Enhancing safety in green adipic acid synthesis: The role of EDTA stabilizer and microchannel flow technology

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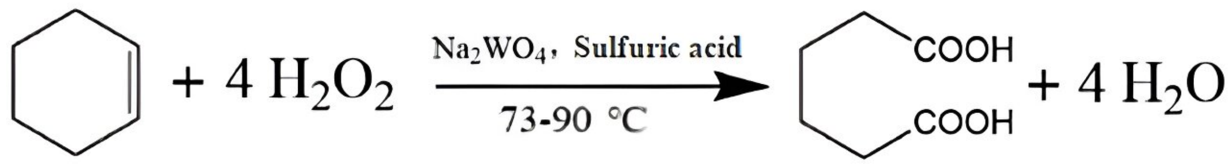

Reaction equation for the synthesis of adipic acid by oxidation of cyclohexene with H_2O_2 catalyzed by Na_2WO_4. Credit: *Emergency Management Science and Technology* (2023). DOI: 10.48130/EMST-2023-0022

Adipic acid, a fundamental component in the manufacture of chemical fibers, nylon 66, engineering plastics, and various pharmaceutical, food, and chemical products, is commonly synthesized through a green process involving the oxidation of cyclohexene with hydrogen peroxide (H_2O_2) catalyzed by sodium tungstate (Na_2WO_4).

In the green synthesis reaction of adipic acid, H_2O_2 undergoes exothermic decomposition easily, and the high exothermic amount of the reaction can easily lead to thermal runaway. Research into the stability of H_2O_2 has shown that certain metal ions can either accelerate or inhibit its decomposition, with the addition of stabilizers like EDTA proving effective in reducing decomposition.

However, there is a lack of research on improving the stability of H_2O_2 in the reaction and enhancing the safety of the production process of adipic acid.

Emergency Management Science and Technology published a research article titled "Effect of stabilizer EDTA on the thermal hazard of green synthesis process of adipic acid and development of microchannel continuous flow process."

This research methodically investigates calorimetric experiments on the green synthesis reaction of adipic acid, specifically focusing on the thermal parameters and reaction kinetics in a pilot-scale RC1e experiment and a microchannel continuous flow process.

The study revealed that the green synthesis of adipic acid involves a two-stage reaction, with significant exothermic reactions posing risks of thermal runaway, especially during the second stage, where no reflux occurs. Incorporating the stabilizer EDTA significantly mitigated these risks by reducing the maximum temperature of the synthesis reaction (MTSR), thereby enhancing process safety.

Furthermore, experiments conducted in a stainless steel capillary microreactor demonstrated that the decomposition of H_2O_2 increases with the increase of residence time and temperature, and the addition of EDTA can effectively reduce the decomposition.

In summary, the research successfully yielded adipic acid with a 63.25% yield in a high-pressure microchannel reactor, showcasing the potential for a safer, more efficient continuous flow synthesis process. These findings not only highlight the effectiveness of EDTA in stabilizing H_2O_2 and preventing thermal runaway but also emphasize the value of microchannel reactors in improving the intrinsic safety and efficiency of adipic acid synthesis.

This advancement holds significant promise for the future application of green chemistry principles in industrial processes, particularly in the production of adipic acid, thereby contributing to safer and more sustainable chemical manufacturing practices.

More information: Weidong He et al, Effect of stabilizer EDTA on the thermal hazard of green synthesis process of adipic acid and development of microchannel continuous flow process, *Emergency Management Science and Technology* (2023). DOI: 10.48130/EMST-2023-0022

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