Evaluation of hydrothermally synthesized green Co-carbon-smectite catalyst for oxidative degradation of dye in the presence of Oxone®

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1. Introduction – Catalytic advanced oxidative degradation of organic pollutants in water is a promising technique for the purification of industrial effluents. Cobalt-based catalysts wa proven to be very efficient in peroxymonosulfate activation and generation of $SO4^{\bullet -}$ radicals, species with high oxidative potential [1]. This work, for the first time, reports the hydrothermal procedure in the synthesis of cobalt-containing chitosan-derived carbon-smectite catalyst. The obtained catalyst was used for activation of Oxone® (potassium peroxymonosulfate). Activated Oxone® was applied in catalytic degradation of toxic textile dye - Orange G dye, that was used as a model of the water pollutant. Based on the presented results, the catalyst can be considered as an eco-friendly catalyst that was evaluated as highly efficient in the process of the oxidative degradation of selected organic dye, and potentially for a variety of water pollutants.

2. Experimental - The novel catalyst was prepared by mixing $Co(CH_3COOH)_2$ and chitosan solution with smectite-clay dispersion. The mixture solution was transferred into a Teflon-lined stainless-steel autoclave and heated at 180 ºC for 24 h. After the heat treatment, the obtained catalyst was separated by filtration, rinsed with distilled water and ethanol, and finally dried.
The degradation of Orange G by Oxone® in the presence of the catalyst was performed in the temperature range from 25 °C to 50 °C.

3. Results and Discussion - The influence of the temperature on the decolorization of the dye, as the first step in dye degradation, is presented in Image 1. The temperature increase was highly beneficial for the dye degradation rate. Under the investigated conditions decolorization after 30 min of reaction, was 43 %, 62 %, 84 %, 100 %, and 100 % for the reaction at (25, 30, 35, 40 and 50) °C, respectively. Nevertheless, the catalyst was proven to be efficient even at room temperature.

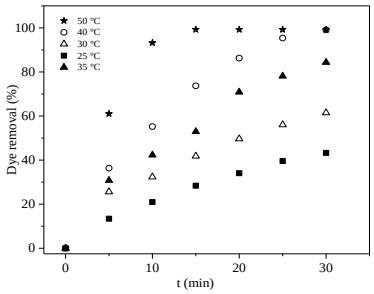

Image 1. Decolorization of Orange G solution at different temperatures using synthesized catalyst

4. Conclusions - This work showed that hydrothermal synthesis can be successfully used to obtain chitosan derived carbon-smectite nanocomposites containing cobalt. Synthetized catalyst was found to be very promising as peroxymonosulfate activator for the degradation of water pollutants. The obtained catalyst is a representative of a novel efficient green solution for cobalt-containing catalysts since it was obtained using chitosan (product of biowaste) and smectite (abundant clay mineral). Both starting materials are economical, naturally occurring materials, and therefore this advantage of the obtained catalyst together with the simple synthesis procedure and high efficiency, implies a perspective for future development and application.

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5. References

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