The Selection of Grout Joint Materials for Ceramic Tile Finishes in Swimming Pools & Water Features

by
Richard P. Goldberg AIA, CSI

Introduction

One of the most important considerations in designing a swimming pool, spa or other type of water feature with a ceramic tile finish is the effect of water treatment and maintenance on the durability of grout and sealant joint materials. This is the one of the most common cause of problems, second only to installation errors. Proper specification for durability of grout and sealant joint materials, especially post-construction maintenance recommendations, is one of the most simple, but often overlooked design considerations. To a lesser degree, the principles discussed in this article are also applicable to adhesive mortars and waterproof membranes used to install ceramic tile.

Water Treatment Fundamentals

Balanced water is the term applied to pool water which is neither corrosive or scale forming. Corrosive water may cause damage to the concrete pool shell, cement based grouts and mortars, ceramic tile finish, membranes, or to the plumbing pipes and equipment. Scale forming water can block pipes, filters and other equipment, as well as cause hard deposits on the ceramic tile finish. Balanced water is a combination of calcium hardness, total alkalinity, and pH value. Checking the water balance regularly and taking corrective action will avoid damage and costly repair work.

The first step in selecting grouts and sealants is to evaluate the proposed disinfection system and water source for the pool and identify factors that could result in imbalanced water. There are several types of pool water disinfection and purification systems in use today

Swimming Pool Water Disinfection Systems

There are many different types of swimming pool water disinfection systems available today. Chemical treatment of swimming pool water with chlorine is the most familiar water disinfection system. There are also several other alternative disinfection methods . Detailed information about each system and the many variations are beyond the scope of this article, and are available from articles or books about swimming pool construction and maintenance.

Chlorine based systems are in-pool chemical disinfectants. They impose a high alkalinity to pool water, which typically requires adjustment of total alkalinity and then neutralization with acid chemicals. Neutralization can be achieved with dry acids such as sodium bisulfate. This system is not recommended for pools with cement based grouts and mortars because sulfate levels greater than 300 ppm, including high levels found in hard source water can deteriorate portland cement. Latex cement grouts are more impervious to attack, although surface deterioration can still occur, but at a comparatively slower rate. Epoxy grouts are immune to aggressive pool water conditions, however they will not fully protect the underlying cement based materials from deterioration

Chlorine gas systems, which have been used extensively in the past, are costly and require special equipment . However, they have great advantages in that water balance is achieved by addition of alkaline materials to neutralize the acidifying effect of chlorine. These systems do not have problems with high total dissolved solids and acidic sulfate based chemicals.

Ozone disinfection utilizes electricity to convert oxygen to ozone gas, which oxidizes harmful organisms and converts back to oxygen. Ozone disinfection leaves no residual substances which can harm ceramic tile finishes, although this type of disinfection can lead to increased deposits of dissolved microorganisms.

Ionization uses low voltage applied to copper/silver electrodes which produce positively charged atoms which kill harmful microorganisms

Swimming pool source water

Portland cement based grout, as well as the underlying cement adhesives and concrete structural shell can be subject to deterioration from source water high in sulfate. Levels above 300 ppm are potentially aggressive to cement based materials. Source waters typically have sulfate concentrations of trace to 250 ppm (limit in drinking water). However, if sodium bisulfate (dry acid) is added for pH correction, pool water sulfate levels are likely to be 500 ppm. Sulfate levels in sodium hypochlorite disinfection systems will be even greater than calcium hypochlorite systems because more sodium bisulfate is needed to neutralize the higher alkalinity of these systems.

Cement based grout can be attacked by water high in sulfate, and can deteriorate a grout joint to a point of requiring regrouting. If the sulfate attacks the full depth of the joint , then the underlying cement adhesive / leveling mortars and concrete

shell can also deteriorate, requiring complete removal, repair and re-tiling. For such conditions, epoxy grout, which is immune to sulfate attack, is recommended. Similarly, epoxy adhesives, waterproof membranes or use of sulfate resistant cement in leveling mortars / screeds and reinforced concrete are also recommended.

If source water is the cause of high sulfate content, then consider a new source. If the disinfection system is the source, then a non-sulfate pH correction material such as carbon dioxide or hydrochloric acid is recommended. It remains important, though, to continue monitoring sulfate levels.

pH value

The term pH is used to measure balance between acidity and alkalinity of water on a scale of 0-14, with 7 indicating a balanced or neutral state. Swimming pool water needs to maintained between a pH of 7.2 & 8.0 . If pH is too high (alkaline), mineral deposits will form on tile and grout, especially at the waterline. Mineral deposits may also form beneath the surface of ceramic tiles and exert pressure resulting in decreased bond strength or delamination. If pH is too low (acidic), etching and deterioration of Portland cement based materials will occur. If this condition persists, grout may become rough or completely deteriorated, leading to further deterioration of adhesive mortar and leveling mortars beneath the tile.

Total alkalinity

Total alkalinity measures the amount of carbonates in the pool water, which are buffering agents that control pH.

Metal content

Iron and copper are common metals occurring in source water. At low pH acidic below 7.2) metals are in solution. At normal pH (7.2-7.8), metals are out of solution and can be deposited as a stain on ceramic tile, grout, and pool fittings/ fixtures.

Mineral content (calcium hardness)

Water hardness or the amount of calcium is defined as the quantity of dissolved minerals (calcium) in water. If the level of calcium is too low (below 200-250 ppm, pool water will use the free calcium present in Portland cement grout, leading to deterioration and etching. Balancing minerals (calcium) will also reduce mineral deposits on ceramic tiles, grout, as well as prevents deposits and corrosion of pool plumbing.

Initial filling of pool

It is important to monitor pool water balance during the initial filling of a pool. The pH and calcium hardness will initially rise due to the alkaline`content of water soluble calcium hydroxide (free lime) of cement grouts and mortars. Free calcium hydroxide is a natural by-product of the hydration of cement.

Movement of water

In pools with dynamic water conditions, such as wave pools, water slides, or hydro-spas, the increased abrasion and rapid exchange of water under these agitated conditions can also lead to rapid erosion of cement grouts even under slightly aggressive water conditions. If the pool water contains dissolved carbon dioxide, there is also the tendency for loss of carbon dioxide gas through agitation, which results in a slight pH change (> acidity). Agitated water requires more frequent and care and analysis to maintain balanced water conditions.

Selection of Grout Material

Selection of grouts and sealants for ceramic tile jointing in swimming pools require careful consideration. The type of pool, source water, and water maintenance program can have a significant effect on life cycle costs. Cement and cement latex based grouts, with a lower initial cost, rely on constant control of pool water balance and higher maintenance costs to insure durability, sometimes with ineffective results. But in many cases, proper treatment of pool water and a strict inspection and maintenance program will allow the use of cement based grouts. Epoxy resin (100 % solids) grouts, provide long term durability under almost all water conditions, lower maintenance costs, and easier water maintenance control, resulting in lower life cycle cost.

Richard P. Goldberg, AIA, CSI *is an Architect and President of PROCON International, an international architectural & engineering consulting company. Mr. Goldberg specializes in the ceramic tile, stone, masonry and concrete industries, and can be reached by e-mail at* ***rgoldberg@proconweb.com***