Life cycle assessment of lignin-containing cellulose nanocrystals

Shiva Zargar[1*], Jungang Jiang[1,2], Feng Jiang[1], Qingshi Tu[1]

1. Department of Wood Science, The University of British Columbia, Vancouver, BC, V6T 1Z4, Canada
2. Beijing Key Laboratory of Lignocellulosic Chemistry, Beijing Forestry University, Beijing 100083, China

* shiva.zargar@ubc.ca

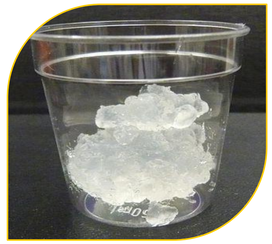
THE UNIVERSITY OF BRITISH COLUMBIA

Sustainable Bioeconomy Research Group

BEIJING FORESTRY UNIVERSITY

Background

Nanocellulose represents a green and sustainable family of nanomaterials

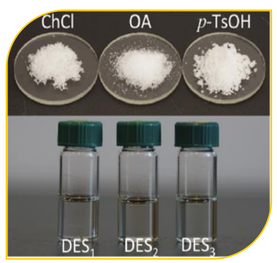


Applications: nanocomposite, biomedicine, packaging, and energy

To produce more uniform lignin-containing cellulose nanocrystal (LCNCs) from the undervalued thermo-mechanical pulp (TMP) with high production yield and minimize the chemical and energy consumption compared to cellulose nanocrystal (CNCs), an acidic deep eutectic solvent (DES) system was developed for isolation

Binary DES (choline chloride:oxalic acid)

Ternary DES (choline chloride:oxalic acid:p-toluenesulfonic acid)



The sustainability of LCNC is highly dependent on the production route

Objectives

Evaluating the environmental impacts of a DES-based laboratory-scale isolation pathway

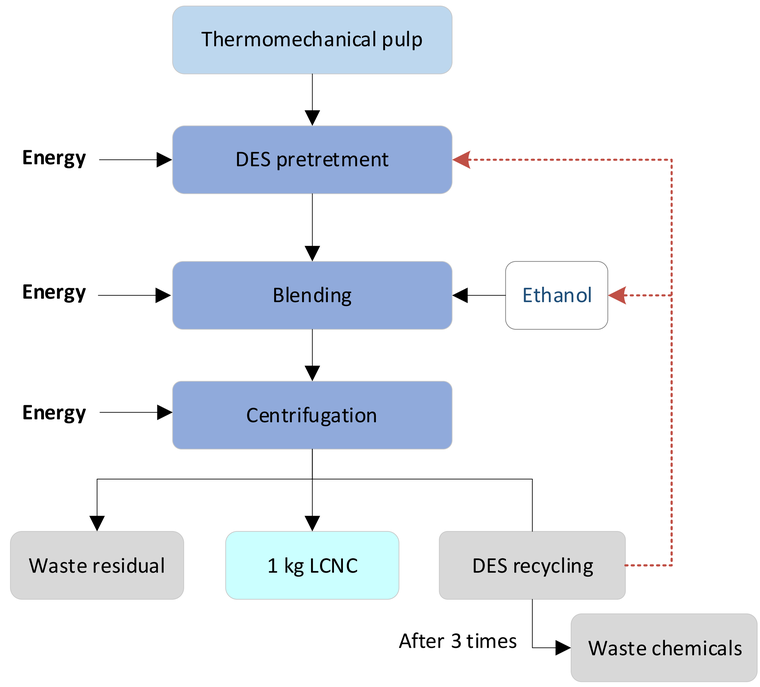
Comparing the impacts of LCNCs production under various DES trials (i.e., chemical composition) as well as different assumptions (i.e., dose of DES)

Methods

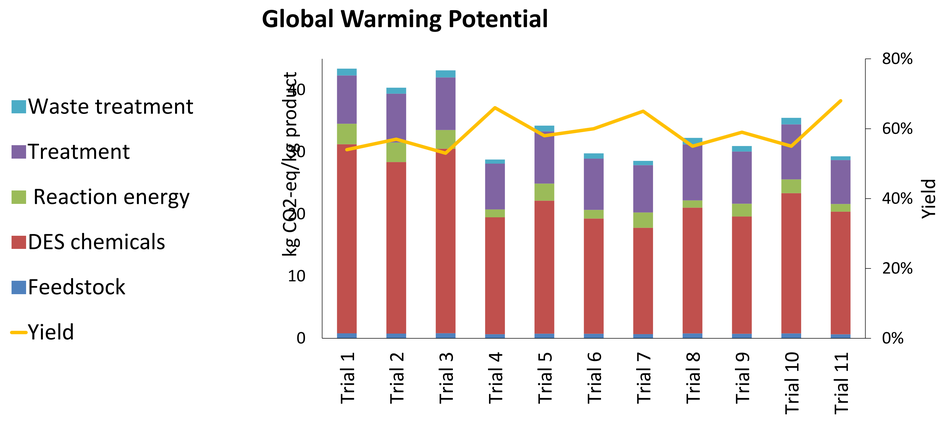
Life cycle assessment:
- Goal and scope
- Life cycle inventory
- Impact assessment
- Interpretation

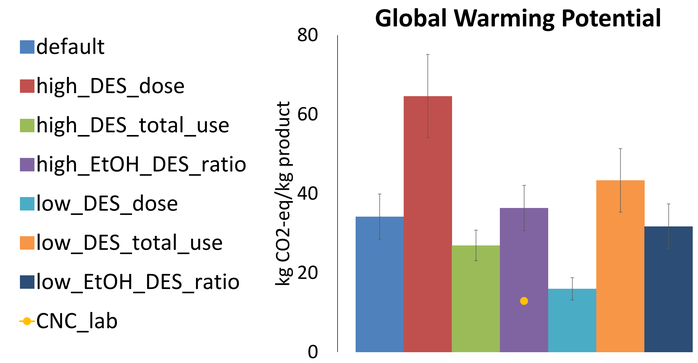
*Functional unit: 1 kg of produced LCNC
*Impact categories: Global warming potential, Acidification, and energy use

A cradle-to-gate system boundary of 1 kg LCNCs production



Results





Sensitivity Analyses

Conclusions

Ternary DES treatment showed lower environmental impacts compared to binary DES pretreatment

Reducing the consumption of high-impact chemicals can have significant effects on the overall impacts of LCNC production

The findings indicate the need for future research that minimizes the net consumption of DES while maintaining the desired yield of LCNCs

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