Distribution of flow in sedimentation and AMD treatment ponds

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Abstract

Ponds are constructed on surface mines to collect sediments created during the mining disturbance process. In the USA, sizing of ponds is regulated and based on the disturbed area. The configuration of ponds can be of various styles based on the topography and can be round or rectangular ponds, or a series of smaller cells to meet the required volume needed to retain the water sufficiently to collect sediments. Sizing calculations are based on the volume required for a designated retention time of the water in the pond to settle suspended solids.

Acid mine drainage treatment ponds, on the other hand, are constructed to collect flocs or sludge from the AMD treatment process. All effective AMD treatment systems produce flocs, which are composed primarily of iron and aluminum hydroxides. These flocs gradually fill the volume of the pond and are periodically cleaned out in order to maintain sufficient retention time for settling of solids. Discharge limits are based on the quality of the water discharging from the pond and therefore ponds must work effectively and efficiently to meet these limits.

Distribution of flow in ponds is commonly disregarded when designing water-related retention structures for treated water. There are no sizing regulations pertaining to the different mechanisms and chemistry occurring in the released water, nor the extra time or volume needed for these retention structures. These deficiencies include settling ponds for active treatment systems, organic bioreactors, limestone beds, alkaline iron staining beds, ALD's, wetlands, vertical flow ponds, low pH iron armoring beds, and other structures where water must be managed.

Experience has convinced us that water flow in ponds will always take the path of least resistance and form specific flow paths. This was confirmed with a series of dye tracer tests conducted to understand flow of water through a variety of retention ponds. We found that flow does not evenly disperse through the pond, which causes short-circuiting and inefficient use of the pond's volume for settling of solids. Small treatment sites with small ponds are particularly difficult to design and to spread the water in the pond for the desired retention time. Example 1 – A large pond at a small operation was calculated to have a theoretical retention time of 47 hours; with dye testing the retention time was only 26 minutes. Example 2 – An organic bioreactor was supposed to have 24 hours of contact time with the medium; it had 35 minutes. Example 3 – A vertical flow pond was designed and constructed to have a 24-hour retention time; it had 20 minutes. There are known methods that can help to distribute flow and eliminate specific flow paths. Baffles and other pond structures and shapes can be helpful to better distribute flow in ponds. But flow distribution in ponds is not well understood or considered in the design of treatment systems.

Figure 1 *Distribution of flow in an iron-staining bed using small rock check dams every 100 feet*

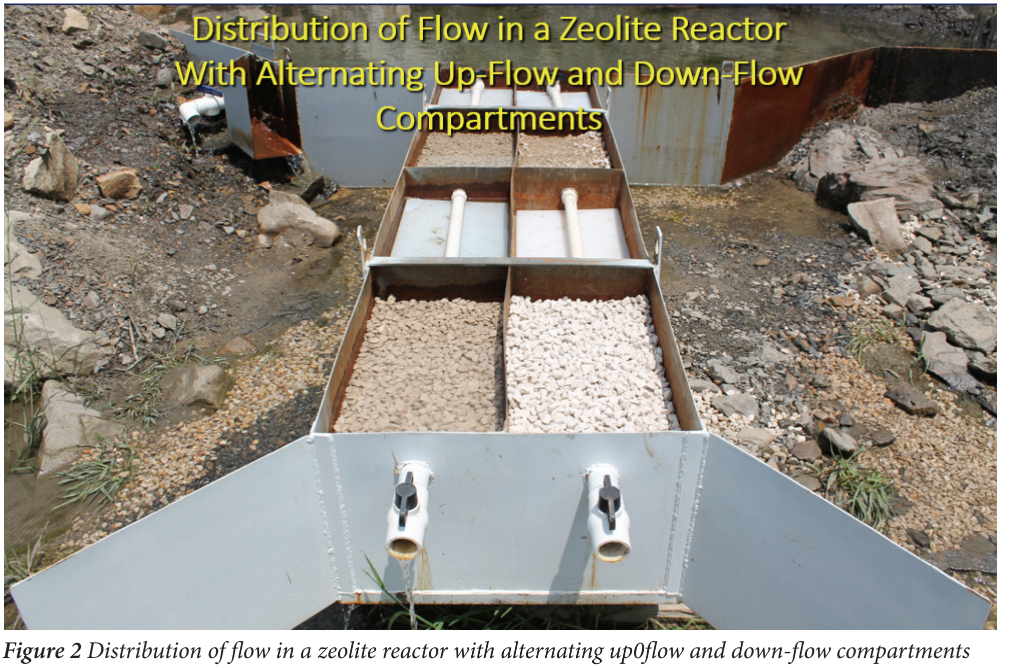

Figure 2 *Distribution of flow in a zeolite reactor with alternating up0flow and down-flow compartments*

Figure 3 Distribution of flow of treated AMD to increase retention time for settling using surface skim baffles

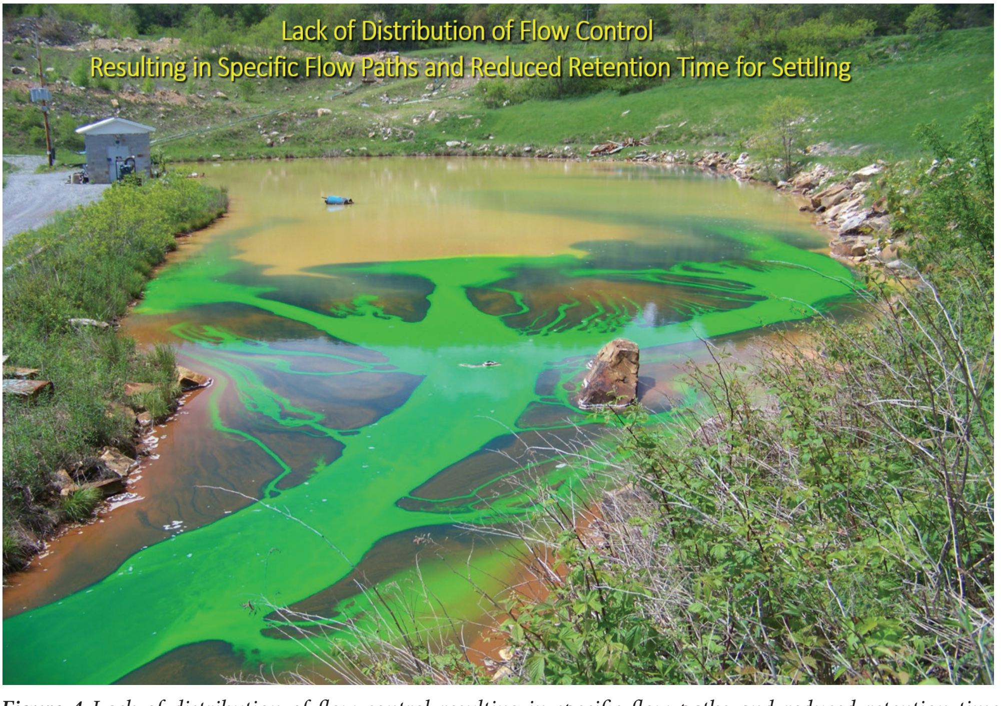

Figure 4 Lack of distribution of flow control resulting in specific flow paths and reduced retention time for settling