Single Step Organosolv Oxidative Pretreatment of Lignocelullosic Biomass Towards Enzymatic and Chemical Valorisation to High Added Value Chemicals and Food Additives

Konstantinos G. Kalogiannis*[1], A. Kalogianni[1], C.M. Michailof[1], E. Topakas[2], A. Karnaouri[2] and A.A. Lappas[1]

[1]*Chemical Process and Energy Resources Institute (CPERI), Centre for Research and Technology Hellas (CERTH)*
[2]*Biotechnology Laboratory, School of Chemical Engineering, National Technical University of Athens*
*kkalogia@cperi.certh.gr

Presentation Layout

1. Introduction – Purpose of the work
2. Experimental units and procedures
3. Experimental results
4. Conclusions

CPERI Chemical Process and Energy Resources Institute
CERTH Centre for Research and Technology Hellas

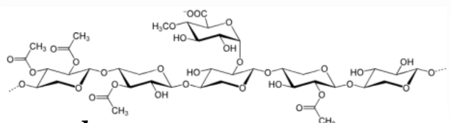
NoWasteBioTech Objectives


corn stover

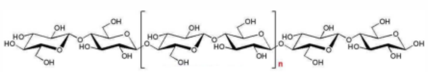
corn cob

Biomass

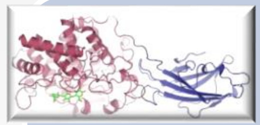
- solid **cellulose** pulp
- aqueous **hemicellulose** oligo-sugars solution



xylan structure



cellulose structure

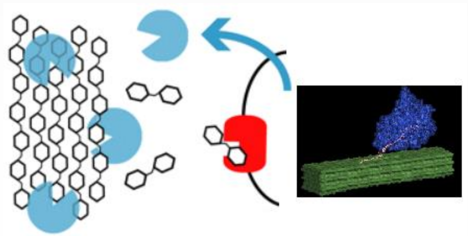



xylanase

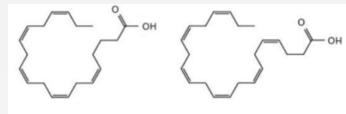
cellulase

Saccharification

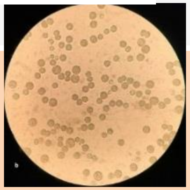
- **enzymatic production** of sugars
- **cellulases/hemice-llulases**



cellulose/hemicellulose hydrolysis



ω-3 fatty acids

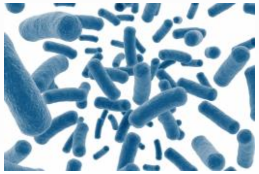


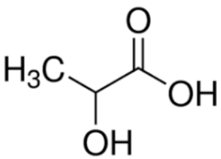

microalgae cells

Fermentation

- **ω-3 fatty acids**
- **lactic acid**

lactic acid bacteria



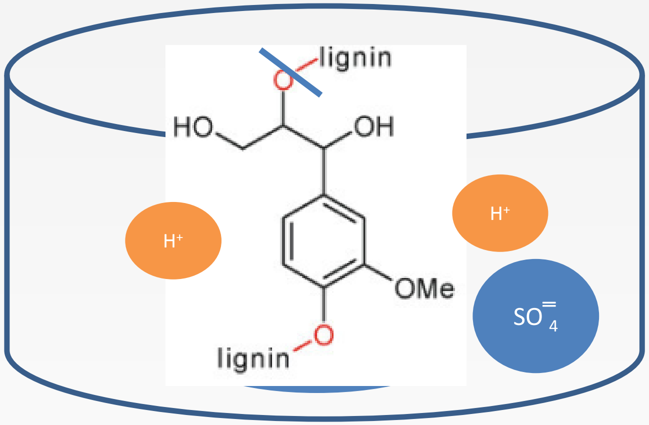


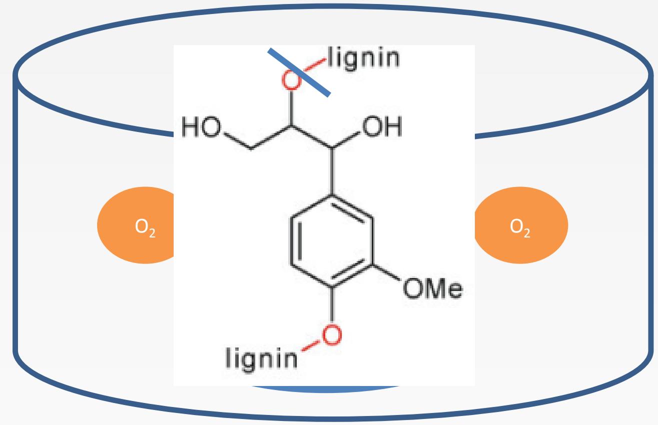
lactic acid

Chemical Process and Energy Resources Institute - CPERI
Centre for Research and Technology Hellas - CERTH

Acid Organosolv Delignification

Oxidative Organosolv Delignification



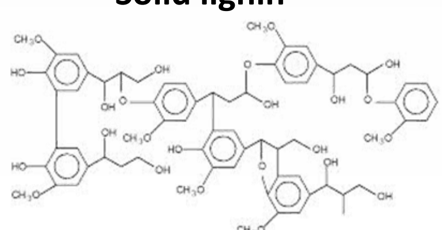


H_2O/Acetone/Lignin one phase liquid

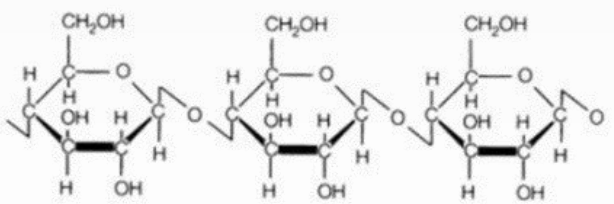
Vacuum distillation

Aqueous hemicellulose byproducts solution

Solid lignin



Solid delignified pulp



Experimental results – Main parameters

Biomass used was Lignocel HBS 150/500 which is a Beechwood sawdust

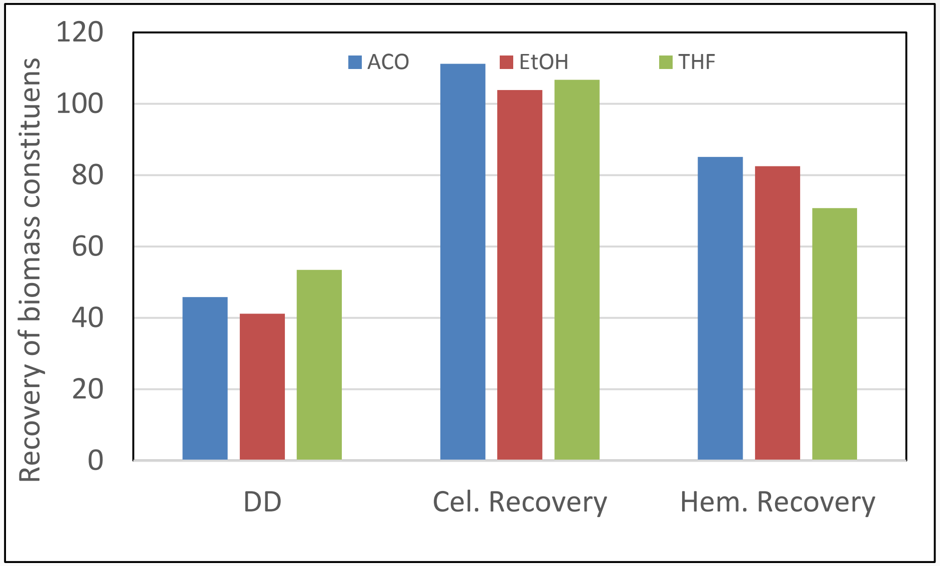
Extracts	A.I. Lignin	A.S. Lignin	Cellulose	Hemicellulose
3.7	21.7	2.5	47.6	21.2

Main Parameters

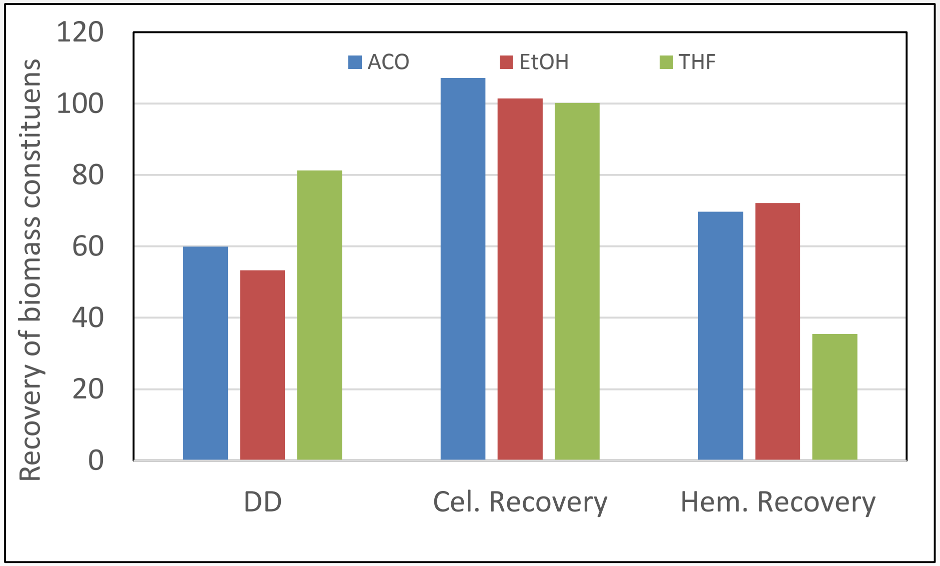
- Solvent
- Pressure
- Time
- Temperature

Solvent effect

❑ 60 min



❑ 120 min



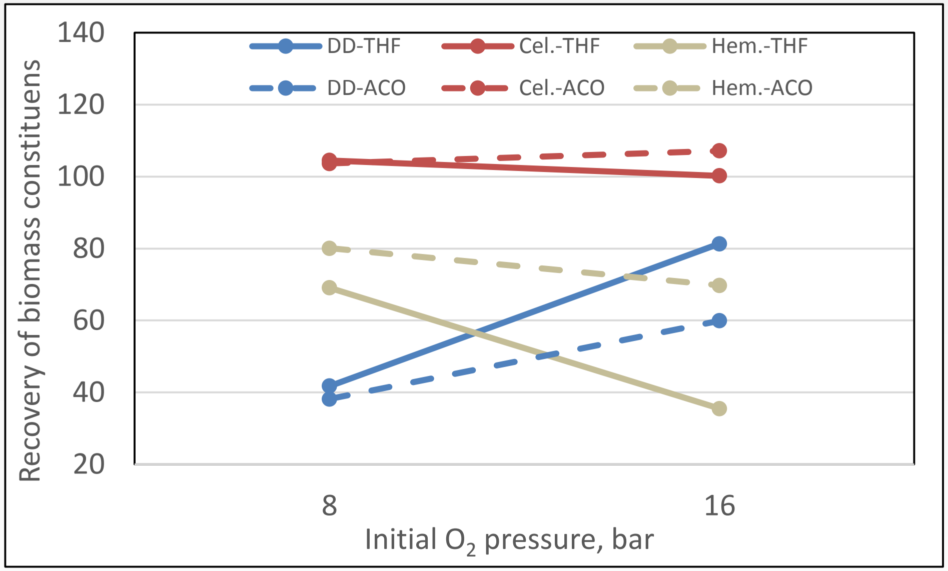
Main Parameters

- ❑ LSR=10
- ❑ Solvent wt.%=50
- ❑ 100% O_2 use
- ❑ T=150 ^oC

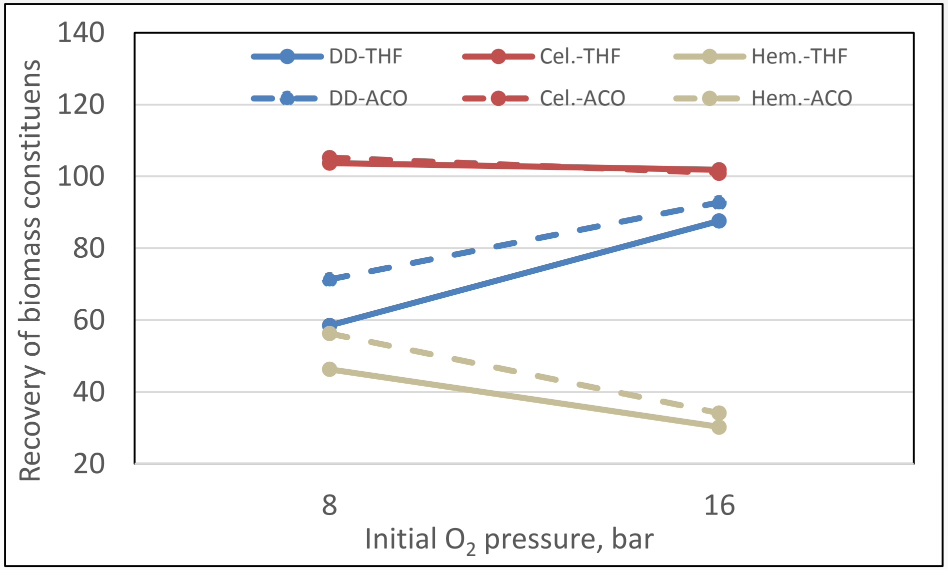
- Solvent effect is significant, Acetone and THF very efficient, EtOH does not achieve high DD at low T
- At higher reaction time, differences more pronounced
- Cellulose recovery excellent in all cases (100%)

Pressure effect

❑ T=150 °C



❑ T=160 °C



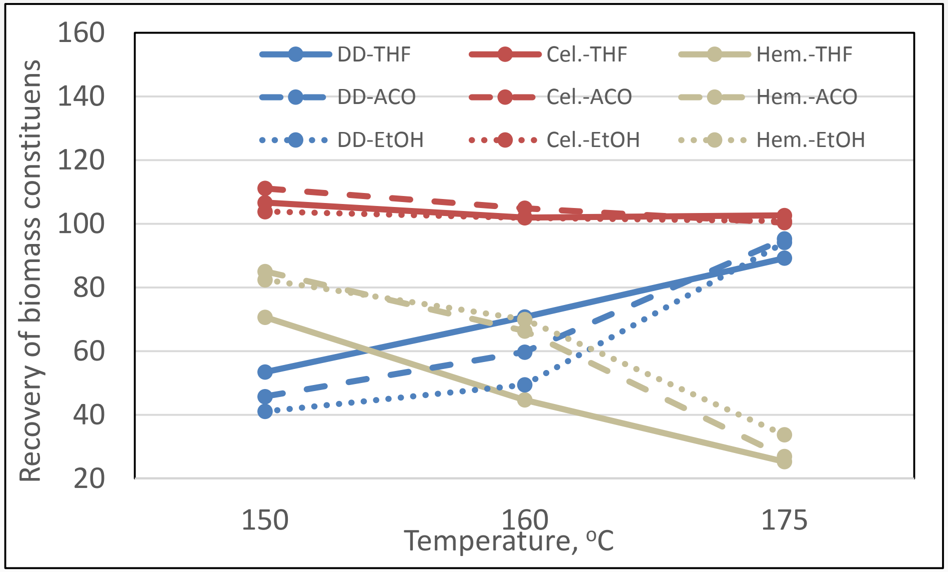
Main Parameters

- ❑ LSR=10
- ❑ Solvent wt.%=50
- ❑ 100% O_2 use
- ❑ t=120 min

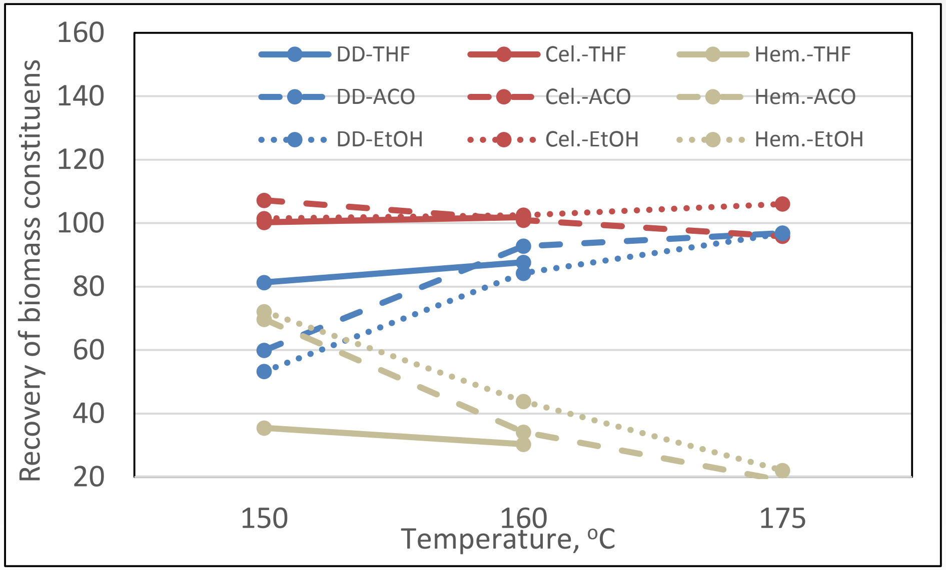
- O_2 pressure significantly affects delignification efficiency at both T, more so at 150 °C
- Hemicellulose is extracted along with lignin
- Cellulose recovery in the pulp at 100% in all cases

Temperature effect

❑ t=60 min



❑ t=120 min

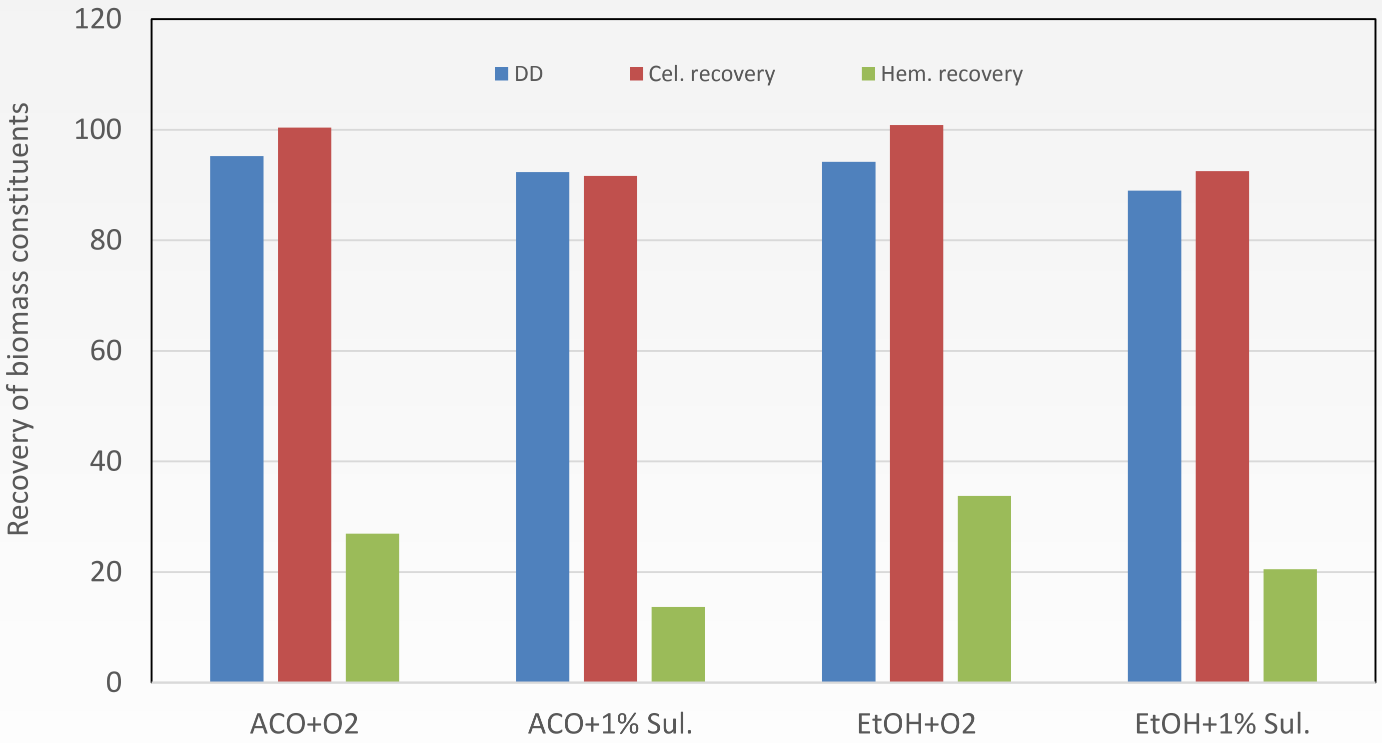


Main Parameters

- ❑ LSR=10
- ❑ 100% O_2 use
- ❑ t=60, 120 min

- Temperature has significant effect, especially at reaction time of 60 min
- 25 ºC increase resulted in doubling of DD (~46 → 95 %) at 60 min
- At 120 min even a 10 ºC increase is enough to increase DD from 60 to 92%
- Cellulose recovery at 100% regardless of T

Acidic vs Oxidative Organosolv Delignification



Main Parameters

- LSR=10
- Solvent wt.%=50
- T=175 °C
- t=60 min

- Use of O_2 instead of acids enhances delignification, up to 95% of lignin removed
- Cellulose recovery at 100% under O_2 delignification as opposed to ~92% under acidic delignification
- Hemicellulose recovery in pulp also increased with O_2 delignification due to less severe pretreatment

Conclusions

Oxidative organosolv delignification

- Use of O_2 instead of acids poses some advantages such as minimization of acidic wastes that require treatment, ease in recycling O_2
- Oxidative delignification was very efficient at removing lignin (>95% DD)
- Cellulose recovery in solid form at 100%
- Parameters effect is intertwined. Overall increase in temperature, O_2 pressure, time results in higher DD.
- Water soluble solvents such as acetone, ethanol and THF can all be efficient under different conditions.
- THF was very efficient at low T (>80% DD at 150 ^{o}C), acetone was more efficient as T increased while ethanol needed higher T to perform well.
- Produced pulps successfully fed to microalgae and LA bacteria producing FA and LA

Thank you for your attention!

kkalogia@cperi.certh.gr

http://nowastebiotech.cperi.certh.gr/

GENERAL SECRETARIAT FOR RESEARCH AND TECHNOLOGY

H.F.R.I. Hellenic Foundation for Research & Innovation

This project has received funding from the Hellenic Foundation for Research and Innovation (HFRI) and the General Secretariat for Research and Technology GSRT), under grant agreement No 1085