Catalytic hydrothermal conversion of lignocellulosic biomass to valued-added organic acid

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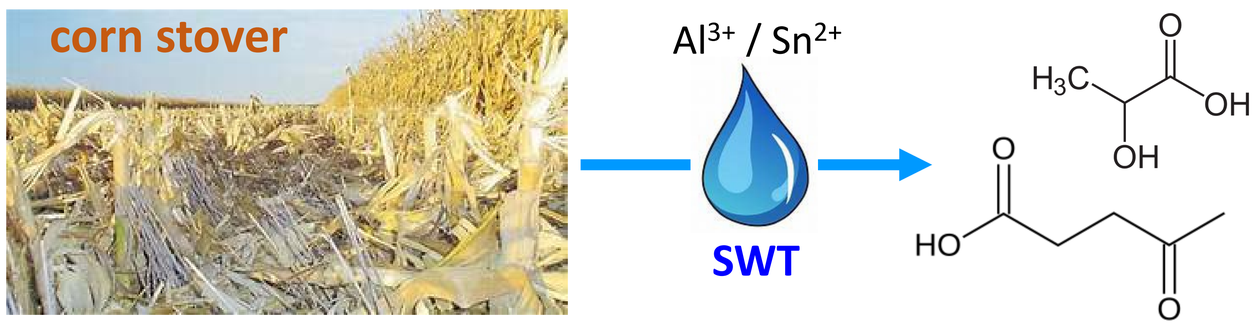
BACKGROUND

General aim: Transit from a fossil based economy to a bio-based economy to produce high value chemicals.

Mean: Subcritical water treatment (SWT) of biomass (corn stover)

Specific work: Selective production of levulinic and lactic acids by using a mixture of Lewis acid catalysts



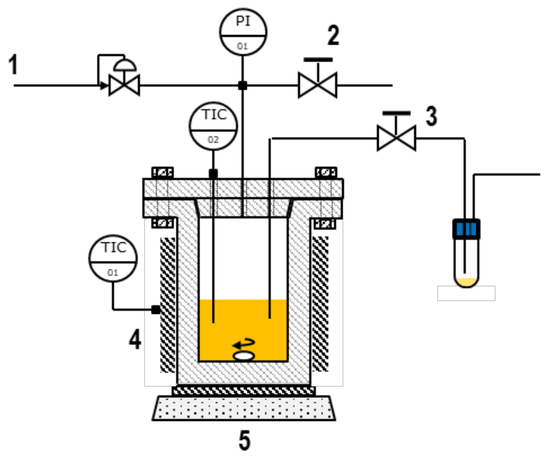
EQUIPMENT & METHODOLOGY

Discontinuous SWT operation

Catalysts: a combination of Al^{3+} and Sn^{2+} chloride salts

Catalyst concentration: 20 % of equiweight fraction of both salts considering the glucan fraction of corn stover.

Yield evaluation: Lactic acid (LA) yield was evaluated considering all the polysaccharide fraction of corn stover (cellulose + hemicellulose), and levulinic acid yield was determined considering only the cellulose fraction

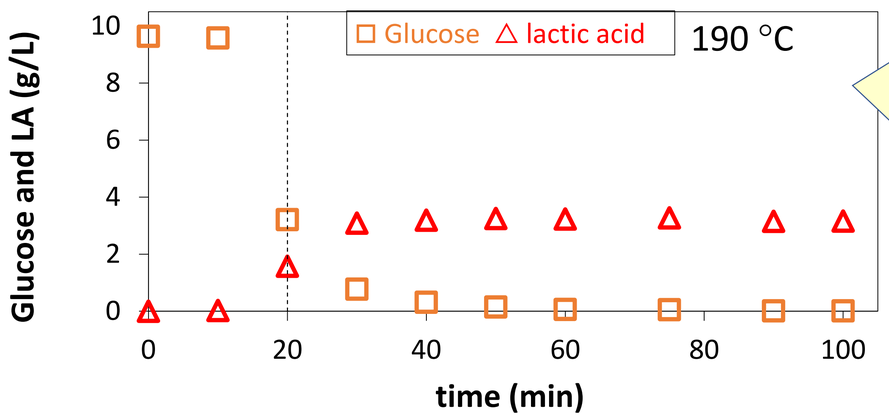


1. Pressurized agent line
2. Gas outlet, with purge valve
3. Sampling circuit, including sampling valve
4. Heating jacket (ceramic resistance 4000 W)
5. Magnetic stirring plate.

Temperature (T) and Pressure (P) Indicators (I) and Controllers (C)

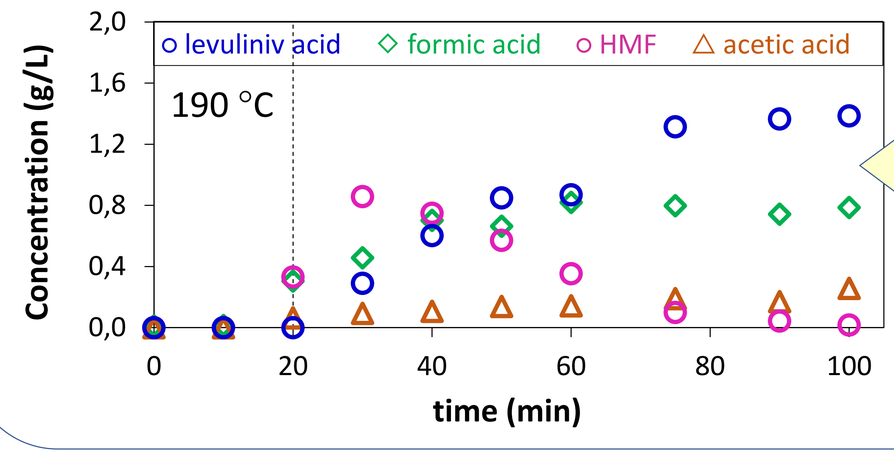
RESULTS

Lactic acid production from pure monomers
Catalyst: Al^{3+}/Sn^{2+}



- Glucose, 9 g/L, produced high LA yield (approximately, 36 %) and concentrations of 3.3 g/L.
- Basic studies with xylose yielded similar results

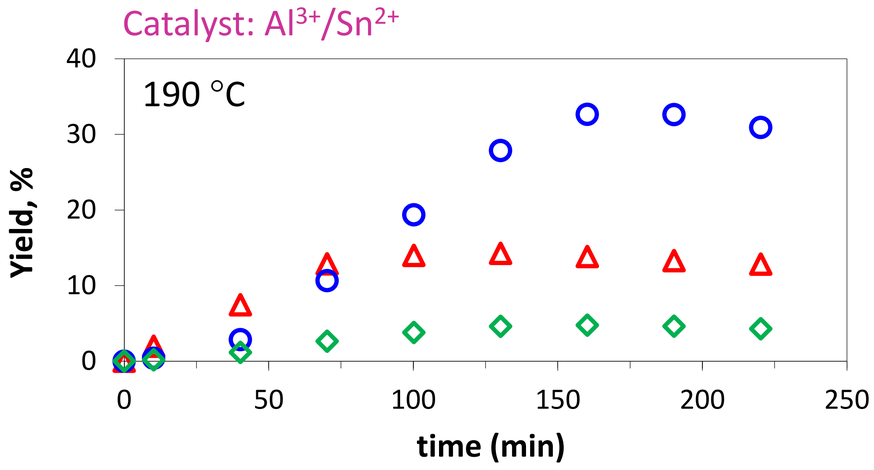
Glucose → Dihydroxyacetone ⇅ Glyceraldehyde → Lactic acid



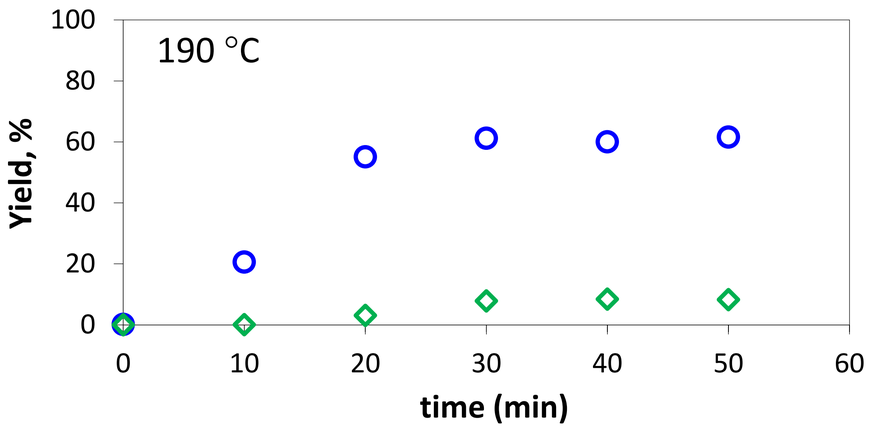
Other degradation products from glucose:

- HMF (dehydration product)
- Organic acids: levulinic acid, formic acid, acetic acid

Organic acid production from corn stover
Catalyst: Al^{3+}/Sn^{2+}



Degradation of HMF
Catalyst: Al^{3+}/Sn^{2+}



Glucose → HMF → Levulinic acid
Formic acid

CONCLUSIONS

Glucose treated at 190 °C with Al^{3+}/Sn^{2+} chloride salts yielded values up to 36 %, 16 % and 6 % for lactic, levulinic and formic acids, respectively

When treating corn stover the major acid released was levulinic acid (more than 30 % yield)

HMF, in the presence of Al^{3+}/Sn^{2+}, degraded very fast into levulinic and formic acids, explaining the high levulinic acid concentration

These results encourage the use of agroindustry residues, such as corn stover, as a source of valuable platform molecules, such as organic acids

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