

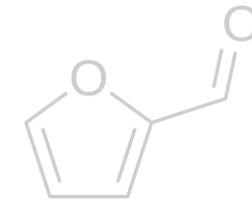
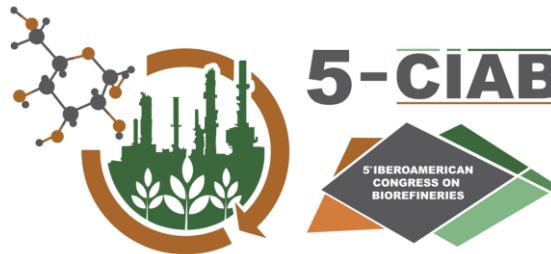
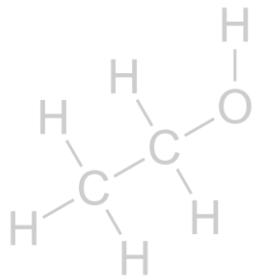


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Valorization of corn stover to obtain biochemicals by hydrothermal and membrane processes: furfural and ethanol

Candela H.^{1*}, Illera A.E.¹, Barea P.¹, Beltrán S.¹, Sanz M.T.¹



1. Introduction



42,1 % cellulose
34,5 % hemicellulose
25,7 % lignin

- ❑ Abundant agricultural by-product
- ❑ Lignocellulosic biomass

1100 million tons of corn stover in 2023

↓ Use of fossil fuels
 Sustainable processes

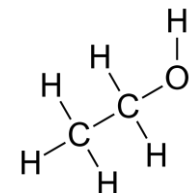
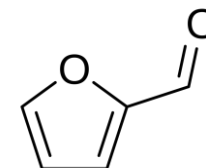
Valorization

Green technologies

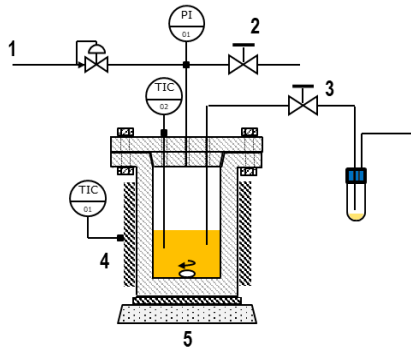
Integral approach

Furfural

Ethanol



2. Furfural production



1. Gas inlet with pressure regulator
2. Gas outlet with a purge valve
3. Sample valve
4. Ceramic heating resistance
5. Magnetic stirrer

Corn stover (5 % w/w)
 CrCl_3 (2 % w/w xylose)

180 °C 50 bar (CO_2)
 3 h V = 200 ml

Biomass hydrolysis

Break interaction between the three
 lignocellulosic components

Hydrothermal treatment: Subcritical water
 (subW)

Mild conditions (160 - 210 °C):

- **Hemicelluloses** are solubilized in **liquid fraction**
- Insoluble solid presents a high concentration of cellulose

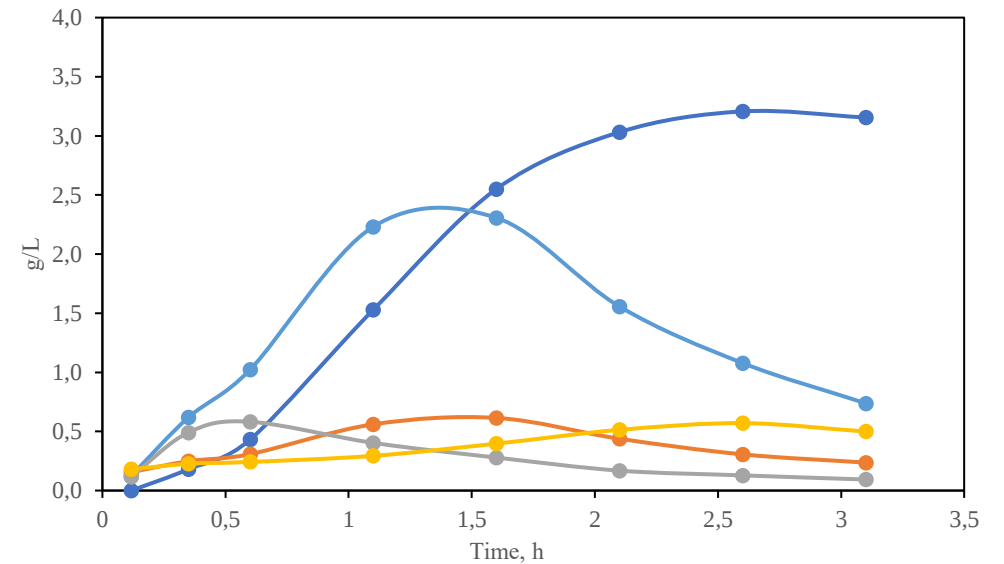
Dehydration

Pentoses → Furfural

Maximum furfural concentration = 3,2 g/L

Maximum furfural yield = 29 %

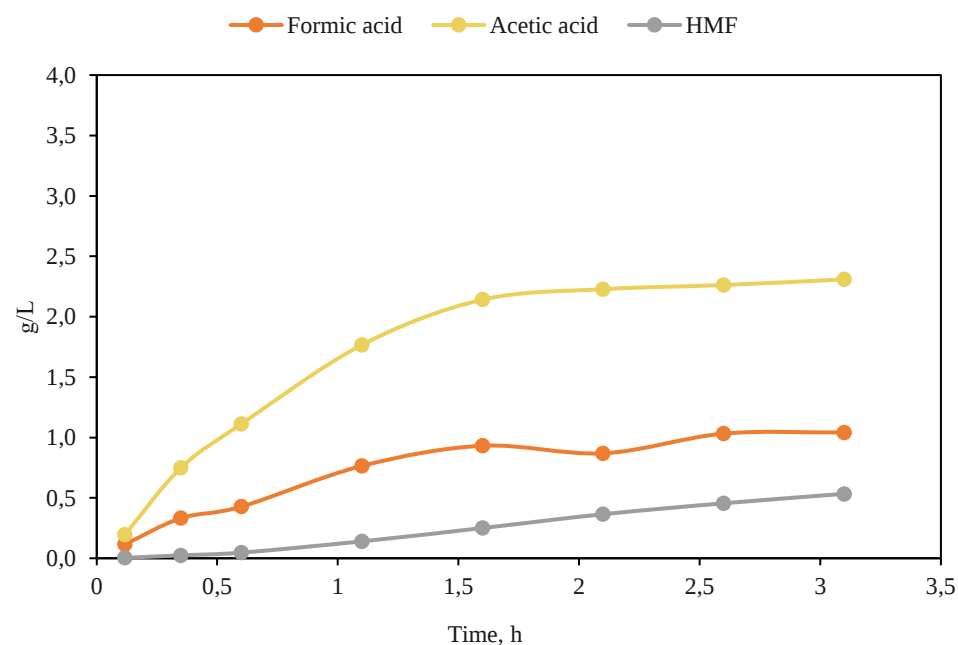
Furfural Xylose Xylulose Arabinose Glucose



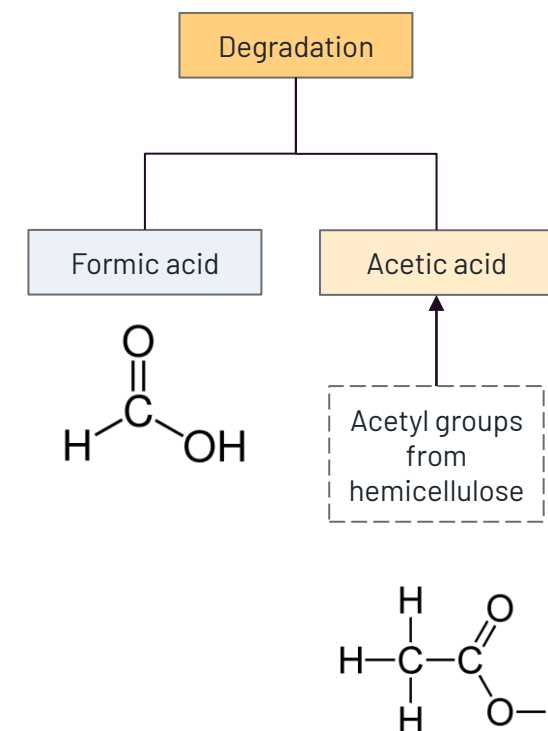
2. Furfural production

Corn stover (5 % w/w)
 CrCl₃ (2 % w/w xylose)

180 °C 50 bar (CO₂)
 3 h V = 200 ml



Hydrolysate	g/L
Xylose	0,7
Xylulose	0,2
Arabinose	0,1
Glucose	0,5
Furfural	3,2
HMF	0,5
Acetic acid	2,3
Formic acid	1,0



3. Ethanol production. Enzymatic hydrolysis

Biomass hydrolysis

Break interaction between the three lignocellulosic components

Hydrothermal treatment: Subcritical water (**subW**)

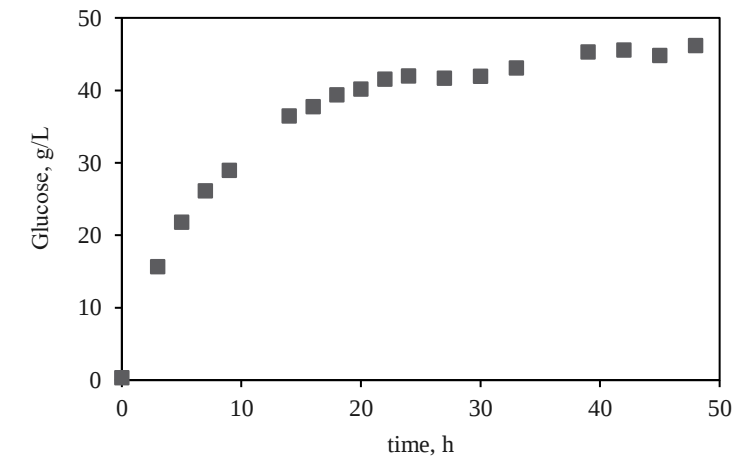
Mild conditions (160 – 210 °C) :

- Hemicelluloses are solubilized in liquid fraction
- **Insoluble solid** presents a high concentration of **cellulose**

Components	Corn stover	PLE solid residue	HE solid residue
Lignin	25,7	36,54	57,5
Soluble lignin	8,3	0,84	1,1
Insoluble lignin	17,4	35,70	56,4
Glucans	42,1	64,88	29,2
Hemicelluloses	34,5	2,31	5,4
Xylans	25,8	2,13	4,9
Arabinans	4,5	0,18	0,5
Acetyl	4,2		

PLE solid residue (8% w/w)
Celluclast 1.5L (45 FPU/g)
50 °C 48 h

[Hydrolysate]_{final}
 46 g/L glucose



Cellulose → Ethanol

- ☐ Enzymatic hydrolysis by Celluclast 1.5L
- ☐ Fermentation by Ethanol Red®

Consecutive saccharification and fermentation process

4. Ethanol production. Alcoholic fermentation

Biomass hydrolysis

Break interaction between the three
lignocellulosic components

Hydrothermal treatment: Subcritical water
(subW)

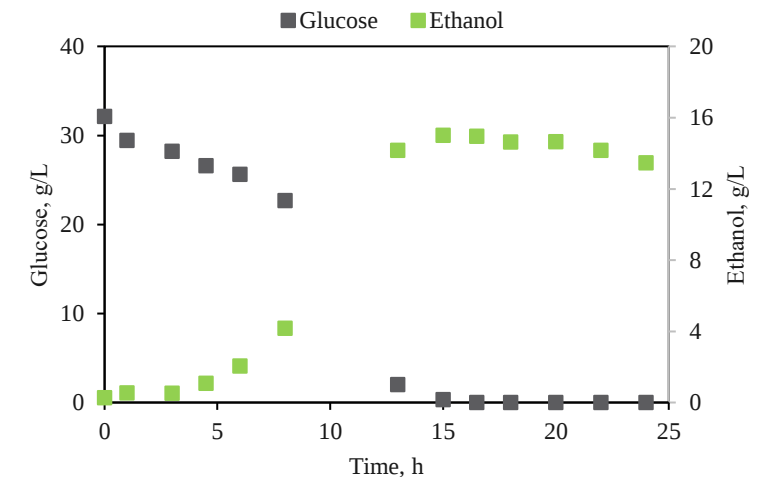
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Glucose-enriched hydrolysate
Ethanol Red®
 28 °C 24 h

[Ethanol]_{final} = 14 g/L
 Ethanol yield final = 82 %

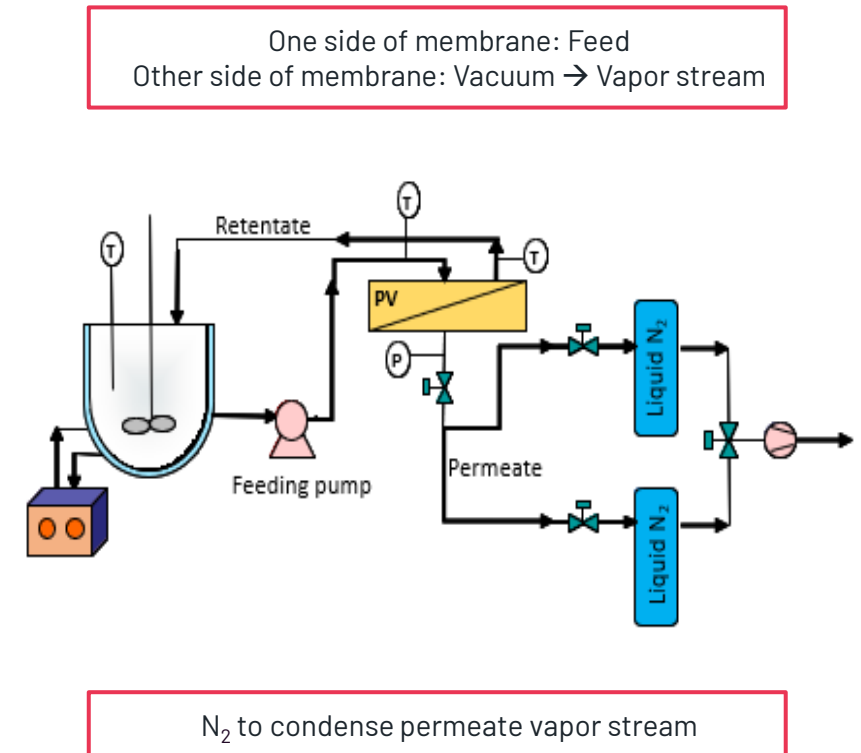
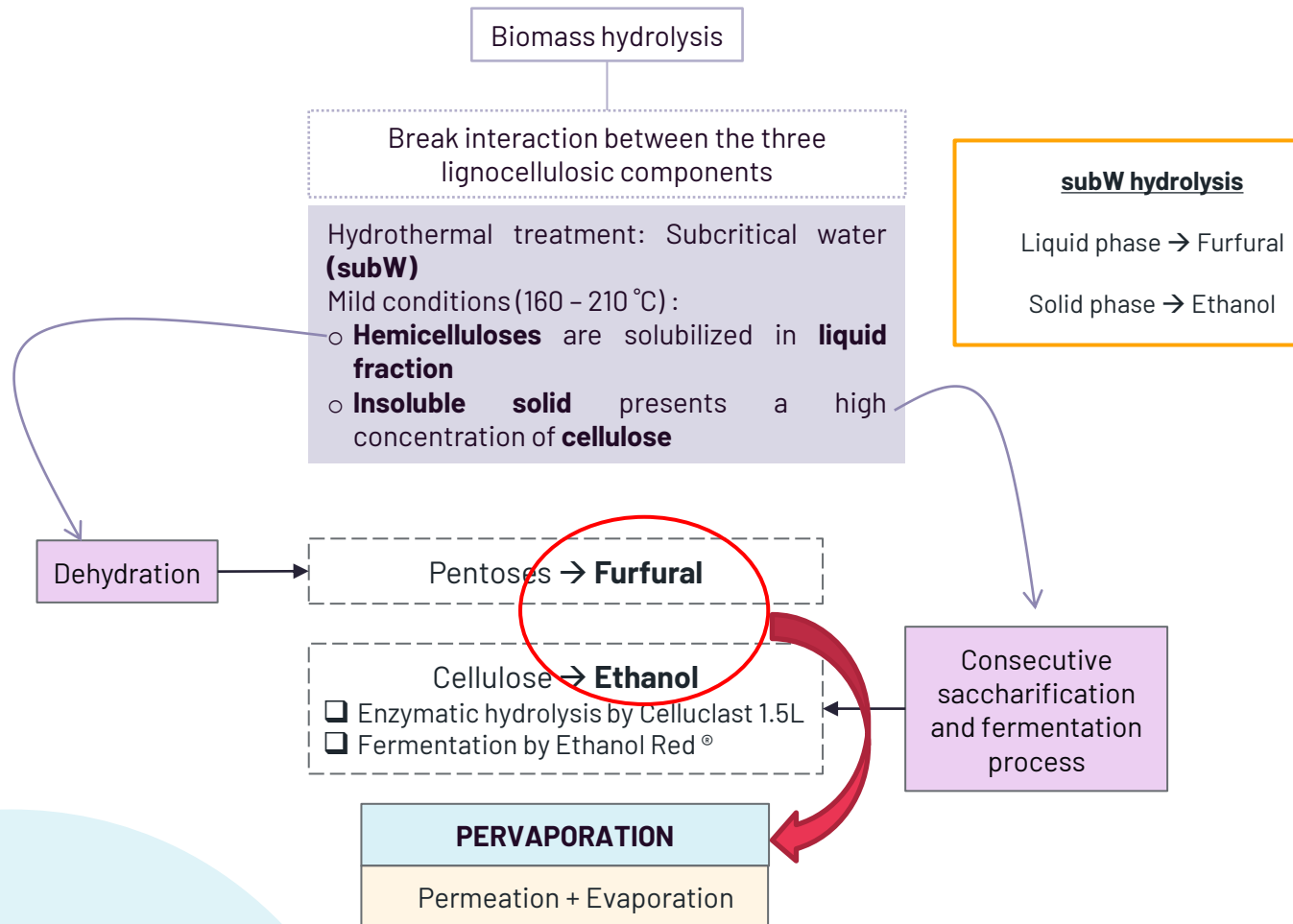


Cellulose → Ethanol

- Enzymatic hydrolysis by Celluclast 1.5L
- Fermentation by Ethanol Red®

Consecutive
saccharification
and fermentation
process

5. Chemicals recovery. Pervaporation

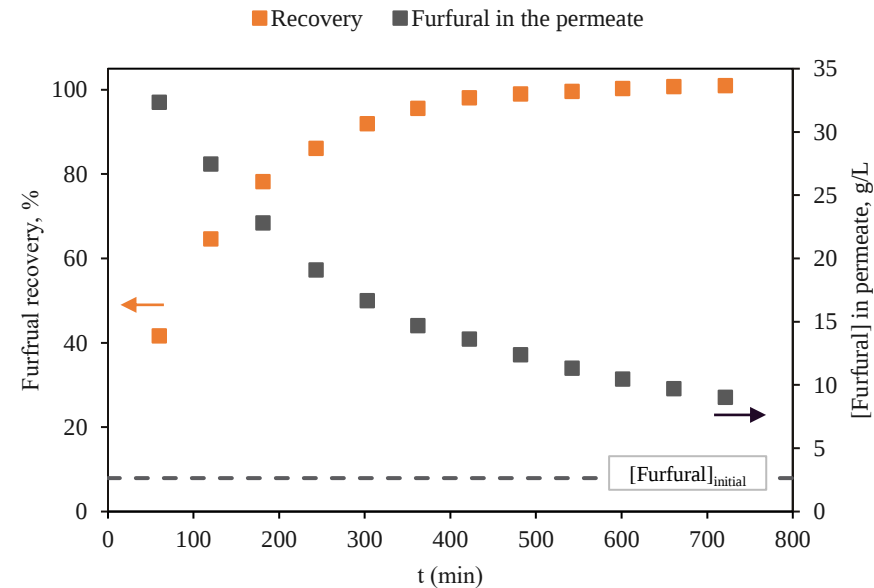


5. Chemicals recovery. Pervaporation

Hydrophobic silicone membrane at 56 °C

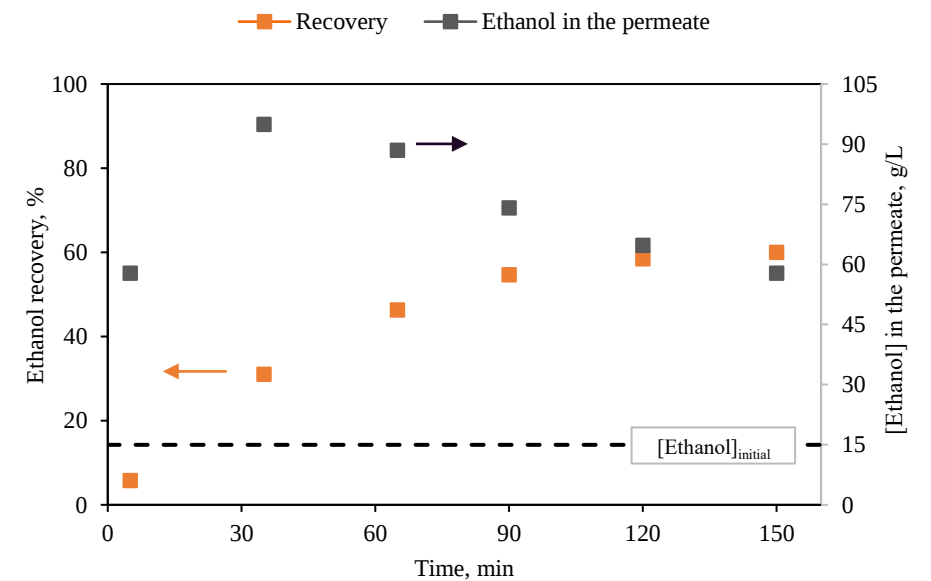
9 g/L furfural in the permeate

100 % furfural recovery



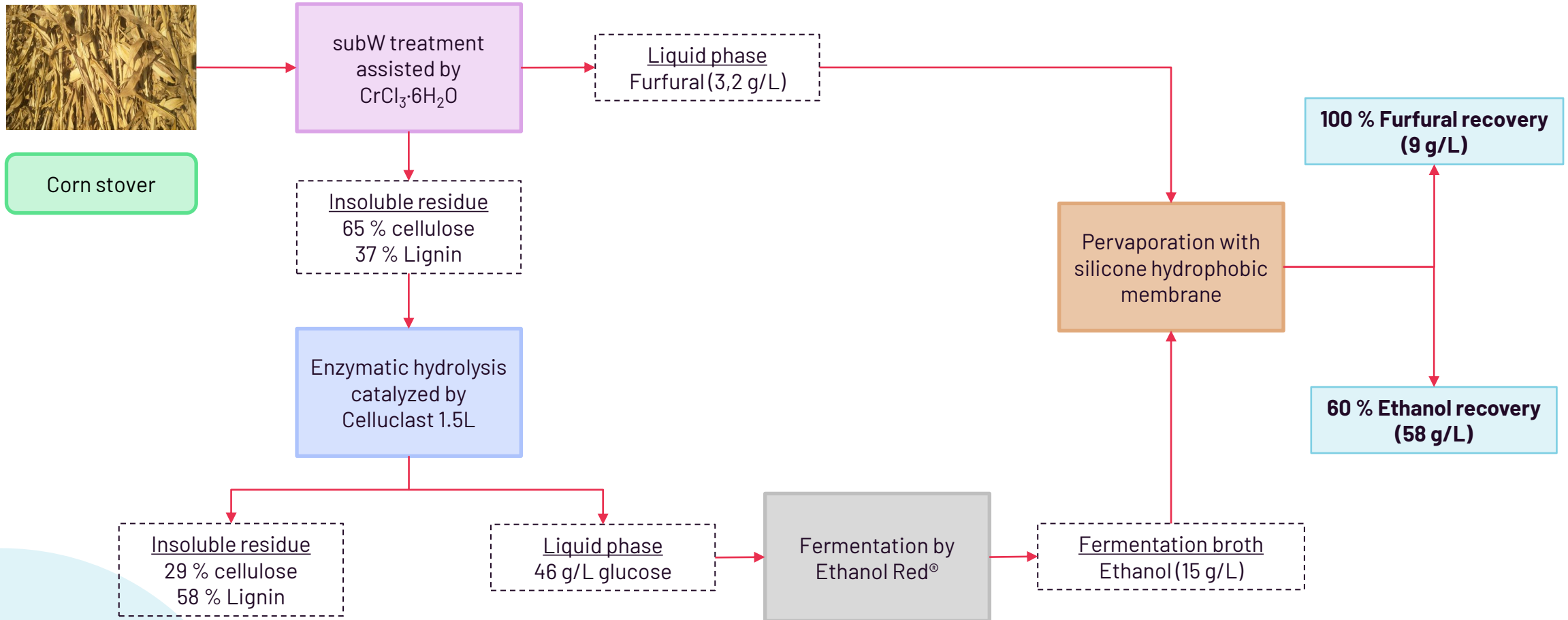
58 g/L ethanol in the permeate

60 % ethanol recovery



Processes can be stopped earlier by setting more or less strict criteria

6. Conclusions





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THANK YOU



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