

Indirect oxidation of Low Concentration
Bio-refractory Organic Compounds
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The elimination of bio-refractory organic species can be reached by direct and indirect electro-oxidation. In the case of the direct electro-oxidation the oxygen evolution reaction is highly inhibited by using specific anodic coating like doped diamond (BDD). Even in this case the oxygen evolution is not avoided when the anode operates at mass transfer conditions, i.e. when the electrochemical treatment concerns low concentration bio-refractory organic compounds. An alternative method is the efficient electrochemical production of highly active oxidants, like persulphate with BDD coating anode and its use in order to oxidize bio-refractory and low concentration organic species, like benzene. This alternative method is the object of this study.

Fig. 1. shows current efficiency of persulphate production vs. sulfuric acid concentration at low temperature in order to avoid persulphate degradation. This results shows that high current efficiency is obtained when a high sulfuric acid concentration and low temperature are used. These operating conditions impose to separate the production step of persulphate from oxidation step of the organic compounds.

The capacity of persulphate to oxidize the organic species increases with the temperature and this is due to the formed very active persulphate radicals that oxidize both organic species and water. For this reason it is necessary to know initially the persulphate consume in solutions without organic species in order to know the kinetic of parasitic water oxidation.

Fig. 2 shows some experimental results of persulphate concentration vs. time at low initial acidity of the water solution (pH = 4) and various temperatures. The kinetic parameters of persulphate degradation to oxidize the water are estimated.

In order to point out the oxidant effect of persulphate on the organic species, the formic acid is used as a representative simple organic species and the benzene as more complex and bio-refractory compound. Fig. 3 shows the case of formic acid oxidation, COD vs. time is reported, at of low acidity solution and without and with persulphate excess. It is interesting to note that a stoichiometric quantity of persulphate is enough to oxidize the oxalic acid.

Fig. 4. shows benzene oxidation vs. time, a high COD reduction has been obtained even in this case using a higher temperature. Also in this case a low excess of persulphate was used and this result indicate that the higher portion of persulphate is used to oxidize benzene and only a small quantity is lost to oxidize water.

The obtained oxidation results of formic acid point out that it is more easier destroy the formic acid than the benzene. While the comparison of the same results with the degradation of persulphate in water indicates that the persulphate reacts preferentially with the organic species than with the water.

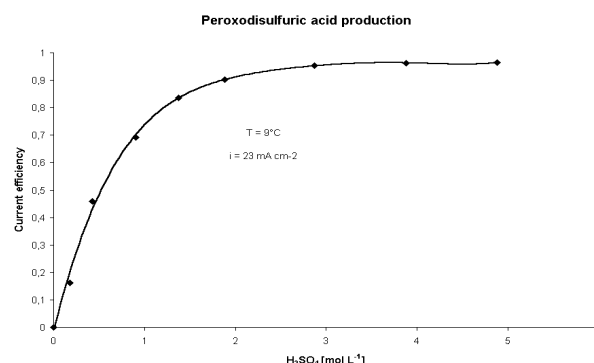


Fig. 1. Current Efficiency of the persulphuric acid production vs. sulphuric acid concentration (T = 9 °C, i = 23 mAcm⁻²).

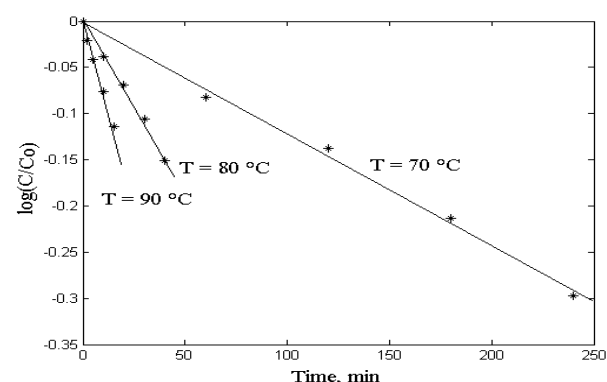


Fig. 2. Persulphate degradation vs. time, pH = 4 initial solution .

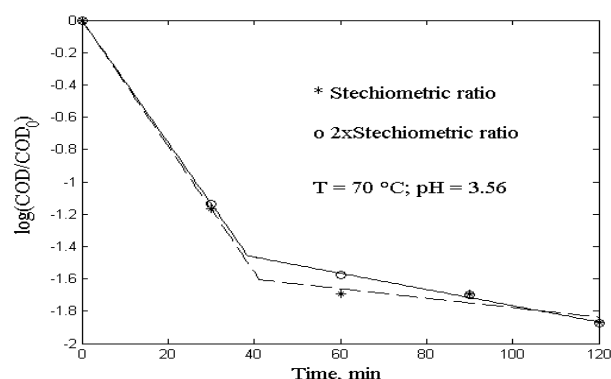


Fig. 3. COD reduction vs. time, in the case of formic acid (with and without persulphate excess)

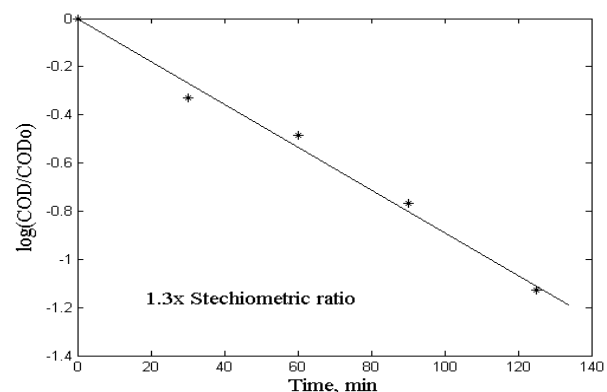


Fig. 4. COD reduction vs. time, in the case of benzene, pH = 6.14, T = 90 °C