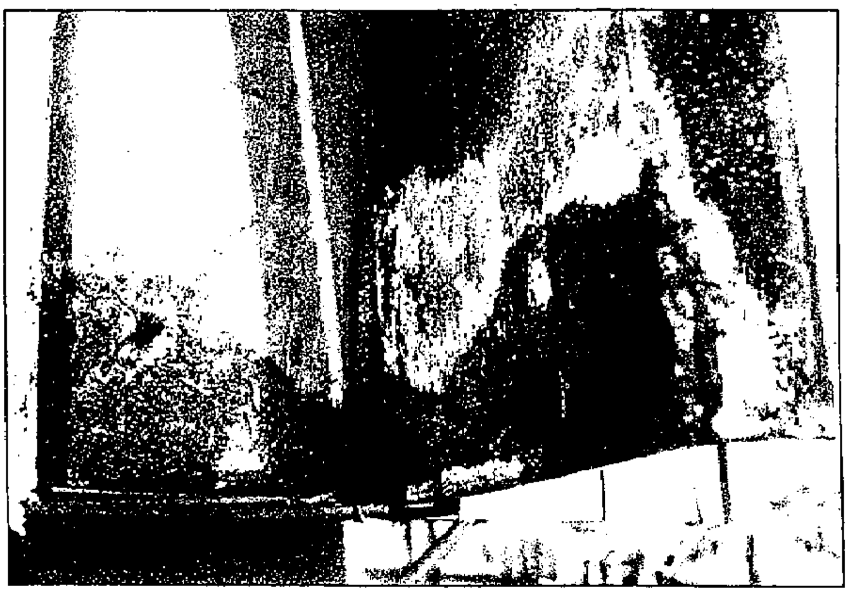
A dehumidification system alone is not enough to prevent humidity from damaging buildings that house indoor pools. Vapor barriers and construction materials also play major roles.

INDOOR POOL DESIGN: AVOID THE POTENTIAL FOR DISASTER



University pool building wall steel panel rusted after 10 years due to nonsealed vapor barrier joints. Note rust on glass fiber insulation.

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We have all been in buildings with indoor pools where mold, black stains, rust, and rot were the predominant visual aspects. Lawyers love this type of building, and professional liability insurers shudder.

It does *not* have to be that way. It does, however, take close cooperation among the owner, architect, and mechanical engineer to accomplish a durable pool building. There are several aspects that must be considered to reduce maintenance expenses, prevent premature structural failure of the building, and avoid lawsuits.

Interior materials

Simple problems, such as "forever wet" carpet, can be prevented with a good quality tile floor. *Any* steel should be avoided unless it is galvanized *and* coated with a high-performance epoxy paint. I have seen many rusty door frames and exit light fixtures that could have been avoided with the choice of corrosion-resistant products.

The pool water treatment (such as chlorine, etc.) also provides a very aggressive corrosion environment for all construction materials in the pool structure. Pool buildings have collapsed due to the chlorine/humidity conditions existing even in well designed buildings.

I have been consulting on a major university pool building that has severely rusted in 10 years. It is a metal building, and both the wall and roof panels have been completely replaced due to the lack of a vapor seal on the vapor barrier joints. This retrofit cost $800,000.

In a YMCA pool building with ordinary gulaminated trusses, I measured 96 percent RH on one cold December day. I predict that this building will never "grow old," but it will grow mold, corro-

Exit light in a Vermont pool building rusted due to out-of-control humidity and a steel frame.

sion, etc. The masonry walls in this building are waterlogged with condensation.

There are very few acoustical ceiling tiles that can withstand pool humidity. One that I have seen perform well is Armstrong Ceramoguard. The grid system must also be able to resist the humidity.

Skylights over pools are not a good idea in cold climates. This is probably a valid statement in *any* climate.

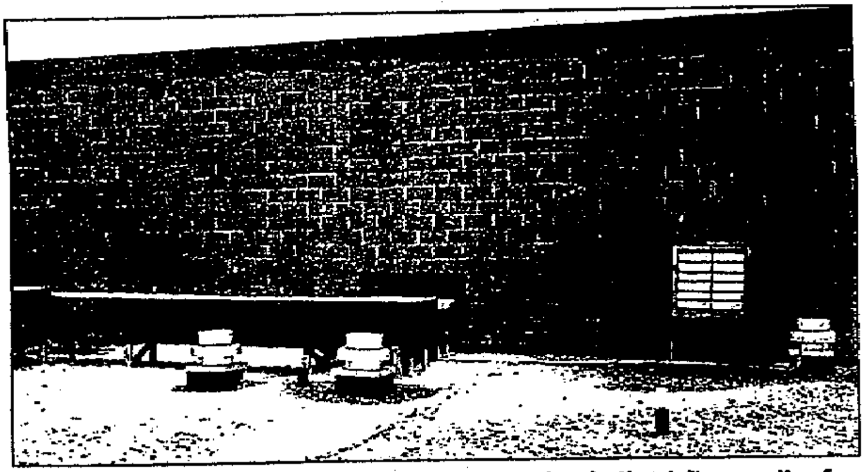
The caulk and sealants used in construction joints do not last forever. Caulk must be inspected yearly and repaired as required.

The mechanical design engineer may not think that carpets and skylights are in his jurisdiction. However, I can assure you that when the building turns black-, green-, and rust-colored, the lawyers will file suit against everybody involved in the project.

I am called in to consult on many pool buildings after the fact, and many architects just do not seem to understand the whole problem of pool humidity. Also, many owners just want low cost, but they forget that when problems occur and lawyers are hired.

Insulation/vapor barrier

The single most critical aspect of any pool building, especially in cold climates, is the insulation/vapor barrier system. Vapor barriers for pool buildings must have a perm rate of 0.10 or less (perm = 1 grain per sq ft per hr per in. Hg pressure difference).



YMCA pool building had no vapor barrier and only the 4-ft propeller fan (right) to dehumidify. Note wetness and ice on the block wall.

Foil-backed sheetrock does not work because there is no way to seal the joints. *The vapor barrier must be continuous and sealed at all joints.* Now, that seems to be a simple, understandable statement. However, I have yet to find a contractor who understands it. All penetrations by mechanical and electrical trades must be sealed air tight. The vapor barrier must be sealed to the door and window frames. The wall vapor barrier must be sealed (not just overlapped) to the ceiling vapor barrier.

As a mechanical-HVAC design engineer, I will *not* accept a consulting project on a pool building unless I am assured that there is a reasonably good vapor barrier. Allowing the electrical contractor to cut holes indiscriminately in the vapor barrier for duplex outlets makes as much sense as installing screen doors on a submarine.

My favorite vapor barriers are high-performance cross-laminated polyethylene or good quality foil-faced foam insulation boards. All joints *must* be sealed with a suitable tape (not just duct tape). I am a firm believer in 1 in. of foil-faced foam insulation board (covered by sheetrock or other suitable fire barrier) on the entire interior of a pool building. If glass fiber insulation is used, the specifier must be careful to inspect for continuity (holes) prior to the application of the vapor barrier. The vapor barrier always gets installed on the warmer side of the insulation.

I recently was asked to inspect a pool building in Pennsylvania that was under construction. There was no vapor barrier—only sprayed-in-place urethane. The wood studs in the walls would have rotted out within a few years. The contractor tore off the sheetrock and retrofitted polyethylene, and the A/E firm paid the six-figure price for it. Sprayed-in-place urethane foam *is not a vapor barrier.*

What *is* an adequate vapor barrier (some people prefer the term vapor retarder)? For pool

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TABLE 1—Permeability of building materials (data from Lotz tests and ASHRAE).

Material	Perms, grains per hr per sq ft per in. Hg
Air (still)	120.00
Plain glass fiber	120.00
Gypsum sheet rock (drywall)	50.00
Plaster on metal lath	15.00
Vinyl-acrylic primer paint	9.00
Vinyl-acrylic enamel paint	7.00
Latex primer paint	6.00
1-in. wood (pine)	5.00
15-lb tar felt	4.00
Primer and oil paint	3.00
¼-in. interior plywood	2.00
Kraft facing on glass fiber batts	1.00
Brick wall	0.80
¼-in. exterior plywood	0.70
½-in. exterior plywood	0.50
Vapor barrier paint	0.50
8-in. concrete	0.40
4-mil polyethylene	0.08
½-mil aluminum foil	0.05

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buildings, I can assure you that the residential facers on glass fiber batts are totally inadequate. As I stated previously, for pool applications, the vapor barrier system should have a rating of 0.10 perm or less. The vapor barrier must be addressed as a system to be effective. By system, I refer to the sealants and tapes used to seal holes and joints. Table 1 can be used for reference, but I suggest consulting the *ASHRAE Handbook* for more complete data.

The wall between the pool room and the rest of the building should have insulation and a vapor barrier on the pool side. Doors in that wall should be weatherstripped as if they were outside doors.

Vapor flow through a vapor barrier is calculated as follows:

lb of water flow = (perms × sq ft × hr × 0.6)/7000

The typical vapor pressure differential in a northern climate is 0.6 in. Hg, and there are 7000 grains per lb. Hence, for 1 perm and 1 sq ft in one year:

(1 perm × 1 sq ft ×8760 hr per yr × 0.6)/7000 grains per lb = 0.75 lb of water into wall

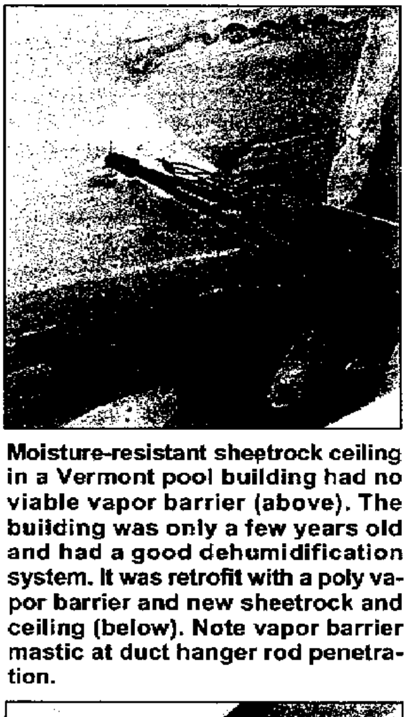
If the exterior of the wall has ½-in. plywood sheathing, then from Table 1, the wall is in for some rot, mildew, and peeling paint.

This is a simplistic approach to a theoretical 1 sq ft section of a wall that has weather, joints and holes, air flow, etc., to complicate the issue.

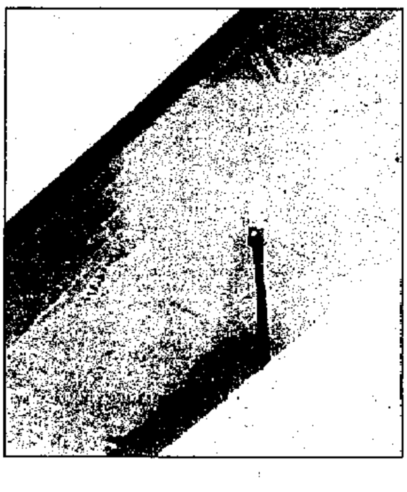
Design conditions

The typical pool is designed for 80 F pool water temperature, 100 to 105 F whirlpool water temperature, and 82 F air temperature with the relative humidity controlled at 50 to 55 percent RH. Recently, I had a client who insisted on 86 F pool temperature after the system was designed and built. I worked through an architect and never met the owner until he complained about the "cold" water. In my opinion, it makes sense in many soils to insulate the pool itself. In cold climates, it is a good investment to install 2 in. of extruded polystyrene or sprayed urethane under and around the pool.

Consider solar gain to the pool area. Some pool structures have a great deal of glass that could result in overheating of the air in the building. Does the owner want to use a pool cover? If so, the cover will affect the dehumidification/pool heating if the HVAC system consists of a dehumidifying heat pump.



Moisture-resistant sheetrock ceiling in a Vermont pool building had no viable vapor barrier (above). The building was only a few years old and had a good dehumidification system. It was retrofit with a poly vapor barrier and new sheetrock and ceiling (below). Note vapor barrier mastic at duct hanger rod penetration.



The pool HVAC equipment rooms will need ventilation to reduce the corrosive effects of the pool chemicals on the HVAC equipment (chemicals are usually stored in the same room).

As I stated earlier, most pool areas are designed for 82 F, 55 percent RH air conditions. The building owner should understand that any bar, lounge, or restaurant in the pool space will be rather uncomfortable for people wearing street clothes.

HVAC system

Hopefully, the day is long gone when the humidity in a pool building is controlled by a propeller exhaust fan in the wall. However, believe it or not, I saw a YMCA pool in New Hampshire built in the late 1980s with that type of "control" (this is the same building mentioned previously that had 96 percent RH and a variety of problems).

ASHRAE 62-1989 requires 0.5 cfm per sq ft of outside air for pool areas. This means the total area of the pool room. I have designed many successful residential pools that have no outside air. Commercial pools generally come under BOCA or some other code that refers back to ASHRAE 62-1989 for outside air.

Some owners request a negative pressure in the pool enclosure to lessen the chlorine odor in the rest of the building. This can easily be accomplished with an air-to-air heat exchanger with an exhaust fan slightly larger than the outside air fan. One must make sure that the heat exchanger can withstand the corrosive environment of the pool exhaust.

Most commercial pool owners want air conditioning during summer months to be able to maintain an 82 F air temperature in the building. Many residential pool owners I see shut down the dehumidification system in hot weather and open all the windows. Issues such as this should be discussed with the

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Controlling humidity

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building owner prior to the start of design. Some manufacturers of dehumidifying heat pumps suggest an extra $2000 to $4000 for equipment provisions inside their unit for future air conditioning ability.

There are many viable, reasonably economical means for effectively controlling humidity in the indoor pool environment. I say "reasonably economical" because none of these is cheap to install or operate. There are several good air-to-air plate-type heat exchangers for controlling humidity. The fans run on a dehumidistat set to operate when the humidity exceeds 50 to 55 percent. Dehumidifying heat pumps accomplish two things with one piece of equipment—humidity control *and* pool water heating.

Good quality [redacted] dehumidifiers are available. Ducts and grilles must be corrosion resistant. Aluminum grilles and registers are the only realistic option (*not* steel).

Whenever possible, install the supply ducts in the floor and direct the air upwards across windows and other glass. Take care not to blow air at or across the water as the air flow will increase evaporation and also be uncomfortable for swimmers.

Conclusion

Mechanical engineers need to be more involved in the total pool building design. Too many architects assume that the engineer's dehumidification system will protect the building. This is an unfortunate error. Indoor air at 82 F and 55 percent RH plus chlorine can be very destructive to the building.

I am not suggesting that mechanical engineers become architects (perish the thought), but I strongly recommend that mechanical engineers involved in pool buildings let the architect and owner know in writing the consequences of holes in vapor barriers, etc. Ω