Continuous Multistage Fenton's Degradation of Organochlorides

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This study was conducted in a laboratory to develop a new and functional method to remediate a 1990's industrial site focused in solvents recuperation. The underground water was contaminated due to bad disposal and by leaks of heavy organochlorides, mainly: 1,2-DCE, 1,1,2-TCE, 1,1,2,2-TCE with concentration around 96 mg/L of total OCC (organochloride compounds).

This industry needed a new, cheaper and more efficient technology to substitute their air stripping technology to improve the efficiency of elimination of OCC and lower the costs. The new system was designed to manage the high underground water flow rate of 15 m^3/h, which is extracted and pumped by a hydraulic barrier.

Our team proposed a laboratory-scale study to meet the requirements above and to develop the better technology option, aiming a full-scale work. Fenton's reaction was the most efficient technology tested, although it was executed in a newer method, including a multistage system with four interconnected vessels and dosage pumps. In laboratory tests, the sample was the real site water collected from the hydraulic barrier.

Moriah developed a bench pilot system: one pump dosed the contaminated water through the four 250 mL vessels at 1 L/h flow rate while another multichannel pump dosed the reagents Fe^{2+} and H_2O_2 simultaneously inside each of these vessels experimenting different volume rates and stoichiometry between the reagents and the sample to find the optimal methodology.

At the end line the reacted water was analyzed by OCC (GC/MS) along with control sample and physical-chemical (ORP, pH, conductivity and sedimentable solids) to comply with local regulations which claim that the disposal water must be at pH 6-9 and sedimentable total solids lower than 20 mL/L. The final targeting of total OCC were concentrations lower than 0,05 mg/L.

At the best ratio of 1COD:2,5H_2O_2:0,15Fe^{2+} dosing each reactant in each 250 mL vessel at 7 mL/h with the contaminated solution rate at 1,0L/h yielded 95% of OCC elimination. Decreasing the sample and reagents flow rates above in half (increasing the contact time) increases the yield to 98%. To comply with local regulations of disposal in a sewer system was needed to complement this technology with charcoal column, as a polishing system, then reaching a final concentration lower than 50 ppb. An additional stage of pH correction with calcium carbonate (after testing and adjusting the sediment volume with many neutralizing agents) was also needed. The Fenton's system was much cleaner, cheaper and with higher yields of total OCC elimination than the actual air stripping process. In a scale up process the problem would be solved by four interconnected agitated tanks of 4 m^3 capacity, dosage pumps memetizing the laboratorial process, charcoal column system and pH correction system.