

Technical Advisory #2

Biomim's "Tip Of The Month": pH, pKa and Organoclay/Carbon Adsorption.

- ✓ Organoclays can effectively remove pollutants from water by a partition process, wherein the pollutant dissolves, or solubilizes, in the organic phase coating the mineral surface. Organoclays work well to remove organic acids from water over very wide pH ranges, but they have maximum efficiency at pH values corresponding to a low solubility of the organic acid. The solubility of an organic acid will be low at pH ranges where the acid is in its nonionic form. Activated carbon also adsorbs at peak efficiency at pH values corresponding to low solubilities of the contaminant.
- ✓ The proper pH for best organoclay and activated carbon performance is determined by the acid dissociation constant (K_a) of the solute. If the pH is much less than pKa (where $pK_a = -\log K_a$), the organic acid is primarily in its nonionic form. Solubility is minimized, and sorption to the organoclay is maximized. The pKa values for various organics are available in handbooks like the Merck Index.
- ✓ Phenol is an example of an organic acid. The pKa value for phenol is 9.8. At neutral pH (e.g. $pH \ll pK_a$), almost 100% of the solute will exist in its nonionic form and will sorb strongly. At high pH values (e.g. $pH = 9.8$), 50% or more of the phenol will exist as the phenolate anion. The anion has extremely high solubility in water and therefore will not sorb significantly. Therefore, as the pH is increased past the pKa value, more and more of the phenol (which sorbs strongly) will change to the phenolate anion (which sorbs weakly). The overall effect is a decrease in sorption as the pH approaches and/or exceeds the pKa. Generally, phenol will sorb well to organoclays and activated carbon at pH values less than 9.
- ✓ Many organic pollutants are in a nonionic form over a wide range of pH values. These include gasoline hydrocarbons (e.g. BTEX), polynuclear aromatic hydrocarbons (e.g. naphthalene, phenanthrene), and chlorinated solvents (e.g. trichloroethylene, carbon tetrachloride). These pollutants will be effectively removed from solution by organoclays and activated carbon over extremely wide pH ranges.
- ✓ For both organic acids at pH values less than pKa and for nonionic organic compounds over a wide pH range, organoclays offer exceptional sorption performance and can significantly extend the life of activated carbon systems when used as a pretreatment for contaminated water.