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ABSTRACTS

BOOK

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Catalytic wet peroxide oxidation of 4-nitrophenol with natural and pillared clays from Kazakhstan: Lumped kinetic model of TOC

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1. Introduction – Research on catalytic wet peroxide oxidation (CWPO) has been mainly focused on the development of highly active, stable and efficient solid catalysts, whereas kinetic studies are scarcely present in this matter. The current work deals with the lumped kinetic modelling of TOC in the CWPO of 4-nitrophenol (4-NP), used as model pollutant, considering natural clays as catalysts from the Akzhar and Karatau regions of the republic of Kazakhstan.

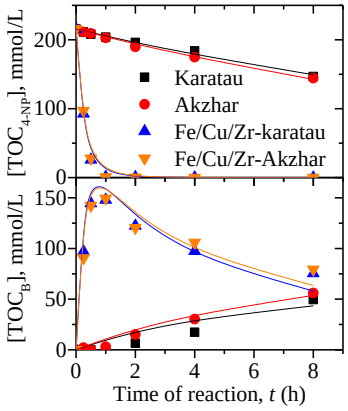

Image 1. TOC removal.

2. Experimental – The natural clays, named by their region of origin (Akzhar and Karatau), were washed with HCl (1 M) and pillared with a pillaring solution of NaOH containing three metals: Fe, Cu and Zr (1:1:1). The pillaring process was performed keeping a ratio of 10 mmol of metals per gram of clay and the resultant material was calcined for 2 h at 550 ºC. The oxidation experiments were performed according to the procedure reported in a previous work [1], under the following operating conditions: 50 ºC, initial pH = 3; and 5 g/L of 4-NP, 2.5 g/L of catalyst and 17.8 g/L of hydrogen peroxide. Kinetic modelling was done by non-linear regression with numerical iteration and applying ANOVA for statistical model evaluation, considering the methodology employed elsewhere [2].

3. Results and Discussion – Image 1 shows the experimental data (symbols) and predicted values (curves) determined from the fitted kinetic model. As observed, the pillaring process increased substantially the catalytic activity of the clays for the CWPO of 4-NP. The best fit consisted on a pseudo-first-order kinetic model assuming TOC as the contribution of the 4-NP and the oxidized products: $(-r_{TOC,4\text{-}NP}) = -k_1 \cdot [H_2O_2] \cdot [TOC_{4\text{-}NP}]$ and $(r_{TOC,B}) = k_1 \cdot [H_2O_2] \cdot [TOC_{4\text{-}NP}] - k_2 \cdot [H_2O_2] \cdot [TOC_B]$. $(-r_{TOC,4\text{-}NP})$ represents the rate of disappearance of the theoretical TOC corresponding to the measured concentration of 4-NP, $[TOC_{4\text{-}NP}]$, and $(r_{TOC,B})$ represents the rate of appearance of the measured TOC subtracting the theoretical carbon contribution of 4-NP.

4. Conclusions – Natural clays from the Akzhar and Karatau regions, in Republic of Kazakhstan, have been shown to be useful catalysts in the CWPO of 4-NP. Their catalytic activity may be increased significantly by pillaring processes. The lumped kinetic model of TOC in the CWPO of 4-NP is achieved, considering the TOC of the medium as sum of the 4-NP contribution and its oxidized products.

5. References

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