

Synthesis of maleic and malic acids by electrochemical reaction of furfural with hydrogen peroxide

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Abstract

The electrochemical reaction of furfural with aqueous hydrogen peroxide leads to the predominant formation of carboxylic acids, 5-hydroxy-2(5H)-furanone and 2(5H)-furanone. Among the carboxylic acids formed, the most interesting are malic and maleic acids. The yield of which depends on the reagents ratio, current strength, type and amount of the background electrolyte. The conditions under which the greatest yields of these products are achieved are found. It was found that malic acid, along with 5-hydroxy-2(5H)-furanone and 2(5H)-furanone, is the main product of the reaction of furfural with aqueous H₂O₂ under anodic oxidation. Its preparative synthesis with 24% yield was carried out at the molar ratio of furfural, H₂O₂ and LiClO₄ as a background electrolyte equal to 1 : 1.6 : (0.1-0.2), and a current of 0.03 A at 50 °C. The yield of maleic acid increases with increasing acidity of the medium and increasing the initial content of H₂O₂ in the reaction medium, while its greatest yield is observed in the solution of chloric acid. At a molar ratio of furfural, H₂O₂ and HClO₄, equal to 1 : 5.5 : 0.01, and a current strength of 0.01 A at 50 °C, its preparative yield reaches 41%. The results obtained suggest that maleic acid is mainly a product of oxidation of the tautomeric form of 5-hydroxy-2(5H)-furanone – *cis*-β-formylacrylic acid, while malic acid can be formed from 2(5H)-furanone and maleic acid. The scheme of maleic and malic acids formation in the studied conditions is proposed.

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