ADSORPTION OF AQUEOUS ORGANIC MIXTURES ON ACTIVATED CARBON : EXPERIMENTS AND MODELLING OF COMPETITIVE ADSORPTION

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An integrated process (AD-OX) has been developed for the treatment of waste water containing refractory or toxic organic compounds. This process couples adsorption and catalytic oxidation in the same apparatus and on the same material: activated carbon. The porous solid plays successively the role of adsorbent under ambient conditions then that of catalyst under air at higher pressure and temperature.

The first step of adsorption of phenols and derivatives is presented in this work, including both experimental results and calculation model. The experimental study is carried out in batch reactor to obtain the kinetics of adsorption and the adsorption isotherms. The theoretical approach is based on the ideal model called "Ideal Adsorption Solution Theory" to obtain theoretical adsorption isotherms.

Two binary mixtures were chosen to investigate the behaviour of the adsorbent in competitive adsorption : a mixture of para-hydroxy benzoic acid and dimethyl phenol (PBHA/2,4DMP) and a mixture of para-hydroxy benzoic acid and phenol (PBHA/Phenol). For each binary mixture, different molar proportions were used: equimolar (50%-50%) and unbalanced proportions (30%-70% and 70%-30%). Activated carbon was supplied by Merck. The solutions were analysed by HPLC.

Experimental dynamic adsorption of pure compounds was performed to compare the adsorption kinetics of the two compounds of the binary mixtures. The kinetics of adsorption of each component out of a binary mixture were similar to those observed for each pure compound.

Experimental adsorption isotherms showed that, for the molecule having the best affinity with active carbon, adsorption in competitive mode is roughly as efficient as in non-competitive mode. For a given mixture, according to the proportion of each component, an inversion in the behaviour of the system was found. The preferential adsorption could be inverted if the proportion of the two compounds was reversed. This behaviour was better observed for lower values of the equilibrium concentrations than for high concentrations.

Partial isotherms for competitive mode predicted by IAST model were in good agreement with the experimental results for equimolar mixtures. For non equimolar mixtures the thermodynamic model was in good agreement with the partial isotherms provided that selectivity does not change. Indeed, in the case of inversion of selectivity the IAST model was not able to predict this change. In these cases, the IAST model presents some limits: the mixture is no longer ideal; the RAST model (Real Adsorption Solution Theory) would be more convenient to predict interactions between the compounds.