

**Proposal Title:**

Black liquor lignin recovery for  
biofuels and value-added chemicals

**PROJECT OBJECTIVE:**

The objective of this project is to evaluate innovative technologies for the separation and recovery of kraft lignin from black liquor and its conversion into a viable biodiesel and/or value-added chemicals. The proposed program will provide a new market for kraft lignin especially for recovery limited pulp mill operations and enhance the performance of current pulp mills.

**PROJECT BACKGROUND:**

It has been estimated that more than 25 million tons of kraft lignin are produced from alkaline pulping of wood chips annually in the US. Although kraft lignin is used primarily for fuel, two developing opportunities suggest a change in this historical relationship between lignin and black liquor combustion. First, several modern mills in North America are operating under recovery-limited capacity considerations. The ability to utilize lignin for alternative applications could facilitate increases in pulp production capacity. Second, the introduction of black liquor gasification technologies will provide enhanced thermal efficiencies thereby reducing the overall black liquor demands for power generation providing an opportunity to utilize excess lignin for value added chemicals and materials.

According to the vision established by the Biomass R&D Technical Advisory Committee, a key issue is to develop kraft lignin products for biofuels and value-added chemicals application from black liquors. Although uses for lignin products are being developed, such as vanillin, binders, bricks, ceramics; most of these lignins were liginosulfonates which are obtained from spent sulfite pulping liquors or are low-volume applications. The conversion of kraft lignin into biofuels remains an unaddressed, technological opportunity. Several publications have highlighted the potential to utilize lignin as a diesel fuel octane additive. For example, Chen has filed a patent for the use of organo-solv lignin as a fuel additive and Baldauf has examined the economic viability of employing lignin for biodiesel applications. Shabtai et al. have recently reported that depolymerized fractions of lignin can be employed as a fuel octane additive. The utilization of fragmented hydroformed lignin for gasoline as an oxygenate additive has also been highlighted in several other recent patents and publications.

**DELIVERABLES and VALUE:**

1. Evaluation of three types of treatments (filtration, extraction and magnetic separation) for separation and recovery of kraft lignin from softwood and hardwood black liquors.
2. Chemical characterization of recovered kraft lignin.
3. Energy value assessment of extracted black liquor lignin and catalytic lignin fragmentation and cracking technologies evaluation for biofuels and valued-added chemicals.

Preliminary cost/performance analysis of the program demonstrates that this program will deliver ~ 20 million dollars revenue for a typical 1000 ton/day pulp mill, after successful completion and implementation of this research program results.

**PROJECT GOALS:**

1. Separation and recovery of black liquor lignin

2. Method optimization for depolymerization/cracking lignin
3. Evaluations of the kraft lignin derivative products for biofuels and valued-added chemicals applications.

**APPROACH:**

The preliminary studies accomplished by our group have provided a sound technical basis from which this program will succeed. In brief, black liquors will be taken from commercial continuous and batch SW and HW kraft pulping processes and subject to different separation technologies to recover kraft lignin. The kraft lignin will be subject to chemical treatment to produce lignin derivatives which will then be examined for biofuel and value-added chemicals applications.