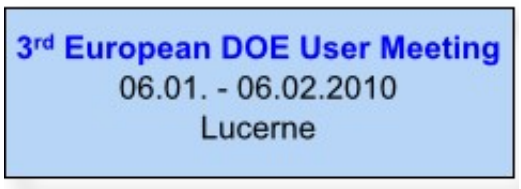
Case Study at the 3rd European DOE User Meeting in Lucerne „Response Surface Modelling and its application in supercritical fluid processes to support the conterminal land remediation technologies“

(06.01.2010 – 115:10 to 15:30 by Dr. M. N. Baig, Department of Chemical Engineering, University of Birmingham, Birmingham, UK)

Abstract

Super critical extraction technology is an alternative method for a new or improved application for the extraction of contaminants from land. It has the potential to be an environmentally friendly ‘green’ processing technique and replacing the traditional organic solvent based extraction technique with the more benign solvent like supercritical carbon di-oxide (CO2) and water. A supercritical fluid (SCF) is made from a gas or liquid, not a solid. When a gas or liquid is compressed (under pressure) and heated past its critical point, it enters a phase called the ‘supercritical phase’ and is referred to as a supercritical fluid. The most important properties of a SCF are its density, viscosity, diffusivity, heat capacity and thermal conductivity. Manipulating the temperature and pressure above its critical point affects these properties and enhances the ability of the SCF to penetrate and extract targeted molecules from source material. There are many advantages of using SC-fluids instead of conventional organic solvents. These include achieving high purity extracts, no residual solvent, single step processing, reduced operating cost, selective fractionation, faster separation and being environmentally friendly and physiologically compatible. Extraction of a specific group of compounds is the most common use for SCF. The major process parameters are temperature, pressure and flow rate. In this context a novel sampling technique that creates a carbon dioxide frozen plug within a closed in situ soil column to which supercritical CO2 (SC-CO2) is applied has been designed and developed. The contaminants partition into the supercritical phase as it migrates up the soil column allowing us to apply environmentally friendly supercritical processes to soil sampling. The process will enable a faster assessment of contaminants, be able to verify the effectiveness of in situ remediation techniques and also locate ‘hotspots’ and contaminant source areas by using a newly designed soil probe (patent no. 2429059). We believe that the technology will reduce sampling time from 3 hours to 30 min with a 65% cost saving over existing technologies it will also drastically reduce the necessity of use harmful solvents to extract contaminants. The probe offers a number of advantages over existing sampling techniques, such as rapid sampling, good solvent power and environmental benefits.

To realise the full potential of supercritical fluids in relation to supports the clean technology concept using supercritical fluid extraction techniques under different process parameters and to address the complex interplay between multiple processing parameters, response surface methodologies (RSM) were adopted and evaluated as a potential tool to assist with the modelling of the process. A Central Composite Rotatable Design (CCRD) was used and a second order polynomial response surface equation was developed to evaluate the influence of operating conditions on the extraction efficiency.



June 1st to June 2nd 2010 in Lucern / Switzerland

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