Eliminating the Risk of Swimming Pool Drains

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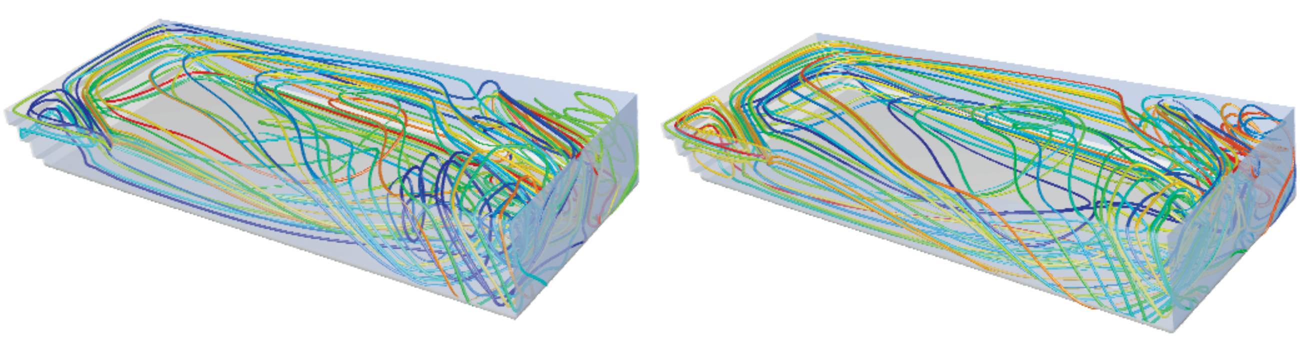
Summertime brings with it a huge increase in the number of people enjoying the clean, clear water of swimming pools. Common wisdom is that drains at the bottom of pools are necessary to maintain water quality by promoting ongoing circulation. Indeed, many building codes require them. Unfortunately, a number of accidents have occurred over the years in which swimmers, usually children, have become entangled or suctioned onto the drains. Ironically, some industry experts are convinced that drains provide no circulation benefit and that proper circulation can be achieved by strategically positioned inlets and skimmers instead.

To test this hypothesis, CFD was recently used to simulate water circulation in computer models of generic pools that were identical except for the presence or absence of drains. The results confirmed that, for the pool geometry in question, inlets and skimmers do provide adequate circulation and that there is no additional benefit associated with the use of drains.

The pool industry has long used drains because of the belief that they are required in order to provide circulation throughout the pool so that contamination will not remain in stagnant areas but will quickly pass through the filter where it can be removed. Although accidents are rare, the risk associated with a drain is very real. Five different types of suction entrapment have been documented.



Pathlines in the pool without (left) and with (right) drains show that both designs promote large scale circulation as well as small scale circulation in the corners

Children are most often the victims because they are fascinated with the currents and forces created by the drain and often intentionally place their hands and feet over it. New drain covers have been developed with improved safety features, but the risk always exists that even these devices could break or be removed. Others have suggested using a safety vacuum release system that is designed to shut off the pump when it senses an excessive vacuum buildup, but this approach adds considerable expense, does not necessarily provide protection from all forms of entrapment, and does not preclude the risk of mechanical failure.

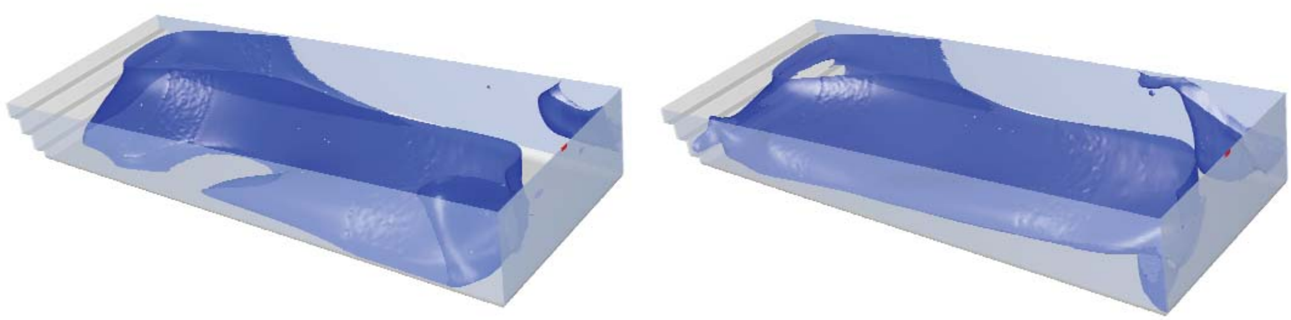
Based on observations of fluid flow, circulation occurs in a pool because of the flow generated by the inlets (or returns) while drains have little or no impact. Consider, for example, that a candle can be blown out at arm's length, but it cannot be extinguished by suction at the same distance. Thus, if one simply points the returns toward the bottom, the water in the lower section of the pool will circulate whether or not there is a drain. Suspended debris with a density less than water can be removed by the skimmer. Settled debris with a density greater than water can be removed with a vacuum, as is normally done. Unless someone has installed an in-floor cleaning system that is designed specifically to remove debris, there is really no compelling reason to install a drain.

The CFD simulations were performed on a swimming pool with and without drains. The pool modeled was 15x35 sq ft, with a depth that ranged from 3 to 6 ft. It had four inlets arranged around its periphery to provide circulation and a skimmer on the waterline where water was extracted. For one of the simulations, the pool had two main drains in the floor, while for the other simulation, the pool had no drains. The water in the pool circulated at the rate of about 60 gallons/min. The steady state flow fields in the two pools were computed first. Both cases showed large scale circulation driven by the returns. A two-foot diameter sphere of contaminant (tracer) was then positioned at the center of the pool, near the floor. Two monitors were placed at each end of the pool, two feet below the surface of the shallow end and three feet below the surface of the deep end. Transient simulations were performed and each monitor tracked the concentration of contaminant for 20 minutes.

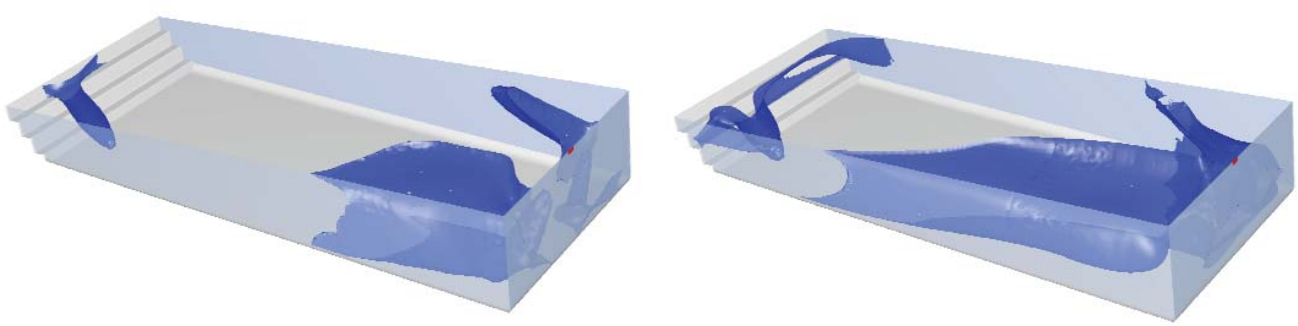
The results showed that the pools with and without drains were essentially equal in their ability to remove the contamination. While the two cases differed initially, after about 15 minutes the level of contaminant at each of the monitor points was the same. In short, the simulations showed that having drains neither improves nor harms the circulation in the pool.

The pool industry has adopted building practices based largely on empirical information. The circulation of water is something that is nearly impossible to see and difficult to measure without sophisticated flow visualization equipment, so in many cases designers have been using drains for historical reasons. By the same token, many building codes and health departments have required drains for the same reasons. The CFD simulations have clearly suggested that drains are not necessary, and that they do not improve the circulation in a pool for the purpose of clearing contamination. The number of injuries and deaths caused by drains in pools may seem small compared with other hazards, yet future episodes could be prevented at no additional cost simply by building pools without drains and sealing the drains in existing pools. Hopefully, these results will allow the pool industry, building officials, and health departments to proactively take steps to allow pools without drains in their standards and codes of the future.

In addition to the type of analysis presented here, CFD can be a useful tool for determining the optimum position and orientation of the returns for complex pool shapes to ensure proper circulation. ■



A surface of contaminant in the pool without (left) and with (right) drains after 10 minutes, suggesting that the drains do not reduce the amount or spread of contaminant



After 20 minutes, the pool without drains (left) has a surface of contaminant that is no worse than that in the pool with drains (right)