Oxygen Soda AQ (OSA) Pulping

GT Project Staff:

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PROJECT OBJECTIVE:

Develop and demonstrate fundamental principles for the production of chemical pulps that will significantly reduce capital and operating costs; while maintaining, or improving desirable fiber characteristics, while eliminating kraft pulping odors. The focus will be on sulfur free Oxygen Soda AQ (OSA) pulping.

The outcome of this program will be the development of fundamental principles for an integrated, new chemical pulping technology that will achieve a 50% reduction in manufacturing and capital costs associated with the sulfur free pulping and chemical recovery system. As such, this program will address the New Cost Platform research objectives, described in the Industry Technology Agenda summit minutes and IPST@GT's strategic vision.

PROJECT BACKGROUND:

Catalyzed soda pulping has continued to be of interest for the last two decades, in-light of the well-established pulping benefits of AQ-pulping catalysts. The addition of low-levels of AQ to a cook increases pulping rates, provides higher pulp yields by stabilizing carbohydrates toward degradation, and reduces chemical recovery bottlenecks.[1] An AQ-catalyzed soda process would have additional benefits by reducing mill odors, simplifying the recovery process, producing a brighter pulp, and allowing for simplified gasification technology to be utilized for recovery. On the other hand, the soda-anthraquinone process has well-known drawbacks, including the historical cost of AQ and the production of pulp with lower tear strength.[2] These drawbacks account for the limited implementation of soda-AQ pulping to a few hardwood pulp mills.

The financial considerations for AQ pulping technologies have been improved over the past decade. First, the cost of AQ has decreased substantially over the past few years, as the AQ pulping patents have lapsed, new inexpensive off-shore AQ production facilities have been established, and several new AQ derivatives have been reported in the literature that exhibit improved activity.[3] In addition, wood costs are projected to increase in North America, thereby increasing the value of pulping technologies that can improve overall pulp yields.

Furthermore, only a portion of the tear deficiency in soda-AQ pulps can be attributed to greater retention of hemicelluloses. The remainder is due to the fact that conventional soda-AQ pulping requires high alkali concentrations, which cause cellulose chain cleavage reactions that are detrimental to tear strength.[4] A process that avoids high caustic concentrations, while retaining the ability to pulp to low kappa numbers, is well expected to yield stronger pulps. Early studies of soda pulping showed that limiting the alkali concentration to 20 g/l Na_2O during the cook resulted in higher viscosity.[5]

Advanced kraft pulping principles over the last few decades have incorporated the use of liquor profiling in continuous kraft delignification systems. These modern pulping systems with concentration profiling level out the active alkali profiles, reduced cooking temperatures, and the displacement of spent liquor. These principles may be expected to apply equally well to soda/AQ pulping. At a lower temperature, a soda-AQ pulping system with proper alkali profiling is anticipated to result in less fiber damage than a conventional soda-AQ system. In addition, liquor displacement may provide a convenient means of recycling the pulping catalyst and allow for the introduction of oxygen into the end of cooking stage. The addition of oxygen in the beginning and end stages of pulping would allow for the integration of chemical pulping/oxygen delignification into one stage. Recent studies support the basic premise of this proposal, but additional engineering/process chemistry studies are required to demonstrate the true value of this concept.[6]

The premise underlying this proposal is that oxygen/soda/AQ pulping delignification will provide a viable alternative to the kraft process, provided that the catalyst cost is low, process savings can be documented, and pulp properties are improved. Recent reductions in AQ cost, higher-wood costs, and an enhanced extended oxygen delignification knowledge and capability appear to dramatically enhance the viability of this overall process.

DELIVERABLES:

First Quarter -	Provide members a detailed literature survey of state-of-art of oxygen Soda AQ pulping; Establish the yield reproducibility of Oxygen Soda AQ pulping;
Second Quarter -	Identify optimal process conditions for Oxygen Soda AQ pulping (OSA) with fixed AQ charge (0.20%) to maximize pulp yield
Third Quarter -	Optimize the AQ/Soda levels for tear improvement in PSA
Forth Quarter -	Develop extended OSA delignification via O2 injection at the beginning and end of cooking

VALUE OF DELIVERABLES:

The proposed new pulping processes will provide a lower capital/operating cost process for chemical pulping while providing improved pulp properties. In addition, this new pulping process will be a low odor pulping technology that will simplify chemical recovery via a direct, inexpensive, gasifier chemical recovery system. The proposed pulping process is anticipated to have a yield advantage of about 3%, avoid the need for an O or OO-stage, and reduce chemical recovery costs. The projected overall chemical, energy, and bleaching stage savings are anticipated to range from $30-60/ton.

PROJECT GOALS:

The goal of this project is to evaluate the possibility of replacing Kraft pulping by an innovative profiled Oxygen Soda/AQ pulping technology that utilizes AQ at the beginning of the cook and oxygen injection near the end of cooking. This process will be sulfur/odor free; therefore, facilitating a low-cost gasification process and eliminating the need for O or OO stages. It is anticipated that the Oxygen Soda/AQ Catalytic (OSA) pulping process will address the historical issues associated with low tear properties of a conventional Soda-AQ cook.

APPROACH:

The proposed pulping studies will be conducted with profiled liquor concentration and liquor displacement rates. For this, one year program pulping studies will be accomplished primarily with southern Loblolly pine woodchips. Target pulp kappa numbers will include lignin contents of kappa 25, 35, (bleachable grades) and 75 (linerboard). Process parameters to be examined include: AQ application levels and alkali levels, time, temperature, liquor displacement, and oxygen enrichment levels. The soda/catalyst cooks will be optimized for maximum delignification, yield, and pulp strength. We will examine the use of high catalyst and different alkali levels in an earlier stage, followed by very little catalyst and higher amounts of alkali in a subsequent stage. Oxygen Soda AQ pulps will be compared to appropriate kraft controls. The yield advantage associated with pulping and oxygen enrichment in the latter stages of pulping will also be investigated.

Cooking liquors will be analyzed for catalyst, lignin, and alkali levels. Recycling liquor from various stages of one cook to another will be investigated. Pulp bleachability is an important parameter in assessing the value a new pulping process. In this study, a limited number OSA pulps will be evaluated via a D(EOP)D sequence to a final brightness of 87. We will assess bleach chemical consumption and the strengths of the resulting pulps. Upon completion of the laboratory studies, the researchers will integrate the laboratory findings in a mill simulation study to assess overall impact of the new process on a modern chemical pulps mill.

STATUS OF INTELLECTUAL PROPERTY:

IPST@GT has an extensive history of research and development in AQ-pulping technologies (see U.S. Patent 6,156,155 (2000)). The wood chemistry group at IPST@GT has studied and reported several research issues concerning AQ-pulping catalyst chemistry, nature of residual lignin; process optimization and bleachability of kraft-AQ pulps and conventional soda-AQ pulps. The authors are well versed in the current state-of-the-art for soda/AQ pulping research and practice, and will provide program sponsors a detailed literature review within the first 3 months of funding.

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