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Study of decomposition of acetic acid, ethanol and isopropyl alcohol by the Fenton reagent

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The Fenton reagent, a mixture of H_2O_2 and Fe^{2+}, is a powerful oxidant that could be used to reduce the COD values of industrial wastewater. It has been suggested that acetic acid could significantly reduce the efficiency of the decomposition of organic compounds. This study mainly focused on studying the decomposition behavior of acetic acid, isopropyl alcohol and ethanol by the Fenton reaction. All the experiments were done using aqueous solutions of ethanol (0.05 M), isopropyl alcohol (0.04 M) and acetic acid (0.04 M). The Fenton reagent was composed of 0.04 M H_2O_2 and 0.0027 M Fe^{2+}. The Fenton reaction was initiated by introducing 1.0 mL of the reagent to 100.0 mL of the organic solution. The residual amounts of the Fe^{2+}, H_2O_2 and COD values were determined on hourly basis for 5 to 6 hours using standard methods. According to the experimental data, the reduction of COD was about 60 % for ethanol and isopropyl alcohol solutions and about 30 % for acetic acid. The consumption of H_2O_2 during the reaction was about 55% for both ethanol and isopropyl alcohol and about 35% for acetic acid. In addition, the Fe^{2+} to Fe^{3+} ratio was similar for ethanol and isopropyl alcohol and it was significantly different for acetic acid. These experimental data suggest that under similar experimental conditions, the decomposition of ethanol and isopropyl alcohol is different from acetic acid by the Fenton reagent. It has been suggested that acetic acid forms stable complexes with Fe^{3+} that is produced by the oxidation of Fe^{2+} during the Fenton reaction. As a result, the catalytic cycle of Fe^{2+} and Fe^{3+} might have been interrupted by acetic acid. In order to prevent the formation of Fe^{3+}- acetic acid complexes, citric acid was added as a competitive ligand. The addition of small amounts of citric acid along with the Fenton reagent significantly improved the decomposition of acetic acid and a 55 % reduction was observed after 5 hours. On the other hand, decomposition of ethanol was not significantly influenced by the addition of citric acid under similar experimental conditions to acetic acid.