Diluted Acid and Peroxide Pretreatments of Douglas Fir

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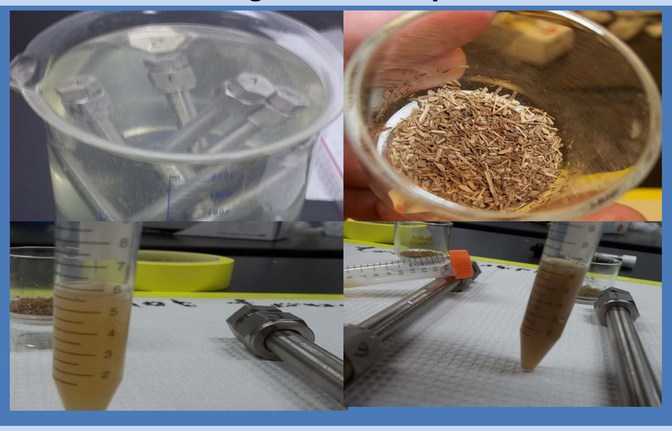
Introduction

Lignocellulosic biomass is an abundant and low cost material that can be used in the production of sugars, chemicals and biofuels. One of the most costly steps in the transformation of lignocellulosic biomass is its pretreatment. The main purpose of pretreatment is to disintegrate plant cell wall structure and make cellulose more accessible to enzymes.

Objective

Evaluate the effect of diluted acid (D.A) and peroxide (P) pretreatments over the cellulose, hemicellulose and lignin of Douglas fir (softwood) and the enzymatic hydrolysability of the resulting pretreated material.

Douglas Fir Samples



Pretreatment

The pretreatment took place in tube reactors submerged in a silicon oil bath heated at different temperatures. Table 1, shows the conditions used in both peroxide and diluted acid pretreatments.

Table 1. Diluted acid pretreatment conditions.

Pretreatment	S/L ratio	Temp. (°C)	Reagent %ODW	Time (min)
Peroxide	1/10	180, 200	0,1,2,4	30,60,90
Diluted Acid	1/10	180, 200	0,1,2,4	30,60,90

When the reaction time was reached the tube reactors were cooled down, filtrated and analyzed. Figure 1 shows the overall procedure used for a high throughput analysis of pretreated Douglas fir samples. Figure 2, shows a typical HPLC chromatogram of a pretreated sample on a Aminex HPX-87H column displaying peaks for sugars and some of the degradation compounds. Its is important to mention that as sugars are overlapping in this column, the samples were also run on a Aminex HPX-87P column were sugar peaks are spread out (see figure 3).

Enzymatic hydrolysis

Enzymatic hydrolysis was made using 0.04g ODW of pretreated Douglas fir sample and a Ctec2 enzyme at 50°C, with a pH of 4.8 (sodium acetate buffer) at 1200 RPM for 120h. During the reaction 10 ul of sample were taken at different time intervals and a glucose detection test was run.

Figure 1. Overall Experimental Set-up

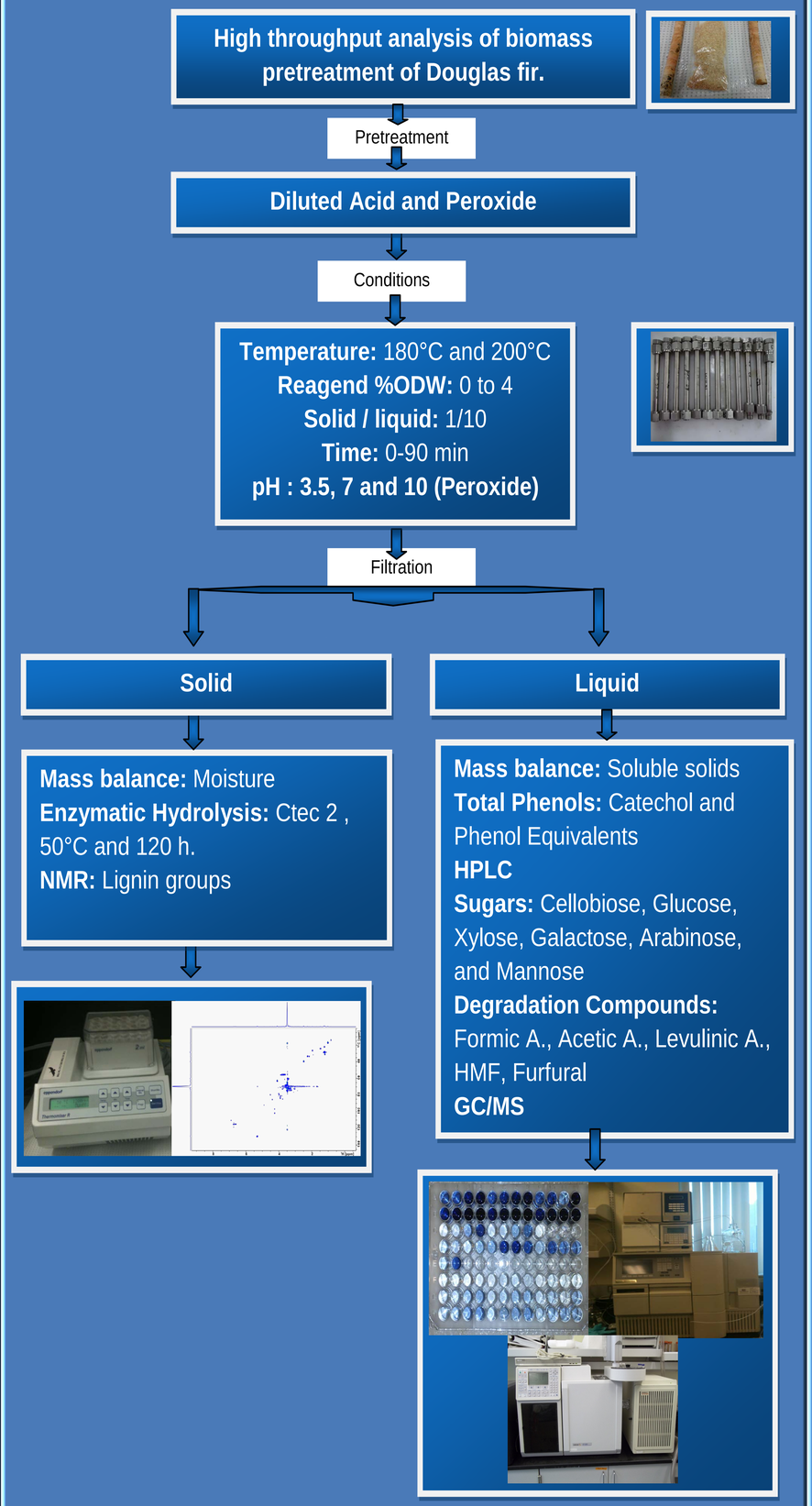


Figure 2. HPLC profile of sugars and degradation compounds on Aminex HPX-87H column.

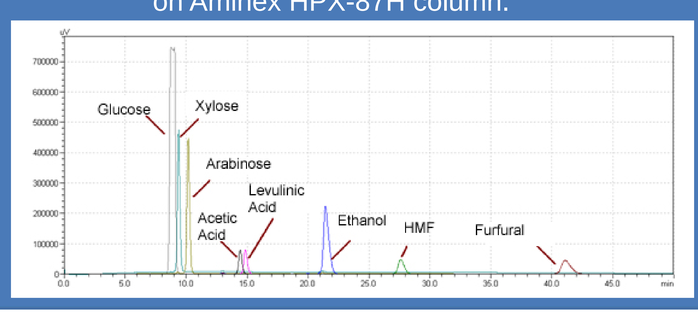
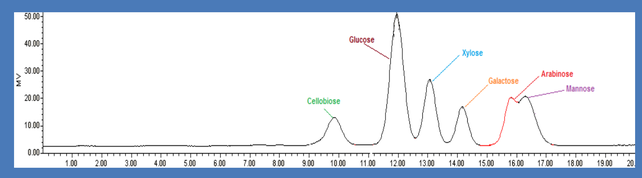


Figure 3. HPLC profile of sugars on Aminex HPX-87P column.



Total Phenols measurement

Total phenols were analyzed by the Folin-Ciocalteu reagent using a methodology previously reported (Singleton, Orthofer et al. 1999; Waterhouse 2002) . The results were reported in figures 2 and 3 as Catechol equivalents (CE or PE).

Figure 2 CE for D.A at 180°C

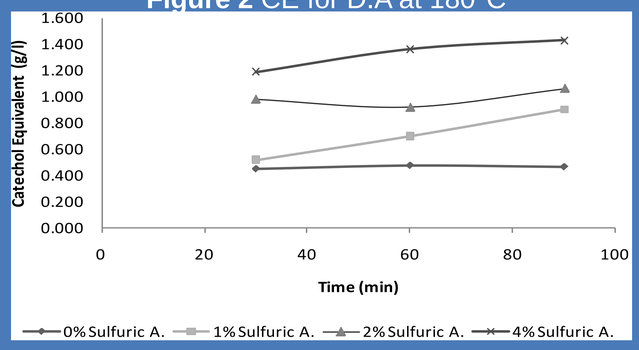
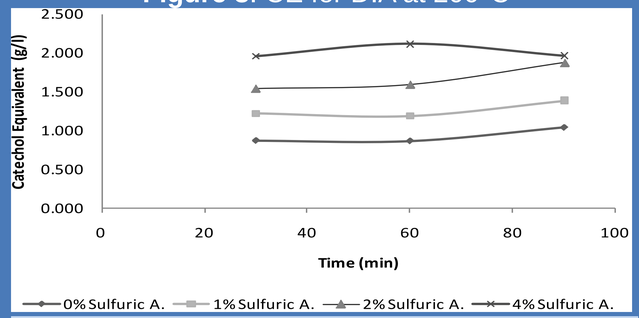


Figure 3. CE for D.A at 200°C



Conclusion

Understanding the effects of D.A. and P. pretreatments on the structure of biomass, carbohydrate recovery, and enzymatic hydrolysability of pretreated substrates can help us to optimize softwood pretreatment process to maximize the production of biofuels and biobased products.

Acknowledgement

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References

1. Boussaid, A., et al., Steam pretreatment of douglas-fir wood chips. *App. Biochem. and Biotech. 2000, 84-86 (1)*
2. Singhania, et al., Pretreatment of Douglas Fir Wood Biomass for Improving Saccharification Efficiencies. *.J. of ASTM Intern (JAI) 2010, 7 (4), 1-8.*