Making Activated Carbon form Un-hydrolyze Biomass Residue

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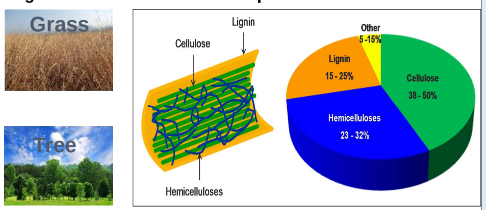
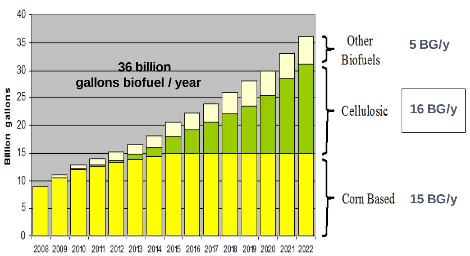
Introduction

Biomass: biological material of living, or recently living organisms.

Lignocellulosic Biomass: from plant.

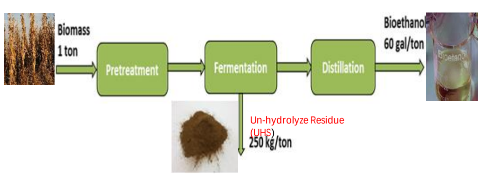


The US Energy Independence and Security Action of 2007 mandates 16 billion gallons per year of advanced biofuels production from lignocellulosic biomass.



Un-hydrolyze Residue (UHS) is from lignocellulosic biomass(corn stover) fermentation.

Possible UHS yield (in 2022) =67.2 million ton/year



Activated Carbon: use for water and air purification.

Commercial AC are made from coal and coconut shell.

Objectives

Find an efficient method of making activated carbon from UHS.

Use of high temperature chemical activation process for the conversion of UHS to activated carbon.

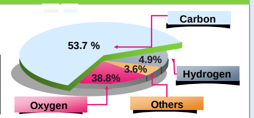
1.Optimize the process conditions to achieve the maximum surface area;

2.Use $ZnCl_2$ as activation chemicals, H_3PO_4 comparison.

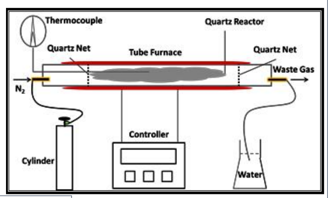
Materials and Methods

1.UHS Composition

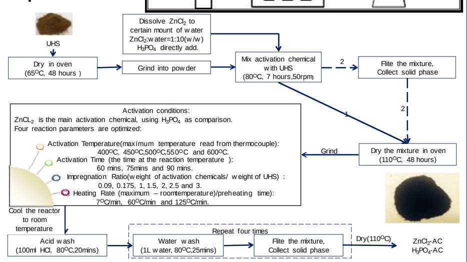
	Glucan wt%	Xylan wt%	Arabinan wt%	Lignin wt%
UHS	13.90	5.79	1.05	52.49



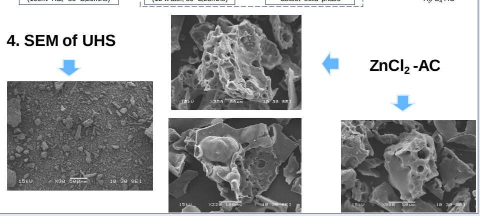
2. Reactor Setup



3.Exp. Procedure



4. SEM of UHS



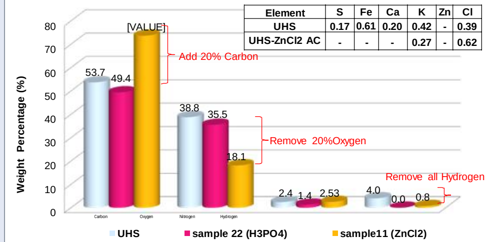
Results

1. Moisture, Ash Content , Bulk density, and particle size.

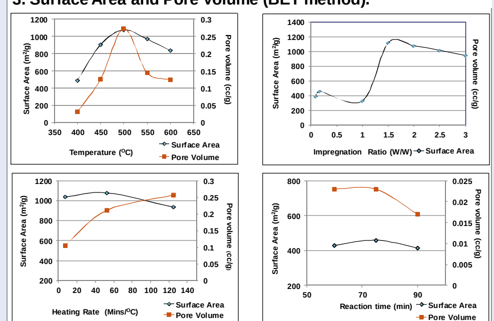
Sample	Moisture wt%	Ash wt%	Bulk Density (g/mL)	Particle size um
UHS	6.9	13.0	0.64	-
UHS-$ZnCl_2$ AC	10.6	27.6	0.21	70
UHS-H_3PO_4 AC	6.3	19.4	0.53	180

2.Element Weight Percentage(%).

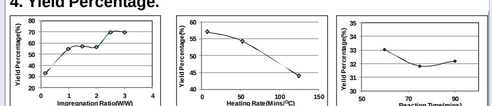
Element	S	Fe	Ca	K	Zn	Cl
UHS	0.17	0.61	0.20	0.42	-	0.39
UHS-ZnCl2 AC	-	-	-	0.27	-	0.62



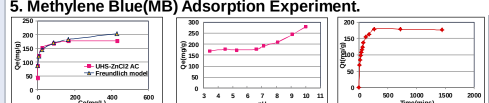
3. Surface Area and Pore Volume (BET method).



4. Yield Percentage.

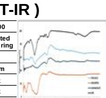


5. Methylene Blue(MB) Adsorption Experiment.

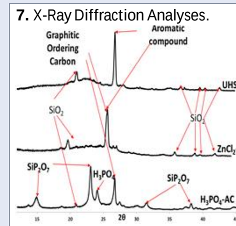


6. Fourier Transform Infrared Spectra Analyses (FT-IR)

PEAK(cm^{-1})	3300	2935	1600	1000-1300	1290	1410	1315	680 -900
Functional Group	Phenolic hydroxyl		Aromatic ring	Aromatic ring	Carboxyl	Alcoholic hydroxyl	Phenolic hydroxyl	Substituted Aromatic ring
Band	(Ar)O-H	C–H	Ar(C=C)	Ar(C-H)	C=O	O-H	(Ar)O-H	
UHS	Weak	Weak	Medium	Strong	None	Weak	Weak	Medium
UHS-H_3PO_4 AC	None	None	Medium	Strong	None	None	None	Weak
UHS-$ZnCl_2$ AC	None	None	Medium	strong	Weak	None	None	Weak
Commercial AC	None	None	Medium	strong	Medium	None	None	Weak

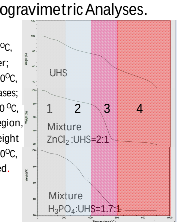


7. X-Ray Diffraction Analyses.



8. Thremogravimetric Analyses.

1. 20 °C to 180 °C, release water;
2. 180 °C to 300°C, volatile releases;
3. 400 °C to 600 °C, activation region, lose 50% weight
4. 600 °C to 900°C, ash is formed.



9. Comparison with Commercial AC.

Index	$ZnCL_2$-AC		Commercial AC		H_3PO_4-AC
Iodine No.	939.5(mg/g)	=	900-1050(mg/g)		
Methylene Blue No	191.5(mg/g)	=	135-210(mg/g)		
Surface area	1117(m^2/g)	=	800~2000(m^2/g)	>	365(m^2/g)
Yield percentage	57.1(%)	>	20~40(%)	<	82%
Ash content	27.6(%)	>	2~4(%)	<	19.4(%)
Bulb density	0.21(g/ml)	<	0.48~0.54(g/ml)	=	0.53(g/ml)
Oxygen Percentage	12~18(%)	>	3~7(%)	<	35.5(%)
Carbon Percentage	73~81(%)	<	90~94(%)	>	49.4(%)
Pore Volume	0.12(cm^3/g)	<	0.2~0.7(cm^3/g)	>	0.05(cm^3/g)

Discussion and Conclusion

1. Comparing to Commercial AC, UHS- ZnCl2 AC has similar Iodine No., Methylene Blue No., Surface area, better Yield percentage, which makes high temperature ZnCl2 activated carbon method is a possible way of utilizing un-hydrolyze biomass residue.

2. Relatively high ash content, higher bulb density, oxygen percentage and relatively lower carbon element, pore volume are the main shortage of UHS-ZnCL2AC.

3. The optimized UHS- ZnCl2 AC activation condition: co-sendiment pretreatment, activation time: 60 min impregnation ratio: 1.5 to 2; heating rate:60mins/°C; activation temperature 500°C. In the best activation conditions, surface area of UHS- ZnCl2 AC could be around 1150 m^2/g and yield percentage could reach around 57%.

4. No Znic residue in UHS- ZnCl2 AC .

Acknowledgements

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