IN SEARCH OF PERFECT POOL WATER - WHAT I LEARNED AT THE AQUARIUM

by Allen Clawson

Increasing press attention to sanitation issues regarding drinking water quality, contaminated food, or outbreaks of disease linked to swimming pools is alarming and can be somewhat misleading. Many of the publicized outbreaks so seemingly common today may not even have been recognized as such as little as ten years ago. This often leads us to believe that these are only recently recognized phenomena. A common misconception among the public is that Cryptosporidium and others are "newly discovered" pathogens never before encountered! Due to increased public awareness, refinement of regulatory procedures and reporting requirements both pool professionals and the public are increasingly more aware of these events and the associated health risks. Though the responsibility on designers and operators to protect the public heath is un-changed the greater attention these cases bring is most certainly followed by changes to perception, technology and regulation within the industry.

Despite the perception otherwise and the attention given to the failures to protect the public health, research on the methods of prevention and treatment go back many decades for these and other, as yet "undiscovered", pathogens. Pools have dealt with the myriad of risks from the beginning as have drinking water treatment, sewage treatment and other industrial processes. One instance is the aquarium industry and Aquatic Animal Life Support Systems (LSS) which have effectively dealt with and treated these issues for many years under conditions not all that dissimilar to what we find in commercial swimming pools and waterparks.

Can the experience and technologies related to aquatic life support systems be applied to waterparks and swimming pools? What can pool designers and operators learn to further improve the sanitation characteristics of swimming pool and pool treatment system design? What can waterparks and commercial pools learn from the growth and water treatment successes of the aquarium industry?

Characteristics of an Aquatic Animal Life Support System:

Many of us have visited an aquarium and marveled at the clarity of water and the abundance of life exhibited there. These facilities are truly wondrous, allowing the guest to observe aquatic creatures in their underwater habitats. It is remarkable to watch a Whale Shark, the largest fish in the sea, trawl through its multi-million gallon swimming pool, the leafy sea-dragon deftly imitating a garland of seaweed or a hippo gracefully gliding about in defiance of its terrestrial bonds. What goes into these incredible feats of aquatic engineering? Are they really so different from swimming pools for people?

Generally speaking, no, they are not so very different. Not surprisingly all of the same principals of filtration and circulation apply. However, without the ability to fall back on chemical treatment that would harm the inhabitants of the exhibit waters or the ability to close down

the pool, LSS engineers rely on the highest quality equipment, redundancy, high turnover rates, mechanical and biological filtration, ozone, and a vigilant husbandry staff to monitor and maintain a healthy environment.

Operations: - Who runs the place anyway?

LSS Operations staff commitment to the animals in their care is truly extraordinary. Maintaining the water quality for the inhabitants of an exhibit is a specialized field for a trained professional with background in not only the biology involved but also in the water quality, chemistry and the mechanical and electrical intricacies of the systems they care for. They are, overall a passionate group, dedicated and serious as can be about their charge caring for these animals and the systems that keep them alive. All aspects of water quality are closely and continuously monitored, then kept in tight control. Trends are tracked and adjustments made early in order to avoid 'issues' before they become 'events'. Would that all pool operations staff saw their pool in a similar light, as the life-giving habitat for their patrons in the same way that exhibit waters are the life of the aquarium. Too often the pool operator is untrained and unskilled in the intricacies of the pool water and pool treatment equipment maintenance. It cannot be stressed enough that proper water quality control and chemical balance are crucial to the health of a pool. No technology, no matter its claims, will ever compensate for poorly maintained and controlled pool systems.

Primary & Secondary Sanitation: - Keeping it clean.

In the treatment of aquarium waters the prevention of pathogen outbreaks is vitally important. No facility wants to risk the health of the animals in their care. Indeed the whistle blow to evacuate the pool can never come. Unlike our people-pools the aquarium inhabitants live in and breathe the water – no sanitizing chemicals allowed, so some decades ago the aquarium industry turned to ozone as a primary sanitizer and oxidizer. Ozone's unique ability to achieve high microbial kill rates within a treatment system while contributing no harmful residual effects to the exhibit waters has enabled the proliferation of large aquarium facilities around the world in recent decades. Ozone also contributes to significant reductions in organic loads through its powerful oxidation characteristics and aids in water clarity by binding smaller contaminants into larger, filterable byproducts. Ozone provides the same benefits to swimming pool waters, and is simply the most powerful oxidizer and sanitizer that can safely be applied, enabling safe, clear water for people the same way it does for sharks.

UV sterilizers have seen a recent rise in use in commercial swimming pools. Though UV is effective under certain circumstances, and also has its place in specialized LSS, it has not provided the aquarium industry with the same dramatic operational improvements that ozone has. While UV is generally less expensive than ozone as a capital cost, it is NOT the most effective method of pool sanitation, nor is it less expensive over time. Recent NSF testing of ozone on crypto inoculated pool water resulted in better than 99.9% (3 log) reduction adding to the previous data on other organisms with similar results. Ozone consistently out performs UV in third party validation testing and is recognized worldwide for its sanitation capabilities.

While ozone's benefits are tremendous, the swimming pool will still require a residual sanitizer which ozone, (due to its rapid reaction rate), does not provide. Nor is ozone a substitute for good mechanical filtration. In order to have clean, clear water the filter must be capable of mechanically removing the contaminating crud that gets into the water from everywhere. A recent article in World Waterpark describes the various factors contributing to water contamination in this "People Soup" (Dallas Wall, PE., World Waterpark, May 2008). Environmental, social/behavioral, physical and chemical factors must all be considered when sizing pool filtration. It is not enough to size filters to minimum allowable values and hope that adding chemicals will make up the difference.

Filtration: Keeping it Clear.

Aquarium LSS are typically designed with a much shorter turnover time than is typical for a swimming pool, shorter still for smaller or more densely populated tanks. Even the largest aquariums, millions of gallons of water, are typically circulated at flow rates high enough to cycle the entire volume in less than an hour. This results in some truly huge pumps and piping connected to football field sized rooms full of filters. It is well recognized that a heavily used pool or a spa, where water volume per person is relatively small, requires a higher filtration flow than otherwise. It is also just as clear that many pool filtration plants are undersized and the actual contaminant loads are not being adequately handled. This can be due to budget constraints or regulatory issues where the designer or owner/operator uses the minimum allowable treatment system without proper consideration for the actual usage and contaminant load, again considering all contributing factors. Plainly within a living environment there is a high organic load to be compensated for that does not exist in the same way in a swimming pool which is intended as a "sterile" system. However, the rule remains – high turnover rates = cleaner water and less opportunity for pathogens to penetrate the pools defenses.

Another aspect of filtration utilized in LSS is Biological Filtration. Bio-filtration is essentially a microbial jungle where only the strong and most numerous survive. Relatively weak and outnumbered pathogen organisms are consumed by the beneficial bacterial allowed to thrive within the bio-filter. Since no chemical residual exists in the exhibit waters to prevent the growth of these bacteria all surfaces within the system and tank become home for these beneficial bacteria – just as in a lake, stream or the ocean. They feed on the naturally occurring nutrients created by the habitat and its inhabitants and provide a level of protection from pathogens. Within the "sterile" swimming pool treatment system, any chink in the armor allows pathogens to propagate essentially un-checked. Chlorine resistant organisms are therefore most perilous.

Quality Equipment and Redundancy – Keeping it Running.

LSS must be designed for continuous operation. Downtime for maintenance or equipment failure is unacceptable as it is a serious risk to the health of the animals, not to mention the loss of water quality for the viewing pleasure of the public. Therefore, designers utilize the highest quality equipment and incorporate redundancy of design allowing for at least partial operation under equipment failure conditions. Fortunately for commercial pools the added expense of fully redundant systems (and backup power, etc) is not necessary. The pool can be shut down if

necessary. But the lesson here is to ensure that the equipment is reliable, has a long service life, and that if maintenance or repairs are required it can be accomplished with minimum effort and pool downtime. These issues are, once again, often sidelined in favor of the capital savings during build and installation. However, the long term costs more likely than not, far outweigh the short term gains.

What does this mean for pools? – Keeping it Real.

As we consider the design of a pool treatment system we must consider the lessons learned from the aquarium LSS. This may require the designer to increase design filtration rates beyond code requirements and above accepted minimums, utilizing filtration sized larger than is customary. Secondary sanitation and oxidation treatment utilizing the proven benefits of ozone must be strongly considered in all cases. It is evident that halogen based treatment alone is not truly capable of sanitizing pool water. These secondary sanitation technologies will interface with water monitoring systems to allow more tightly controlled water quality parameters. This gives the operator tools to minimize intervention and effort otherwise required to monitor and maintain great water quality.

The apparent increase in pool-related outbreaks, or at least the publicity they receive, mandates that pool professionals take the steps necessary and available to them to improve standard practices. Utilizing solutions developed in other related industries such as aquatic life support enables the designer and operator to make available the additional protection that these methods and technologies provide in the ever elusive search for perfect water.

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Allen Clawson is employed as a Project Manager for Cloward H2O and has built a very successful international reputation in water treatment and equipment design since 1994. As Director of Engineering for a major water treatment equipment manufacturer Mr. Clawson was directly responsible for developments and technologies in water treatment now standard practice in Swimming Pools, Aquatic Life Support, Agri-Food and Surface Sanitation. Mr. Clawson holds or is named on numerous patents and has published many articles and papers relating to these fields. Mr. Clawson's resume includes work on and support for aquariums, zoos, resort hotels, theme parks, water parks, aquaculture facilities, government research, agri-food, private developments, and public facilities throughout the US and in 16 foreign countries. Mr. Clawson has worked directly with the US EPA, US FDA, NSF, UL and others developing policies and evaluation criteria for water treatment and sanitation technologies and has been active for many years in trade organizations such as AZA, AALSO, IOA, NSPI and WQA.