Heatstar
Energy Technology Systems

- Pool Hall Climate Control - General Design Guidelines

The following factors must be considered as part of the overall heating and climate control design for an indoor swimming pool:

Pool Water Temperature

The pool water requires to be heated to an acceptable temperature. Within a typical indoor pool, the pool water is normally heated to a temperature between 27°C and 30°C. The majority of the heat loss from the pool water is by evaporation from the pool surface into the pool hall air.

Pool Hall Air Temperature

The pool hall air requires to be heated to an acceptable temperature. Ideally, in order to limit heat loss and evaporation from the pool water surface, the pool hall temperature should be maintained slightly higher than that of the pool water. I.e. if the pool water temperature is 27°C, the pool hall air temperature should be maintained at 29°C. It should be noted that, although such high air temperatures provide a pleasant environment for suitably attired bathers, for whom wetted skin enhances the chilling effect on the body, such conditions may prove uncomfortably warm for other activities and for fully clothed spectators.

Pool Hall Humidity: What is Humidity?

The water which is continually evaporated from the pool surface is present in the pool hall air in the form of humidity. This moisture loaded humid air also contains the majority of the heat lost from the pool water and therefore is rich in energy. This energy is referred to as latent heat. The amount of humidity is expressed as '% Relative Humidity' or '%R.H.' The amount of moisture which the air can contain before condensation starts to take place is 'relative' to the temperature of the air. The cooler the air, the less moisture can be contained and therefore condensation will occur sooner.

How is the Humidity Level controlled?

If the pool hall humidity level is not limited, then heavy condensation will occur on the pool hall structural, leading to rapid deterioration of the decor and possible eventual structural failure. To prevent this a method of 'dehumidification' must be employed.

In the past, fuel costs were comparatively cheap and therefore it was possible to simply expel the humid energy laden pool air to out side, whilst replacing it with cooler fresh air, which required rapid heating to an acceptable temperature. Given present fuel costs, such a wasteful approach would understandably prove prohibitively expensive to operate and would now be in breach of building control regulations.

Modern systems therefore utilise methods of energy recovery, often using refrigeration technology to condense out excess humidity without the need to 'throw away' the warm pool air. Such systems also enjoy the ability to 'reclaim' the latent heat contained within the humid pool hall air back to either the air or pool water.

What is the ideal humidity level?

Within a typical indoor pool, the humidity would be controlled at around 60-65% R.H., which would provide pleasant conditions for bathers and minimal condensation on the pool hall structure. If the relative humidity is reduced further, then the rate of evaporation, and therefore the heat loss from the pool water is unnecessarily increased together with the requirement for dehumidification.

How does a 'Pool Surface Cover' work?

Savings on operating costs are often possible through the use of a pool surface cover. Such a cover primarily acts to 'seal off' the pool water surface, reducing evaporation and heat loss to an absolute minimum.

When a pool surface cover is in place, the pool air can then be allowed to fall to a temperature below that of the pool water without any adverse effects. This is referred to as the ‘set back air temperature’.

Prior to the pool cover being removed, the pool hall air temperature should ideally first be restored to the normal level i.e. higher than the pool water temperature.

A pool surface cover can provide the following energy saving benefits :

- When a pool surface cover is in place, the heat loss through convection and evaporation from the pool water is reduced and, as a result, less pool water heating is necessary.
- As the pool air can be maintained at a lower temperature when a pool cover is in place, less air heating is necessary.
- In reducing evaporation from the pool surface, the amount of dehumidification necessary is also reduced.

Liquid pool covers are evaporation inhibitors which reduce evaporation from the pool whenever the water is still. However, unlike a conventional pool cover, an appreciable amount of evaporation will remain present and, therefore, a ‘set back’ air temperature cannot be fully utilised. Where the intention is to use a liquid pool cover, the climate control equipment must be selected on the basis that the pool is uncovered, with dehumidification duties and equipment specification upgraded accordingly.

Factors Affecting Heat Loss & Humidity

The following factors affect the rate of evaporation and heat loss from the pool water surface and subsequently the humidity within the pool hall air :

Surface area of the pool and other water features, pool water temperature, pool hall air temperature in relation to the pool water temperature, swimming activity within the pool, wetted pool surround resulting from swimming activity, humidity level of the pool hall air, air movement across the pool surface, use of a pool surface cover.

The following factors affect the rate of heat loss from the pool hall air :

- Structural / fabric heat loss from the pool hall roof and walls etc.
- Amount of out side fresh air ventilation into the pool hall.

The heat loss from the pool hall structure is calculated using the probable temperature difference between the out side ambient fresh air temperature and the internal pool hall air temperature and the thermal insulation property of the various parts of the pool hall structure. For example the insulation value of a typical roof would be expressed as 0.25 Watts per m^2 of roof per °C of inside/outside temperature differential. This is referred to as the ‘U-Value’.

Fresh Air Requirements

The majority of modern heat recovery systems primarily ‘re-circulate’ the pool hall air. The amount of fresh air ventilation which requires to be deliberately introduced varies depending upon the nature of the application:

A small lightly used domestic pool using pool surface cover will require only minimal fresh air ventilation. A large commercial pool with high levels of usage will require a much higher rate of fresh air ventilation.

Air Distribution Methods

The heating and climate control unit would normally be located in the equipment plant room.

Therefore the heated / conditioned air supplied by the climate control unit is ideally distributed around the pool room using a channel of ducting with outlet grilles into the room.

General Air Ducting Channel Design Considerations:

The air duct channel should be designed to ensure :

- Air is discharged via grilles directly over external glass areas prone to condensation.
- There are no significant parts of the pool hall through which air is not being circulated.
- That air discharge velocity across or towards the actual pool water surface is minimal.
- That operational noise transfer is considered and reduced to a minimum.

Consider that the air ducts will be comparatively large in size and that the cross sectional area of the duct should not be restricted through the necessity to work around physical obstructions etc along the proposed duct route.

Make the ducts as large as possible – this will limit the fan power consumption necessary to drive air through the duct.

Drainage pipe or small bore pipes cannot be used for air ducting due to the high accumulative resistance / pressure drop.

Flexible or ribbed air ducting offers a very high resistance on the flow of air.

Flexible connections between the ducts and the ventilation unit will help prevent operational vibration transferring into the building structure.

External fresh air intake grilles should be at least 1900mm from any boiler flue.

The fresh air intake and air exhaust grilles should be kept a distance apart.

Thermal insulation to ducting:

Unless the duct is located actually within the pool room air space, the duct should be thermally insulation as well as is physically possible. This is especially important if the heat source is of comparatively low output capacity, such as a heat pump boiler.

For reference, a minimum 100mm of closed cell slab insulation is recommended.

All insulation must be on the outside of the duct. Insulation on the inside is prone to becoming unattached and blocking the duct.

The duct should be directly thermally insulated, even if it is located within an insulated void, otherwise the ability of the system to effectively deliver warm air into the pool room when demanded is compromised.

Where should the delivery air ducting channel be located?

A ducting channel positioned at low level or under the pool hall floor is the most effective approach as the warm supply air can then naturally convect up over the glazing.

An overhead ducting channel can be used, although the air discharge velocity from the duct has to be greater to force the warm air down over the glass. Invariably, the air curtain achieved from overhead ducting is unlikely to reach down to cover areas of glass near the floor.

Under Floor Ducting

If under floor air ducting is to be used, the following should be noted :

- Under floor ducting should not be used if ground water drainage problems are found to exist on site or a high water table is present. If there is water present in the air ducts, the whole system will not function satisfactorily.
- The pool shell should be positioned away from the walls and foundations to allow sufficient space for the under floor air ducting to be positioned along side where necessary.

- The air ducting and discharge grilles should be located as close to the walls / glazing as possible. The grille louvers should be angled towards the glass and be fitted with manually adjustable dampers / shutters.
- Care should be taken to ensure that the path of the ducting is not obstructed by foundations, drains, pipes etc.
- A water drainage point should be provided from the under floor duct to prevent the possibility of the duct flooding in the unlikely event of a hose being left on over a grille etc. Normal splash water down the floor grilles is not a problem as it will be rapidly evaporated by the warm dry air.

Overhead Ducting

If overhead ducting is used then care should be taken to ensure that the ducting is fully insulated and air tight if positioned within a cold roof space above the pool hall ceiling vapour barrier.

Noise through air ducts

Some air noise will invariably be transferred into the pool hall area through the air duct openings.

Air vents to outside are also a potential source of external noise breakout and should be positioned to give regard to nearby neighbours etc.

Try to avoid positioning the pool hall air intake to the climate control unit straight through the pool hall wall – this will add notably to air noise transfer. The greater the distance between the climate control unit and the pool hall wall, the greater the options for noise reducing measures.

If minimum noise transfer into the pool hall is a priority, then allowance should be made for in-duct noise attenuators.

Ductwork design / installation

Although the duct system would normally be designed, supplied and installed by a specialist contractor, Heatstar are pleased to advise on this aspect.

Through-wall suck & blow arrangements

If a full system of air duct work cannot be accommodated, then the air can be discharged back into the pool hall via a single wall grille. However, please appreciate that air distribution throughout the pool hall will be compromised and that there will be no opportunity to create an air curtain across glazing etc. The limitations will be apparent through uneven temperatures and humidity levels in the far reaches of the pool hall and increased levels of condensation can be expected on glazed surfaces.

A high degree of air noise transfer into the pool hall can be anticipated with such an arrangement.

Non-Ducted Systems

If, for instance on an existing project, a proper climate control system cannot be accommodated and the use of separate air heating and dehumidification products are necessary, the following should be noted:

Standard domestic radiators should not be used as their pattern of heat convection from low level is not beneficial for an indoor pool and may increase evaporation and humidity. In addition, when considering that the pool hall floor may be wet and slippery, they also represent a potential safety hazard.

Warm air blowers are preferable and are far more suitable for the application. Equally a warm air heating coil can be incorporated within the dehumidifier.

The positioning of any dehumidification equipment is not as important as achieving even heating and air temperatures throughout the pool hall.

Care should be taken to ensure that the intended positioning of a dehumidifier or warm air blower does not contravene current electrical regulations i.e. within 2m of the pool surround.

Give due consideration to the noise and vibration transfer generated by such equipment, particularly if it is mounted from a wall.

Equipment Plant Room

Frequently insufficient space is allowed for the plant room area. The machinery necessary to operate an indoor pool is considerable - pumps, filters, fuel boilers, air handling units etc. Sufficient space must be provided for all the equipment together with adequate access for service and maintenance.

If the plant room is to be used as a plenum chamber for the pool hall air, i.e. the pool hall air is drawn into and through the plant room, then the plant room must be thermally insulated and sealed to the same high standards as the main pool hall. In addition, only fuel boilers fitted with a balanced flue, as opposed to a conventional flue, can be positioned within the same area. Care must also be taken with the storage and use of chemicals within the plant room and the enclosing of any vulnerable electric / electronic equipment.

If the plant room / pool equipment is located at first floor level then appreciate that there is a risk of extensive flooding in the event of a leak in a pool water pipe or fitting. A typical swimming pool pump delivers water at a very fast rate with the potential for notable resulting damage.

Noise & vibration transfer from plant room

The plant room equipment will obviously produce a level of noise during operation. Consideration must be given to potential noise and vibration transfer. For example, the plant room should not be located near to bedrooms and should ideally be positioned away from occupied areas. Be aware that vibration can also be transmitted through walls, ceilings and air ducting.

How intrusive noise transfer will prove is dependent largely on the acoustics of the pool hall. The pool hall should be designed to offer ‘soft’ acoustic reflection to prevent echoing.

Pool Hall Structural Insulation

Pool halls are normally maintained at temperatures significantly higher than those normally experienced in domestic dwellings. Therefore, in order to conserve energy and limit condensation, it is important to ensure that the structure is insulated to a standard which is at least equal to or greater than the current building regulations.

Internal doors and windows should be well sealed to prevent the pool hall air migrating into adjoining areas.

The building should be well sealed to prevent cold air seeping through gaps around external doors and windows etc.

Although the overall structure may be well insulated and thus condensation free, there can be points where structural members such as lintels or RSJ's cause cold bridging, resulting in localised condensation forming on the interior of the fabric. When designing the structure, this can be averted by adding additional insulation and vapour sealing to problematic areas.

Adjoining Rooms to Pool Hall

Provision must be made for adequate heating and ventilation of any rooms adjoining the pool hall such as changing, toilet or storage areas to prevent localised condensation.

Pool Hall Air Migration – negative air pressure

Ideally, there should be a negative pressure differential between the pool hall and any adjoining areas to help prevent the pool hall air from migrating into these areas.

Pool Hall Ceiling Vapour Barrier

To prevent the moisture within the pool hall air from penetrating through the ceiling insulation and condensing to water in the cold sectors of the roof, provision <u>must</u> be made for the inclusion of an effective vapour barrier in the pool hall ceiling.

Please note:-

- A material that is water proof is not necessarily vapour [gas] proof.
- Example material : Monarflex Reflex Super (Tel : 01727 830 116) or equivalent.
- The method of installation should ensure that the vapour seal is complete and secure.

- Care should be taken to ensure that other trades people do not puncture the vapour barrier with fixings etc.

- If using pre-assembled insulation sheeting already fitted with an approved vapour barrier, it is essential that the joints between the separate panels are also completely vapour sealed and insulated.
- Light fittings should not be located where they penetrate the vapour barrier.

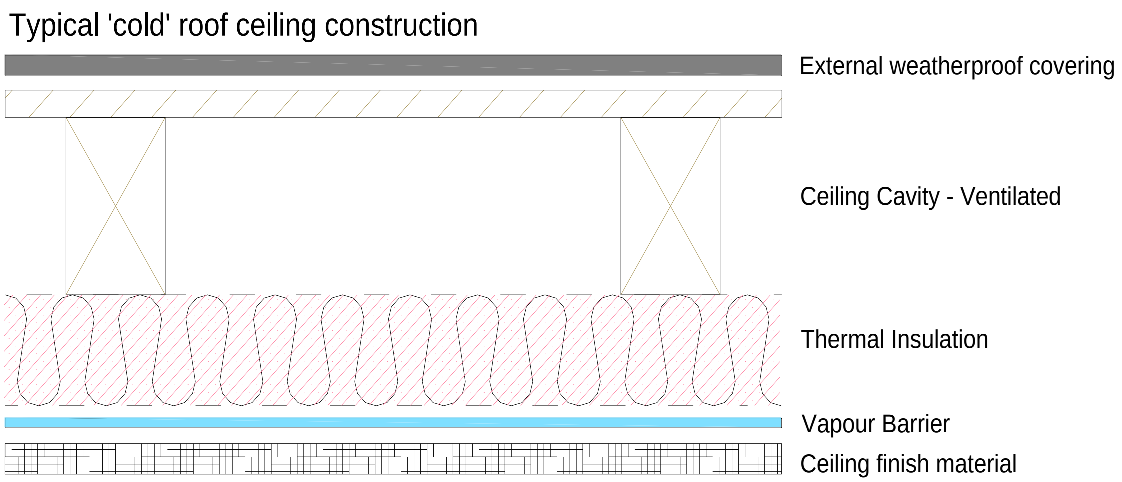
Breathing / ventilation of cold roof space

In practice no vapour barrier will be totally effective as a small amount of vapour can still be passed through the insulation to cooler areas of the roof. It is therefore essential within a 'cold roof' design to provide a space above the insulation which can breathe to the ambient outside air, allowing the moisture to escape and not concentrate and condense to water.

Pitched roofs must have ventilation provision [building regs]. Flat roofs can either have breathers in flat surfaces or ventilation through the edges.

This will ensure that the insulation remains dry and effective and that the roof structures will not be subject to heavy condensation and mould growth etc.

Alternative 'Warm roofs' designs, which do not use a breathable space, require absolutely perfect vapour barriers and there is no margin for compromise if the project is to be successful.



Building Structure Interior Finishes

Consideration must be given to the selection of materials used within a swimming pool hall.

If the pool hall environment is properly controlled, then even materials which are hygroscopic in nature such as plaster, plasterboard and artex can be used without problem.

However, if climate control is lost, for example in the event of a power-cut etc, then these materials could be damaged by excessive humidity. With pools which do not use a pool surface cover, it is recommended that a temporary cover be stored somewhere on site to be deployed in such an event to stop evaporation from the pool and so protect the interior finishes.

Any timber used must be conditioned for use in damp areas or, if kiln dry timber is used, allowance must be made for expansion under pool hall conditions.

Timber that has not been appropriately seasoned will shrink and twist under the wide range of pool hall temperature and humidity conditions which may typically be anticipated. It is important that the suppliers of any timer are fully informed as to the anticipated operating conditions.

Glazing

Even if the pool hall environment is correctly controlled, some surface condensation can still be anticipated on double glazing during the colder winter months as the internal surface temperature of the glass can be below the dew point temperature. If this is not acceptable the use of triple glazing or heated glazing should be advised to the client. Due to the comparatively poor thermal insulation value of glass, the overall operating costs for the project will largely depend on the amount of glazing within the design.

Current new building control regulations stipulate the use of high quality glazing which should be more than suitable.

However, please consider:

- The use of raised frames will restrict the warm air curtain reaching the glass.
- Recessed windows of any description will result in increased condensation risk.
- External glazing positioned close to a spa should be triple glazed or heated.

On older, retrofit installations, problems may be encountered if the following are used :

- Single glazing, secondary glazing. Soft wood window frames, window frames without thermal insulation, sliding patio doors with imperfect air seals, air gaps in double glazing units less than 12mm, cold bridging through conservatory metal frame structures.

The amount of glazing or polycarbonate used within a design will determine the amount of solar heat gain which may be anticipated during the summer months. If, for example, the roof is glass or polycarbonate, the solar heat gain will be vast and no practical amount of ventilation or cooling will prevent excessive air temperatures. If this is not acceptable for the project in question, then a system of blinds, shades or solar reflective glass should be considered.

Roof Windows:

The use of roof light glazing is discouraged as they can often become a trap for localised condensation. In addition, it is difficult to provide a good seal between the ceiling vapour barrier and the roof light, making the surrounding area vulnerable to condensation.

If roof lights are required, it is strongly recommended that they be triple glazed with thermal breaks in the frames.

If twin or triple wall polycarbonate sheeting is to be used, limited condensation can be expected during the winter months. Care should be taken to ensure that the edging of the sheets are properly sealed to maintain the thermal efficiency.

The high level of solar heat gain that such materials can allow should also be considered.

Stretched ceilings:

A plastic stretched type ceiling offers a number of benefits and provides an excellent vapour barrier. However such ceilings are prone to move up and down to a notable degree when exposed to the normal air pressure differentials which a typical ventilation system is intended to create, therefore:

- If any lights are incorporated within the ceiling, due allowance should be made in the length of any connecting power or fibre optic cables.
- The roof structure above the ceiling should be at a sufficient distance from the ceiling to ensure that the two do not come into contact when the ceiling level moves upwards. There should be no sharp fixings above the ceiling as these will damage it.
- The fixing battens supporting the ceiling should be sufficiently strong enough to cope with any air pressure which the ventilation system may place upon the ceiling area.
- Make the client aware at an early stage that the ceiling will deflect and not lay flat.

Unusual furnishings:

Sometimes a client may wish to locate gym equipment or TV’s etc within the pool hall. It must be appreciated that the normal operating conditions within a pool hall may invalidate the manufacturers warranty for that type of product and that such equipment may be prone to damage due to the humidity levels which may occur.

Likewise, if plants or flowers etc are stored within the pool hall, then the client must accept responsibility for constantly monitoring the pool hall conditions to ensure that any such plants are not adversely affected by the pool hall conditions which may occur.

Condensing fuel boiler:

Modern high efficiency condensing fuel boilers require to operate at lower hot water heating circuit flow temperatures than conventional fuel boilers in order to achieve optimum efficiencies. It should be confirmed that the climate control system has been designed to consider the lower heating circuit flow temperatures offered. Invariably this will necessitate an increase in heat exchanger and air flow capacity. It is very important to ensure that the required design circuit temperatures are communicated to the fuel boiler system suppliers.

Fuel Boiler Water Circulation pump :

The capacity of heating water circulation pump required in likely to be notably greater than that for a typical domestic heating system. Ensure that the fuel boiler system suppliers are aware of the correct pump size required.

Ground source & fresh air source heat pump boilers:

If a heat pump boiler is to be used to provide the primary heat source, in place of a fuel boiler, then the climate control system must be designed especially to consider the lower heating water circuit flow temperatures offered. Invariably this will necessitate an increase in heat exchanger and air flow capacity. Typically, due to the comparatively warm air and pool water temperatures required for a swimming pool application, a minimum circuit flow temperature of 55°C will be required from the heat pump boiler. It is very important to ensure that the required design circuit temperatures are communicated to the heat pump boiler system suppliers.

Salt water pools:

If salt is used in the pool water for salt or electrolytic chlorination, then metals in contact with the pool water, including the heat exchangers within the climate control unit, may be exposed to an increased risk of corrosion damage. To help guard against such damage, the Heatstar systems can be specified at time of order with special components, like titanium heat exchangers.