How Good is that Solvent?

The MCA emphasizes asking, “How clean is clean”. It is the overarching question in any cleaning process. However, in this regulatory environment, a different question, “How good is that solvent replacement?” is incredibly important. In this short article, you will learn how solvents are ranked and how you can be sure a replacement will work for your process.

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Solvent cleaning is in the news. The webinar circuit and recent conferences have discussed the impending EPA action on 1-bromopropane (1BP), also known as n-propyl bromide (NPB), trichloroethylene (abbreviated as TCE or sometimes as simply (TRI), perchloroethylene (PCE or perc), and other solvents.

Cleaning equipment manufacturers, solvent producers, and the end users who do the cleaning are already maneuvering their businesses to avoid disruption and, if possible, to enhance their position in the market.

When comparing proposed replacement solvents and solvent blends, there are several criteria that must be considered – performance criteria (kauri butanol number, Hansen solubility parameters, Hildebrand solubility parameters), safety criteria (flash point, azeotropy, toxicity, exposure limits), environmental criteria (ozone depletion potential, volatile organic carbon status, global warming potential, hazardous air pollutant status, regulated release levels), cost, and more.

The following highlights the performance criteria only.

The kauri butanol (KB) number is an interesting cloud point titration test (ASTM D1133). A saturated solution of kauri tree sap/gum in butanol is titrated to a defined cloud point using the solvent or blend that is being evaluated. This is compared to the cloud point performance for high solvency toluene (KB = 105) and a low-solvency blend of 75% heptane and 25% toluene (KB = 40). Without going into it further, we can see that a “good” solvent has KB values near 100, while a “poor” solvent has KB values near 40. There is one catch, though. These values measure how good the solvent is at keeping kauri gum in solution. If your soil differs dramatically from kauri gum, then this may not be the most relevant measure for your process.

A better measure for solvency is based upon a match of the Hansen solubility parameters (HSPs) of the solvent (or solvent blend) to the HSPs of your soil. The Hansen solubility parameters consist of three types of energy holding a soil in solution – dispersion (electron cloud interactions), polarity (positive/negative portions of the soil and solvent) and hydrogen bonding (strong interactions between oxygen, hydrogen, and some nitrogen atoms in the solvent and soil). For historical sake, we mention the Hildebrand solubility parameter, which is a combination of the three HSPs. The HSPs are much more useful and informative.

"Like dissolves like" is a phrase that captures the match of the HSPs of solvent and soil. If you know that a particular solvent works very well for your soil and is compatible with your surfaces, then you will want to know the HSPs for that solvent. With that knowledge, you can compare the HSPs for potential replacements as an initial screening tool.

In the end, do not make a decision until you have tested the potential replacement solvents with your surfaces, soils and process parameters. This should not be something you do alone after hours. That can end in disaster. Get a team together with management, equipment suppliers, solvent providers, your ESH experts, and even your best customers. Have the team evaluate the best way to test potential process changes. That way, every stakeholder will be on board with the improvements.

As leader of the Cleaning Research Group at Sam Houston State University, I'd love to discuss this further with you.