Potential of producing medium chain dicarboxylic acids from kerogen in kukersite in a continuous-flow oxidation reactor

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Highlights

- Continuous-flow oxidation reactor has been constructed to produce dicarboxylic acids from kerogen
- The environmental impact and product utilisation have been reviewed
- The Kerox technology shows the potential of being scaled up industrially

1. Introduction

Medium chain aliphatic dicarboxylic acids (DCAs, C4-C10) are a crucial and versatile feedstock for the chemical and plastics industry. The direct applications range from food additives (succinic acid) and acne treatment (azelaic acid) to nucleating agents (pimelic and suberic acid). They are also used as building blocks for polyamides (adipic acid for Nylon 6,6), polyesters (succinic acid for PBS, a biodegradable plastic), plasticisers (sebacic acid for DBS) and polyster polyols (polyurethanes and resins). In industry, DCAs are mostly produced through many steps from crude oil. [1] The Kerox technology, chemical processing of kukersite, oxidises the organic part of oil shale, kerogen, directly into DCAs. Kukersite, also known as oil shale, is an abundant resource in Estonia and around the world with known oil shale deposits accounting for more than three times the oil equivalent compared to conventional crude oil reserves. [2] Currently, kukersite in Estonia is mainly used for electricity generation and shale oil production. The current thermal processing has a large environmental impact (gas emissions, ash land fields, semi-coke formation, etc.). [3] For the Kerox technology to be competitive industrially, it needs to have a low environmental impact and high added value compared to current oil shale processing.

2. Methods

The Kerox technology can broadly be divided into three stages: kukersite enrichment, oxidation and post-treatment. The core of the technology is a self-constructed three-phase (solid, liquid and gas) continuous-flow oxidation reactor. The potential of bringing the technology to market, including a primary environmental impact assessment and product utilisation options are being reviewed.

3. Results and discussion

The oxidation reactor parameters have been optimised to give the greatest yield of dicarboxylic acids (C4-C10) and mass flows mapped. The optimisation results in DCA production in the hundreds of grams to kilogram scale with minimum environmental impact. Some potential uses, such as pimelic acid as a nucleating agent for polypropylene, DCA mixtures as potential plasticisers and residual organics as plant growth stimulators have been tested.

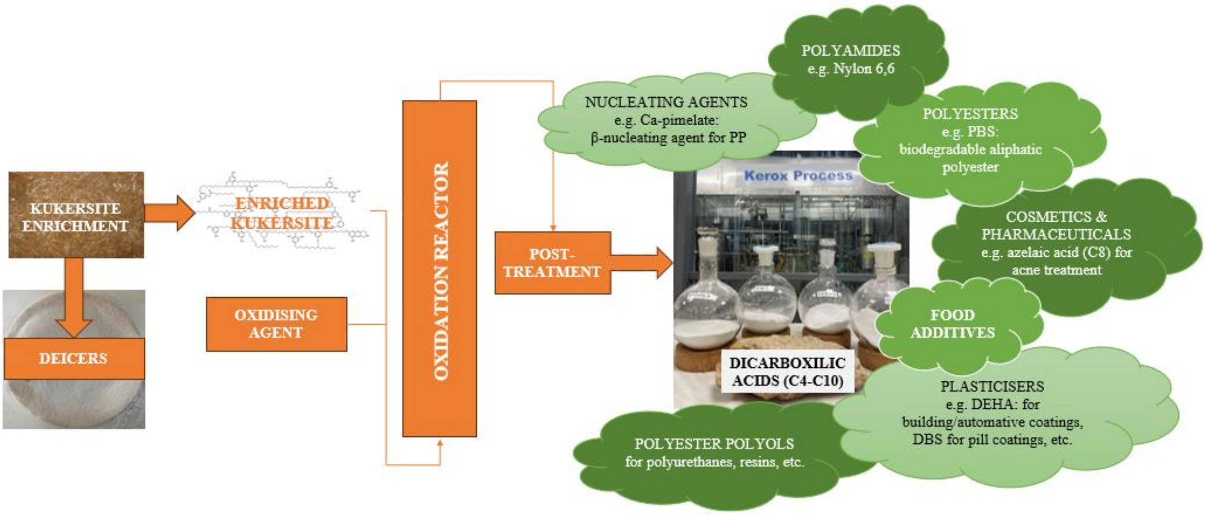

Figure 1. Kerox Technology

4. Conclusions

A continuous-flow laboratory-scale oxidation reactor can produce valuable and versatile DCAs from the organic part of kukersite, kerogen. The technology shows the potential of being scaled up and redesigning the current shale oil industry in Estonia, whilst providing an alternative to the current DCA production from crude oil.

References

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Keywords
Continuous-flow oxidation reactor, dicarboxylic acids, kukersite, oil shale