0273-2289/98/70–72—0937$8.50

Session 6

Biotechnology in the Pulp and Paper Industry

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One of the areas of biotechnology that has been rapidly expanding is its application in the pulp and paper sector. Many of the microorganisms, enzymes and approaches that have been used to try to completely breakdown lignocellulosic substrates to fermentable sugars have found a related application in fiber modification. For example, combinations of cellulase enzymes used at low concentrations can produce desirable pulp characteristics such as enhanced dewatering or better inter-fiber bonding while leading to very little yield loss. Other enzyme applications in the pulp and paper sector include pitch removal, deinking, reduced fiber coarseness, and biobleaching. Many of these areas have moved rapidly from initial laboratory observation to full scale commercial application. For example, Finnish researchers in 1986 first showed that xylanase treatment of kraft pulps could significantly decrease the bleaching chemicals required to reach a target brightness. A little more than ten years later, many pulp mills routinely operate with an enzyme step in their bleaching sequence to both reduce the level of pollutants in the waste water stream and reduce chemical costs. In the session describing advances in biotechnology in the pulp and paper sector a range of topics were covered. It was shown how classical mutation, selection and the addition of molecular biology have allowed enzyme companies to produce "tailored" xylanases which can operate at elevated temperatures and pH. More fundamental studies described how xylanases could be divided into two major "families" based on their protein sequence and secondary structure. Further subgrouping based on the pI of the enzyme indicated how enzymes with alkaline pI's have a greater affinity for xylan substituted with uronic acid side chains which normally impede xylanase activity. Thus a combination of very fundamental and commercial work has allowed rapid implementation of enzymes while improving the

properties of the enzyme at the same time. Other enzymes with potential roles in the bleaching of wood pulp were also described. These include laccases plus redox mediations, cellobiose dehydrogenase (CDH) and manganese peroxidase (MnP).

The mechanism of cellulase action continues to receive considerable attention with the availability of individual, cloned enzymes allowing synergistic studies to be revisited while direct commercial application of these "cellulase cocktails" growing in areas such as "biostoning" of denim jeans. "biopolishing" of dyed cotton fabric and other textile, detergent and food/feed applications.

It is likely that many of the biotechnology applications that might be used in the bioconversion area will first find a related use in the pulp and paper area. This is partly because of the need to find more cost effective, less environmentally polluting ways of producing pulp and paper. However, the main driver is that enzymes will help produce a cellulose based product that usually sells for more than $600 a tonne. Thus the large scale application of enzymes in the processing of biomass will likely be pioneered in the pulp and paper sector with much of the low value fiber then available for bioconversion into other products such as ethanol.