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ENZYMATIC MODIFICATION OF WOODY CELL WALLS FOR IMPROVED STABILITY OF PULP FIBRES

BY

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Declaration

I, the undersigned, declare that the thesis, which I hereby submit for the degree of Doctor of philosophy at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

…………….....
Grethe Strey
Signed in Pretoria on September 2009

AL WAT STAAN TUSSEN 'N MENS EN WAT
HY UIT DIE LEWE WIL HÊ, IS DIKWILS DIE **WIL**
OM TE PROBEER EN DIE **GELOOF** OM TE
GLO DIT IS MOONTLIK.

RICHARD M DEVOS

TO MY SAVIOUR

WHO GAVE ME THE ABILITY,

FAMILY AND FRIENDS

TO HELP ME REACH A DREAM

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SUMMARY

ENZYMATIC TREATMENT OF WOODY CELL WALLS FOR IMPROVED STABILTY OF PULP FIBRES

by

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The bonding of fibres in paper is influenced by environmental changes (e.g. moisture) that may cause unstable fibres to move. These movements include cell-wall swelling, fibre lifting and/or puffing that break inter-fibre bonds and lead to reduced strength and surface roughness. Fibre puffing is defined as the expansion of the lumen area as result of changes in the environment.

Puffing was investigated through image analysis of scanning electron micrographs. Detailed images were obtained with samples that were embedded in resin and then etched. Puffing of fibres was then quantified by calculating the ratio of lumen area to fibre area. Stability of softwood and hardwood fibres was studied in this way, and to simulate printing, handsheets were calendered and rewetted. This method was later validated against commercial sheets. Compared to softwood, hardwood fibres were more stable and most of the handsheet properties were retained after rewetting. Mannanase and/or endoglucanase treatments resulted in improved fibre stability by increasing fibre bonding, fibrillation or fibre collapse.

Mannanase improved handsheet smoothness and strength as well as fibre stability, but endoglucanase was less effective. The effect of the enzymes was more difficult to observe on hardwood fibres, because even untreated fibres were more stable under moist conditions. Thin-walled fibres such as earlywood were less stable than latewood fibres, but it responded better to mannanase treatment. Thick-walled fibres (latewood), on the other hand, were more difficult to improve with enzymes.

The potential of enzymes to improve fibre stability of commercial pulp was tested on chemi-thermo-mechanical pulp (CTMP) and bleached CTMP. Enzyme treatment improved fibrillation and reduced beating energy of bleached CTMP. Mannanase again resulted in the most improved fibre stability. On rejects, a lack of response to enzymes was overcome by pre-treating the pulp with alkaline peroxide.

This study provided new insights into the stability of fibres with different morphology. It was also demonstrated that fibre stability can be improved with enzyme treatment and it is expected that this knowledge could have significant commercial value.