CHEMISTRY OF AN OXIDATIVE ALKALINE EXTRACTION BETWEEN CHLORINE DIOXIDE STAGES

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Abstract: Environmental concerns have prompted many pulp mills to change from chlorine-based bleaching to elemental chlorine free (ECF) bleaching. A vital portion of the ECF sequence is the first oxidative alkaline extraction stage (E1). This research furthered the understanding of this stage by studying its effects on lignin structure. Five specific types of alkaline extraction stages were studied including 1) a stage free of ambient oxygen; 2) a conventional extraction stage; 3) an O_2 reinforced stage; 4) a H_2O_2 reinforced stage; and 5) an O_2 and H_2O_2 reinforced stage.

Chemically pulped wood produced from a single softwood tree was treated in a DED bleach sequence, varying the oxidant reinforcement in the E1 stage. The resulting bleached pulps and effluents were characterized for delignification, selectivity, brightness, and other properties. Lignins were isolated from the remaining pulps and effluents and characterized via liquid chromatography, visible spectrophotometry, and nuclear magnetic resonance techniques. The pulp characterization results indicated that considerable lignin modification occur during oxidative alkaline extraction stages. Delignification and brightness increased with oxidant reinforcement, as expected. Oxidant reinforcement also slightly decreased adsorbable organic halide content and increased carbohydrate degradation. Lignin visible absorption studies indicated the bleached pulp brightness changes correlated well with color differences between the isolated lignins. Chromatography studies indicated that the dissolved lignins were degraded by oxidant reinforcement, which represents a loss of oxidant. Further experimentation indicated only small amounts of oxidant are consumed reacting with dissolved lignin.

NMR results indicated that several major functional group changes had occurred in the lignin during the oxidative alkaline extraction. These included increases in lignin carboxyl group content, attributed to muconic acid methyl ester saponification; decreases in phenolic group content in O_2 reinforced stages, attributed to autoxidation reactions; and decreases in the content of quinone structures with H_2O_2 reinforced stages, attributed to perhydroxyl addition reactions. Interestingly, even though the quinone content de-creased, the alkyl carbonyl content was unaffected by the oxidative E1 stages. Other functional groups that were modified in the various bleach stages include methoxyl, formyl, aliphatic hydroxyl, and various aromatic substituents. Generally, the NMR results corroborated theorized reactions from literature model compound studies.