Degradation of TNT and RDX in groundwater using palladium catalyst and hydrogen sources

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Explosives such as 2,4,6-trinitrotoluene(TNT) and 1,3,5-trinitroperhydro-1,3,5-triazine(RDX) are frequently found in the groundwater and soils around military shooting ranges, thus efficient degradation techniques of these contaminants have been studied to supply for the safe drinking water. Catalytic degradation is a promising and emerging techniques for transforming explosives to less harmful materials to environment. In this study, TNT and RDX in groundwater are degraded by reduction using palladium(Pd) catalyst impregnated onto alumina(henceforth Pd-Al catalyst) and hydrogen sources such as formic acid and hydrogen gas.

For the experiments, approximately 300 ml of TNT(50 mg/L) and RDX(30 mg/L) solution with artificial groundwater is prepared, and degraded using 20 mg of Pd-Al catalyst and formic acid(2 ml) in room temperature. Concentrations of TNT and RDX are periodically measured by high performance liquid chromatography(HPLC) with ultraviolet(UV) detector. Degradation by products of TNT and RDX such as nitrate, nitrite and ammonium ions are measured by ion chromatography(IC) and UV-VIS spectrophotometer.

TNT degrade with a pseudo first order rate constant(k) of 4.27 h^{-1}, and it is faster than those of RDX(k = 0.03 h^{-1}). The TNT and RDX solutions are mixed to make 300 ml solution with 9:1, 8:2, 7:3, and 5:5 volume ratio, then degradation rates are also measured, respectively. Degradation rates of TNT decreased from k = 1.00 h^{-1} to k = 0.15 h^{-1} with increase of RDX volume ratio. Degradation rates of RDX also decreased from k = 0.41 h^{-1} to k = 0.08 h^{-1} as RDX volume ratios are increased. The results show that degradation rates of TNT in the artificial groundwater using Pd-Al catalysts with formic acid are influenced by the concentration of RDX. Degradation rates of TNT and RDX in the artificial groundwater using Pd-Al catalysts with hydrogen gas and degradation by products will be presented.