SUMMARY

Pulp and paper industry is the foundation of literate society but is also the main cause of environmental pollution. Biotechnology is emerging as a major substitute to traditional process as it exert little pressure on the environment when compared to others. In the recent past, the pulp and paper industry is also exploiting this unique process to reduce the environmental impact of the polluting effluents. For the manufacture of paper and paper board, wood is generally used to make pulp. More then 90% of the total annual production of pulp is obtained by Kraft pulping. The pulping treatment removes majority of lignin which imparts dark brown colour to the Kraft pulp. These are removed by multistage chlorine based bleaching processes which increase the brightness of the pulp to marketable grades but produce highly coloured toxin chlorinated phenols and dioxins in the waste bleach waters which are resistant to degradation. Chlorine is the cheapest and most versatile bleaching agent for pulp but at increasing environmental cost.

In response to great pressure from environmental groups and new Government regulations for emissions of organo-chlorine concentrations in bleachery effluents, the pulp and paper industry is investigating a variety of reduced chlorine and chlorine-free sequences. Amongst the various alternatives, the pretreatment of pulps with cellulase free hemicellulases enzyme especially xylanases facilitate bleaching, showing its potential to reduce the consumption of chlorine in subsequent chlorine bleach processes.

In the Kraft pulp, hemicellulose acts as a cementing material between lignin and cellulose. Partial and selective hydrolysis of hemicellulose by xylanases hydrolyse the bonding between lignin and cellulose. In turn, this
xylanases at 6g/L xylan as a substrate and optimum temperature was 45°C at pH 6.0.

The enzymes produced by both the species possess little or no cellulase activity and the enzyme has great potential for its application in pulp and paper industry. During fermentation, the yeast extract is required by the fungus in limited amount and is probably utilized only in early stages of the growth. It was interesting note that A. fumigatus yielded the similar activity of the enzyme even in the total absence of yeast extract. Amongst various substrates, it was found that wheat bran is most suitable and cheap substrate to replace more expensive substrates for production of xylanases. On the optimization of wheat bran concentration in LSF, the highest xylanase activity was produced at 20g/L substrate (1.84 ± 0.02 IU/mL) at pH 6.0, 45°C temperature. The enzyme activity in A. nidulans was 4 times more than that of A. fumigatus (8.30 ± 0.04 IU/mL) in LSF. When the enzyme activities of LSF were compared with that of SSF, it is evident that the enzyme produced under SSF is more than 4 times, than that of LSF, in both the species.

The enzyme preparation of A. fumigatus can best be used at 55°C while that of A. nidulans at 60°C temperature. At pH 6.0 the enzyme preparation of A. fumigatus showed maximum xylanase activity while for A. nidulans, it was pH 7.0. To further enhance the xylanase activity the experiments were set up of fed batch fermentation. On optimization of substrates, temperature and pH for the production of xylanases by A. nidulans in fed-batch culture the optimum temperature was found 45°C at pH 6.0 and at 20g/L. wheat bran as substrate.

The enzyme preparation of A. nidulans showed optimum activity at pH 7.0, 60°C temperature. This enzyme preparation is not highly stable at high
temperature for longer periods. It decreased and was 30% after 90 min and 50% after 120 min.

For the xylanase pretreatment of pulps, pulp consistencies in the range of 1-10% without optimizing the bleach boosting effect of the enzyme preparation have been used and highest yield of reducing sugar released by 10 IU/g pulp at 5% pulp consistency. During alkaline based pulping, xylan is dissolved and redeposited on the surface of the cellulose fibres. Thus initial release of reducing sugar would be due to xylanolytic attach. This endogenous attack would result in a decrease in the degree of polymerization of the surface xylan resulting in an increase in permeability to bleaching agents and improved extraction of residual lignin and lignocarbohydrate of the enzyme treatment was found on paper properties of the fibres.

After spectrophotometric analysis of treated pulp filtrates, it was found that chromophoric material was released as a result of enzyme action. Treatments with Aspergillus nidulans xylanase preparation reduced the Kappa number and accordingly increased the brightness of pulps subjected to the conventional CEHH bleach sequence at 4% chlorine charge. Untreated pulps subjected to the CEHH sequence at 6% chlorine charge were found to have brightness (ISO) value 73.3 ± 0.2 indicates that even at the lowest enzyme dose, equivalent brightness can be obtained with 20% reduction in the amount of chlorine required.

After TLC analysis, the products were identified as xylose, xylobiose, xylotriose and little amounts of xylotetrose. It suggests that the enzyme preparations have multiple isoforms of different xylanases which act on different bonds of xylan and release of xylooligomers. The enzyme preparations of A. nidulans had no cellulase activity. No detection of