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POOL & SPA NEWS ONLINE

Brave New Pool

Science proves that pools don't necessarily need main drains. Here are the latest options available for the industry.

By Ray Cronise October 2004

Since the days of the Roman bath thousands of years ago, drains have been as much an integral part of swimming pools as the water they hold.

Now, two millennia later, "main drains," or suction outlets, are still part of nearly every inground pool built. However, suction outlet sources used to collect water for the pump can be dangerous when high levels of water flow or vacuums exist. It doesn't have to be that way, though. Today, much more powerful tools are available to examine the technical underpinnings of circulation system design.

Though old habits are hard to break, the specter of suction entrapment still looms over the industry. Many industry experts think it's time to take a closer look at the way we build our pools.

Standard procedure

Unfortunately, when it comes to pool-building standards, many of the rules currently in place were defined by previous practice. Industry and health officials simply wrote down commonly accepted safe building practices to create codes and standards. This was a valuable first step in the standardization of pool circulation system design and construction.

Historically, it is easy to see how required main drains ended up in our codes and standards. It was a result of the evolution of pool design and equipment combined with a successful method of building pools handed down from one generation to another.

This series of events has led to some inaccurate views of how circulation works in a pool. Inspectors, code writers, pool

builders and others believe that because pool water can be

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builders and others believe that because pool water can be circulated by strategic location of a main drain, it cannot be done properly without one. This has enormous implications in today's debate over how to protect bathers, particularly children, from dangers associated with suction outlets in pools.

The paradox

A pool circulation system provides several functions. For example, skimming removes debris and organic material that accumulates on the water's surface, suction outlets provide sources of water for pumps used in filtration and distribution of sanitizers, and return inlets uniformly distribute sanitizers and, sometimes, heated water.

These basic circulation functions have been captured over the years, and instituted through various voluntary standards and building codes. A review of these standards and codes provides useful information.

First, most codes provide a maximum time frame during which a certain volume of water must move through the circulation system. For example, according to *ANSI/NSPI-5 2003*, a 20,000-gallon pool requires that the same amount of water be moved through the system every 12 hours. To do this, one must move at least 1,667 gallons per hour or approximately 28 gallons per minute. During this turnover period, the water is filtered, sanitized and distributed throughout the pool.

The standards also provide guidelines regarding the number of return inlets for a given pool surface area. Under the *ANSI/NSPI-5 2003* standard, a residential pool requires a minimum of one return inlet for the first 300 feet squared and one additional return for each fractional 300 feet squared thereafter. As vessels become larger, this provides more points in the pool for returning filtered, sanitized water.

The same is true for surface skimming. A skimmer is required for each 800 square feet, and an additional one is required for each fractional 800 square feet thereafter.

While not required by the latest ANSI/NSPI public or residential standards, some previous revisions (for example, *ANSI/NSPI-1 1991*) and state building codes also provide for a "main drain." It's typically located at "the deepest end of the pool." With the exception of new requirements calling for dual main drains — the second one only included to mitigate suction entrapment — there seem to be no provisions for more of them to be added as the pool size increases.

At first, this appears to be an oversight. If one were to build a small 10-by-20-foot pool, or even a large 100-by-100-foot pool, existing codes would require each of these pools to have only one set of dual main drains, but the return inlet side of the pool would require at least one return in the first example and 34 in the second.

So, could the original authors have made a mistake in requiring only one set of drains, no matter how large or small the pool? The answer is no. It does not make a difference how many — if any — drains exist in a pool.

Fluid dynamics

Fundamental principles of pool circulation can be found in the study of fluid mechanics. From an engineering perspective, a fluid is a substance that tends to flow. It can be a liquid or gas.

In the pool industry, hydraulics seem to be well understood. However, many people don't understand what happens once the water gets into the pool. This is covered in a more specific circulation mechanics study called "fluid dynamics." Only within the past decade has it become possible for scientists to use computers to analyze such flows.

Once the water is inside the pool, it's helpful to see what is happening in the actual water motion. If the water is circulated or "turned over" during a prescribed period of time, the code will be met. Is this enough to guarantee a clean pool?

Absolutely not.

When many of these codes and standards were written, no one could have envisioned the multitiered pools, complete with vanishing edges, grottos and bench seats that are more and more a part of residential pool building. Pool shape and design has become incredibly complex, but the standards governing the circulation system are not as specific as they could be. They need to teach the builder where to locate these components.

Think of a 40-foot length of 2-inch PVC pipe as an imaginary pool connected at either end back to a filter and a pump. If the water enters one end, it would exit the opposite end in a time dependent upon the flow rate. All the water entering one end of the 40-foot pipe comes out the other end, passing directly through with no dead spots.

Now think about hooking the same circulation system up to a larger pool instead of pipe — a 10-by-40-foot rectangular pool that is 1-foot deep, for example. We don't have a smooth transition from round pipe to round pipe; we have to consider all of the corners. With a return on one end and a suction outlet on the other, it's not hard to imagine a few dead spots in the corners on both ends close to the inlet and outlet.

Proper water circulation probably could be achieved with this configuration. But what happens when we increase the size to 20-by-40-by-1-foot-deep, with one 2-inch return inlet and one 2-inch suction outlet located in the center of each end wall? The dead spots in the corners start to make a difference. In fact, one return inlet and one suction outlet could conceivably cause large areas of low circulation in the corners and along the sides.

As we add more depth and floor transitions to our imaginary

pool, this exercise just keeps getting more complicated. How does this work from a fluid dynamics perspective? Keep the water mixed and provide an adequate turnover to move it through the filtration system, and distribute sanitizer throughout the pool.

Returning to the 20-by-40-by-1-foot pool, how can circulation be improved? A return inlet and suction outlet could be added every foot so that each end had 20. We might also try adding 20 returns at one end and then two more — one on each side wall — on the suction end pointed toward one outlet. The suction outlet may need to be enlarged to keep the water flowing to the 22 return inlets, but it seems clear that it would work.

Let's examine the opposite solution. What if 20 suction outlets were added at one end and one more at each opposite-side wall with only one return inlet? Would this work as well as the first example? Probably not.

This reveals a fundamental property of any fluid: It cannot be "pulled." It can only be "pushed." To illustrate this point, consider using air as the fluid. At arm's length, you can easily blow out a candle. But what happens if you try to "suck" it out from the same distance? Obviously, it won't work.

Unlike a return inlet, a suction outlet has only a small influence on the water around it. While a return might affect water as far as 15 feet away, a suction outlet, especially one with an anti-vortex cover, rarely affects movement inches away. As it turns out, suction outlets only have a small amount of fluid movement associated with them. With a bottle of dye, it is easy to demonstrate by allowing the substance to enter the pool near the drain. It's interesting to note just how close you have to be for the dye to be drawn into the suction outlet.

Defining moment

Code and standard writers were wise to realize that the bigger the pool, the more returns necessary to circulate the water. With the simple rectangular and oval shapes of the past, they deemed it obvious that no one would cluster all the returns in one spot. More modern commercial pools, for example, such as some found in Orange County, Calif., require that in-floor returns be strategically located for pools exceeding a certain width.

What is the misunderstanding in the pool community? Let's revisit our paradox of needing more returns as the pool gets larger, but only one set of dual main drains for any size. The underlying issue is encapsulated in the term itself: main drain.

This term seems to date back to early pools, which ironically had no circulation system. A "drain and fill" design prevailed with cheap sources of freshwater pools. It's obvious why such systems are a thing of the past with all the restrictions that apply to the size of today's toilet tanks.

Still, if a "main drain" is defined as a suction outlet, it may cause more confusion. For example, some states such as Florida

require that a surge tank isolate every drain. In these cases, the main drain has no suction associated with it.

In other words, when one blocks the outlet, it is the equivalent of putting a finger over a leak in the pool. No further depression occurs in the plumbing on the other side of the blockage. This is not to say that some of the other hazards such as hair entanglement or limb entrapment are not possible. In this case, it may be neither a main drain nor a suction outlet, but simply an “overflow” source of water.

Another option

If it’s a safety issue, especially where loss of life is not only possible but has actually happened, all viable options should be considered.

Circulation is dependent upon a number of factors. It is affected by the pool’s turnover rate. The number of returns also must increase with the size of the pool if all areas are to be circulated efficiently. The same is true for skimming, but for reasons relating to wind direction and debris collection.

The number and location of suction outlets have limited influence on overall circulation. Therefore, placement strategies become complex. In addition, in pools of complex geometry, adding returns to areas of low circulation (for example, grottos, behind bench seats) is the easiest way to influence circulation.

If one were to contemplate a vanishing-edge pool with only floor returns, it’s conceivable the project could be built without suction outlets. Circulation would be from the bottom up, which means that most debris would not likely fall to the bottom in the first place. The vanishing edge would serve as the skimmer.

All these concepts should be reviewed when attacking the problem of suction entrapment. If a design allows for the removal of a hazard altogether with no additional cost, engineering ethics should require that it be considered. This approach has been eliminated by some because of a fundamental misunderstanding of fluid dynamics.

Opponents often argue that the drain removes dirt and debris. This is only true when debris is actually “pushed” to the drain. In-floor cleaning system designers say that if the drain is not built with larger openings to accept debris, and precisely located jets are not arranged on the floor to push sand and leaves to the drain, it won’t be effective.

Next time you run across an area of low circulation in a pool, think about replacing a suction outlet with a return inlet. The results will be immediately obvious.

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