

Liquid-Phase Oxidation of Inorganic Sulfides in Aqueous Media in the Presence of a Homogeneous Catalyst Based on 3,3',5,5'-Tetra-*tert*-Butyl-4,4'-Stilbenequinone

H. Y. Hoang^{a,*}, R. M. Akhmadullin^b, F. Yu. Akhmadullina^a,
R. K. Zakirov^a, and A. G. Akhmadullina^b

^aKazan State University of Research and Technology, Industrial Biotechnology Department, Kazan, 420015 Russia

^bAkhmadullins—Science and Technologies, Kazan, 420029 Russia

*e-mail: nhochieny@gmail.com

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Abstract—The rates and factors influencing the rates of liquid-phase oxidation of inorganic sulfides by oxygen in aqueous media in the presence of a homogeneous catalyst based on 3,3',5,5'-tetra-*tert*-butyl-4,4'-stilbenequinone dissolved in the kerosene fraction have been studied.

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Sulfur compounds are undesirable components in oils, as they sharply impair the quality of petroleum products and pollute the environment when used. Purification of petroleum products from sulfur compounds often produces sulfurous alkaline wastes (SAWs) that contain inorganic sulfides in high concentrations. Being toxic, SAWs cannot be discharged to water bodies or collected and purified together with the other industrial sewages even though considerably diluted.

There are various methods for decontaminating SAWs, the most promising being the liquid-phase oxidation of SAW by air oxygen in the presence of a catalyst [1–3]. In the present study, we propose a new homogeneous catalyst based on 3,3',5,5'-tetra-*tert*-butyl-4,4'-stilbenequinone (hereafter, referred to as stilbenequinone) dissolved in the kerosene fraction, for the liquid-phase oxidation of sulfide–hydrosulfide derivatives; this catalyst has high catalytic activity and selectivity and is stable in alkaline media. In choosing the kerosene fraction, we were guided by its low solubility in water, low volatility, and a satisfactory solubility of stilbenequinone in kerosene.

EXPERIMENTAL

The catalytic component, 3,3',5,5'-tetra-*tert*-butyl-4,4'-stilbenequinone, was prepared by following method: a 500-cm³ cylinder-shaped glass reactor was loaded with 30 g of 2,6-di-*tert*-butyl-4-methylphenol, 3 g of potassium iodide, and 120 mL of isopropanol,

and the contents were heated to 70°C under stirring. After the reaction mass was heated for 30 min, 42 mL of 35% aqueous hydrogen peroxide was dropped in, and the reaction was continued for 9 h at 70–75°C. The resulting mixture was cooled to room temperature; the precipitated crystals were filtered off and dried. The 3,3',5,5'-tetra-*tert*-butyl-4,4'-stilbenequinone yield was 98%.

An aqueous ammonium sulfide solution was prepared as described in [4]; sodium hydrosulfide solution was prepared as described in [5].

The sodium sulfide used corresponded to the GOST (State Standard) 2053-77. Sodium sulfide solutions were prepared by dissolving Na₂S · 9H₂O in distilled water.

Also used were: technical grade oxygen in cylinders (GOST 5583-78), aqueous ammonia (GOST 3760-79), technical grade argon in cylinders (GOST 10157-79), kerosene fraction (GOST 10227-2013), and technical grade toluene (GOST 14710-78).

The oxidation of inorganic sulfides was performed in a 150-cm³ glass three-necked cylinder-shaped reactor. To the reactor, 40 mL of a solution of an inorganic sulfide and 20 mL of kerosene were poured in the presence of a calculated amount of the catalytic component. The oxygen was fed from a cylinder to the reaction solution at 0–625 h⁻¹. The solution in the reactor was stirred at 1400 rpm. The temperature of the reaction solution was maintained at 90°C by a temperature-controlled stirrer. In certain periods during an experiment, oxygen feeding was stopped, the magnetic