Degaradation of 2,4,6-Trinitrotulene (TNT) in Wastewater by Advanced Oxidation System $Fe^0/H_2O/Na_2S_2O_8$/EDTA

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Background/Objectives. Environmental pollution by wastewater from the explosion-proof drug factory is a serious problem, TNT (2,4,6-trinitrotoluene) is as raw material for the production of explosives, and may be a significant contaminant in waste water, TNT is highly toxic to humans and animals and need to be treated in waste water. Currently, in Vietnam there are some technologies for the treatment of TNT such as the absorption TNT by activated carbon, the degradation of TNT by UV radiation, or chemical method $NaHSO_3$, Na_2S to decompose TNT, but these technologies are suitable for low TNT concentration (<40 mg/L TNT), and it is limited for high TNT concentration (80÷100 mg/L TNT) towards the recover TNT chain from nullity cartridge because the treatment efficiency is not very high and quite expensive if the concentration of TNT so high. Therefore, in this work, we applied the new method for the TNT treatment by advanced oxidation system $Fe^0/H_2O/Na_2S_2O_8$/EDTA (ZVA). The advantage of this method is low cost, high efficiency, and safe for environment because the reaction can proceed under normal condition (i.e., temperature, pressure), the reagents are not expensive, and the last reaction product is sulfate, which is less polluting for environment. Free sulfate radicals are able to reduce pollutant organic compounds in water 1,000 to 100,000 times faster than persulfate ions, so that must be to create free sulfate radicals. The oxidation system of ZVA was used to create the free sulfate radicals: $Fe^0 + S_2O_8^{2-}$ à $Fe^{2+} + 2SO_4^{2-}$; $Fe^{2+} + S_2O_8^{2-}$ à $Fe^{3+} + SO_4^{-\bullet} + SO_4^{2-}$. The advanced oxidation process occurs in two stages: converting the nitro compounds of TNT to amine compounds then Oxidation in the presence of free radicals create: converting amine compounds to CO_2, H_2O, NO_2^- /NO_3^-, SO_4^{2-}. Fe^{2+} is easy oxidation to Fe^{3+} in high pH, so that the addition of a ligand to complex with Fe^{2+}. In this oxidation system, at pH = 12, hydroxyl and sulfat radicals were generated simultaneously $Fe^{2+} + EDTA \rightarrow Fe^{2+}EDTA$ then $2Fe^{2+}EDTA + O_2 + H^+ \rightarrow 2Fe^{2+}EDTA + H_2O_2$; $Fe^{2+}EDTA + H_2O_2 \rightarrow Fe^{3+}EDTA + HO^\bullet + HO^-$. Fe^{2+}EDTA acts as a catalyst for the formation of free radicals ($OH^\bullet$).

Approach/Activities. We conducted a study to select the optimal conditions for TNT degradation, to investigate the characteristics of wastewater and apply to treat TNT wastewater. The chemicals were added to the reactor containing 100 mg/L TNT (saturated concentration). The experiment varies the concentrations of Fe, EDTA and $Na_2S_2O_8$ to find the optimal reaction conditions to treat 100 mg/L TNT. The reaction is agitated with a magnetic stirrer, the pH meter attached to the reactor to monitor the pH. After 30 minutes, 2 hours, 4 hours, 6 hours, take 5 mL of the reaction mixture was filtered through the yellow filtered paper, then analyzed the solution to quantify TNT, determine the reaction efficiency.

Results/Lessons Learned. The results show that the addition of EDTA increases the persulfate ion activation, maintaining the solubility of Fe^{2+}; EDTA is commonly used due to its to low price and high processing efficiency. It creates a stable oxidation system when generated with two free radicals, which accelerates the rate of TNT decomposition. The addition of EDTA in the reaction increased efficiency from 66.1% to 98.9% after 6 hours. In this experiment, we get result, when degradation 100 mg/L TNT using the concentration of Fe^0 10 g/L, $Na_2S_2O_8$ 0.005 mol/L, EDTA 0.01 mol/L is the most appropriate. This research could be applied to the treatment of organic compounds such as chlorine compound, styphnic acid because of the strong oxidation capacity of $SO_4^{-\bullet}$ as explained in B/O.