

Catalytic Properties of Iron Oxides in the Reaction of Low-Temperature Ozone Decomposition

A.S. Truba*, T.L. Rakitskaya, A.A. Stoyan, V.Y. Volkova

Faculty of Chemistry, Odessa I.I. Mechnikov National University, 2 Dvoryanskaya Str.,
65082 Odessa, Ukraine

* truba@onu.edu.ua

Iron oxides show low activity as catalysts of redox reactions at ambient temperature and normal pressure. However, the significant attention paid to them lately is caused by the possibility to obtain the desired phase composition, physicochemical properties and, as a result, maximum catalytic activity by varying the nature of their precursors, the ratio of their components, the temperature of their calcination and other factors. The work presents the results of determination of the catalytic activity shown by maghemite ($\gamma\text{-Fe}_2\text{O}_3$) synthesized by coprecipitation of $\text{FeSO}_4\cdot 7\text{H}_2\text{O}$ with $\text{FeCl}_3\cdot 9\text{H}_2\text{O}$ (sample I) or with $\text{Fe}_2(\text{SO}_4)_3\cdot 9\text{H}_2\text{O}$ (sample II) in non-protected medium followed by thermal treatment of coprecipitation products at 200, 300, and 500 °C. The samples thus synthesized were characterized by X-ray phase analysis, IR spectroscopy, water vapor ad/desorption, DTG-DTA, pH-metry and also tested in the reaction of ozone decomposition. The both samples calcinated at 200 °C contained maghemite as a dominant phase and minor amounts of magnetite (Fe_3O_4), hematite ($\alpha\text{-Fe}_2\text{O}_3$), and goethite ($\alpha\text{-FeOOH}$) as impurity phases. The calcination of the samples at 300 and 500 °C led to a change in the ratio of the phases with domination of hematite as indicated by a prevalence of reflexes corresponding to it.

The testing of the samples in the reaction with ozone depicted in Figure (a, b) was carried out at its initial concentration of 1 mg/m^3 which was by an order of magnitude greater than the maximum permissible ozone concentration, MPC_{O_3} . Since a half-conversion time, $t_{1/2}$, is one of the mostly used parameters characterizing the reactivity substances in the reaction with ozone, all tests were finished when a final ozone concentration became equal to 0.5 mg/m^3 .

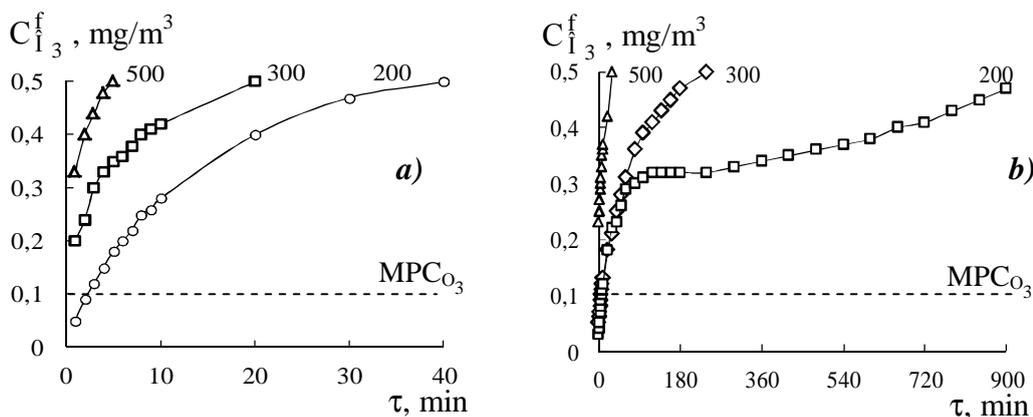


Figure. Time dependences of a final ozone concentration in the course of ozone decomposition by the synthesized samples calcinated at different temperatures: sample I (a) and sample II (b)

Analyzing the kinetics of ozone decomposition, some conclusions can be drawn. Samples II prepared from Fe(II) and Fe(III) sulfates are much more active than samples I: their $t_{1/2}$ values and the amount of ozone entered into the reaction up to a moment of experiment termination are many times higher than those for samples I. Both samples I and samples II lose their activity with the increase in the calcination temperature due to the following phase transformation: $\gamma\text{-Fe}_2\text{O}_3 \rightarrow \alpha\text{-Fe}_2\text{O}_3$.