Ivey-sol® Surfactant Technology

"TODAY'S ENVIRONMENTAL SOLUTIONS FOR A BETTER TOMORROW" ®

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The No. 1 Choice For Improving The Performance of Soil and Groundwater Remediation

Adsorption of Contamination

The number one challenge associated with most site remediation designs and methodologies is that 90% to 95% of all environmental contaminants; including hydrocarbons (LNAPL), chlorinates (DNAPL), and heavy metals; are present in a sorbed (i.e., absorbed or adsorbed) phase onto soil and bedrock surfaces within both saturated and unsaturated zones. As such, the absorbed contamination has reduced mobility and low water solubility. These factors greatly limit the 'Availability' of the subject contamination for extraction or treatment during In-situ and Ex-situ remediation treatment.

This condition is further exasperated when the contamination is present in fine-grain soil media (i.e., silty sand, to silty clays) with greatly reduced permeability, i.e., $K=1x10^{-5}$ to $1x10^{-6}$ cm/sec, and a corresponding increased surface area onto which the contaminants may sorb. Thus, the sorbed contamination will often exhibit reduced mobility and limited *'Availability'* for treatment using many commonly employed in-situ and ex-situ remediation technologies and processes. As a consequence, site remediation can be much longer than desired and exceed even the best of cost estimates; a source of considerable frustration for many clients.

Among the many commonly employed remedial technologies negatively affected by contaminant absorption include, but are not limited to:

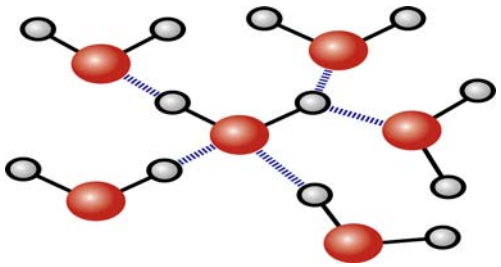
- **Pump and Treatment (In-situ);**
- **Bioremediation of Recalcitrant Compounds (In-situ and Ex-situ);**
- **Chemical Oxidation and Chemical Reduction (In-situ and Ex-situ);**
- **Steam Injection Mobilization or Vaporization (In-situ and Ex-situ);**
- **VES - Vapor Extraction Systems (In-situ and Ex-situ); and**
- **Reactive Barrier Wall Technology (In-situ)**

Opportunity

If we could overcome contaminant sorption, we could improve most forms of soil and groundwater remediation.

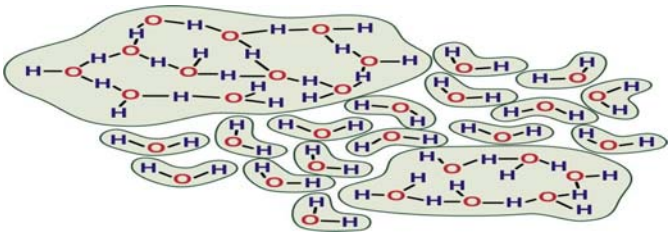
Water Clusters and Surface Tension

Water is often viewed to be a single molecule of H_2O by many Engineers and Scientists, when in fact it is not. It is actually a conglomeration of water molecules called *'Clusters'* (See Figure Below) due to the attractive force called '*Hydrogen Bonding'* that exists between neighboring water molecules. Hydrogen Bonding gives rise to water's *Surface Tension* explaining why water beads on a surface and why it hurts when you do a Belly-Flop onto a pool of water. Water has a surface tension of 72 dynes which is very strong for a liquid.



Hydrogen bonding between individual water molecules giving rise to surface tension and formation of water clusters.

The Permeability K value for water in a given soil type is a function of the water's surface tension, i.e., it's tendency to bead and act as a small *Clusters*, i.e., like a small spheres. Water's surface tension and clustering directly affect the associated permeability (K) of water in all soil types.



The formation of water clusters directly affects water permeability (K) in soil and bedrock. If water clusters did not form, water would have the ability to flow more freely in finer grain soils and bedrock fractures

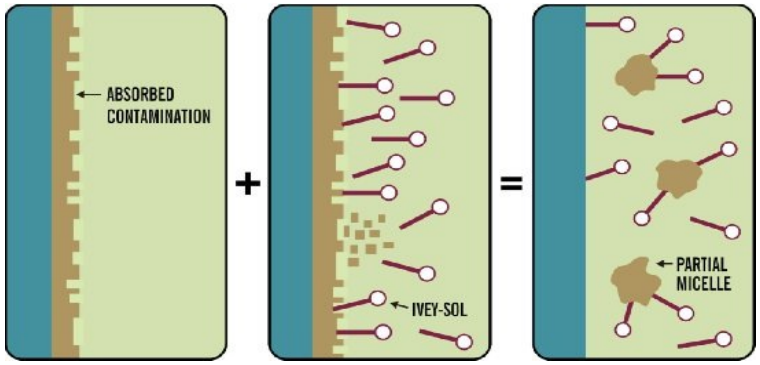
Opportunity

If we could reduce the size of water clusters and lower surface tension, the effective permeability (K) of water would increase for fine grain soil and bedrock.

Ivey-Sol Surfactant Technology (An Innovative Opportunity)

Ivey-sol® Surfactant Technology is comprised of several nonionic surfactant formulations that have the unique ability to selectively desorb and liberate petroleum hydrocarbons (gasoline, fuel oil, diesel, etc.); Polycyclic Aromatic Hydrocarbons (PAH), and Poly Chlorinated Biphenyl's (PCB) contaminants from soil and fractured bedrock surfaces, and into solution. This technology has also proven very effective at liberating chlorinated solvents (PCE, TCE, DCE, DCB, etc.), MTBE, TBA, NORM, and Metals for treatment.

Ivey-sol® makes the de-sorbed contaminants more *'Hydraulically Available'* for extraction by Pump and Treatment; more *'Bio Available'* for bioremediation (In-situ or Ex-situ); and by increasing the dissolved aqueous-phase contaminant concentration, it improves their *'Chemical Availability'* for Oxidative and or Reductive treatment (In-situ & Ex-situ).



Ivey-sol shown desorbing contamination off a surface. Once liberated, the desorbed contaminants have increased available improving the associated remediation method.

In summary, Ivey-sol® surfactants, when introduced into contaminated soil and groundwater regimes, can reduce the surface tension of water from 72 dynes to as low as <30 dynes. Thus improves the wetting ability of the water and its *Effective Permeability* (K). Furthermore; Ivey-sol® surfactants reduce the size of the Water Clusters allowing the water to penetrate less permeable soils such as: silty sand, silt and clay, and fractured bedrock.

Hence, Ivey-sol accomplishes two feats; first it overcomes the challenges associated with contaminant adsorption; and secondly, it lowers the surface tension of water improving both its wetting and associated permeability (K) properties.

Ivey-sol surfactants present a significant and cost effective opportunity for improving the performance of In-situ and Ex-situ Remediation.