled condensers connected in series. Advantage with series connection: Reduced condensation pressure gives a higher COP. Heat distribution to both air and water simultaneously. Both air and water often need heat at the same time. (Not suitable in conjunction with pool covers.)
- The heat pump must run when there is a heating requirement.
- A PIR sensor is an effective way to reduce energy loss in case of long opening hours and only occasional use (especially for hotel pools).
- After-cooling increases the heat pump's dehumidification and may be energy-saving, but it will not normally be energy-efficient. The after-cooler requires cold water, after-cooler connected to feed water reduces the control of water quantities. The water side has good recovery systems for water exchange, and should cover this function.
- Pre-heating coil at low outdoor temperatures.
- System limit. Energy loss above the system limit is an important measure of the unit's efficiency. Electricity supplied for operation of the unit is NOT.

6. System limits, an important tool for the evaluation of swimming pools

You have to consider the complete energy consumption when choosing equipment. Focusing at one single energy consumer, might course inappropriate waste of energy at other energy consumers. In order to keep control of energy flow, it is important to draw a system limit.
The losses of ventilation and air conditioning units are reflected in the enthalpy increase in the exhaust air compared to outdoor air. This should be minimized.

In many cases it is an advantage to increase the power supplied for the operation of the unit if this helps to reduce the loss of the system limit. A large compressor power and long life compressors will keep down the loss above the system limit if you can use added and released energy internally to cover transmission loss and water heating.

Dantherm
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Dehumidification:
Mobile and stationary dehumidifiers for drying buildings and for use in private pools and wellness centres.

Ventilation:
Large ventilation systems used in swimming pools and buildings such as shopping centres and cinemas requiring frequent air change. The range also includes domestic ventilation products based on high-performance heat exchangers.

Mobile heating and cooling:
Products for heating or cooling of tents and equipment used by the armed forces and aid organisations. The customers are primarily the armed forces in NATO countries as well as tent and container manufacturers.

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