

Treatment of recycled fiber with *Trichoderma* cellulases

Recycled paper

Recycling of waste paper fibers can reduce the consumption of chemicals, water and energy and also the produced waste in large-scale.

In the recycling process the refining gives the pulp greater strength, but also enlarges the amount of fines that lowers the rate of drainage.

Advantageous of improved drainage:

- the paper machine could be operated at a faster rate that improves productivity,
- a greater dilution could be used in the headbox of the paper machine that allows better sheet formation,
- by adding enzymes to the pulp before the refining the power consumption of the refiner could be lowered,
- in case of same power consumption the refining rate could be improved, which gives better strength properties to the end product, or allow us to use poor quality raw materials.

The aim

Of our work is to compare the efficiency of two commercial enzymes (Pergalase A40 and IndiAge Super L) under industrial conditions on recycled pulp drainage.

Cellulase enzymes

The cellulase components are classified on the basis of their mode of action. Cellulase enzyme system contains cellobiohydrolases, endoglucanases and β -D-glucosidases.

Endoglucanases randomly attack the amorphous regions of cellulose substrate, yielding mainly higher oligomers.

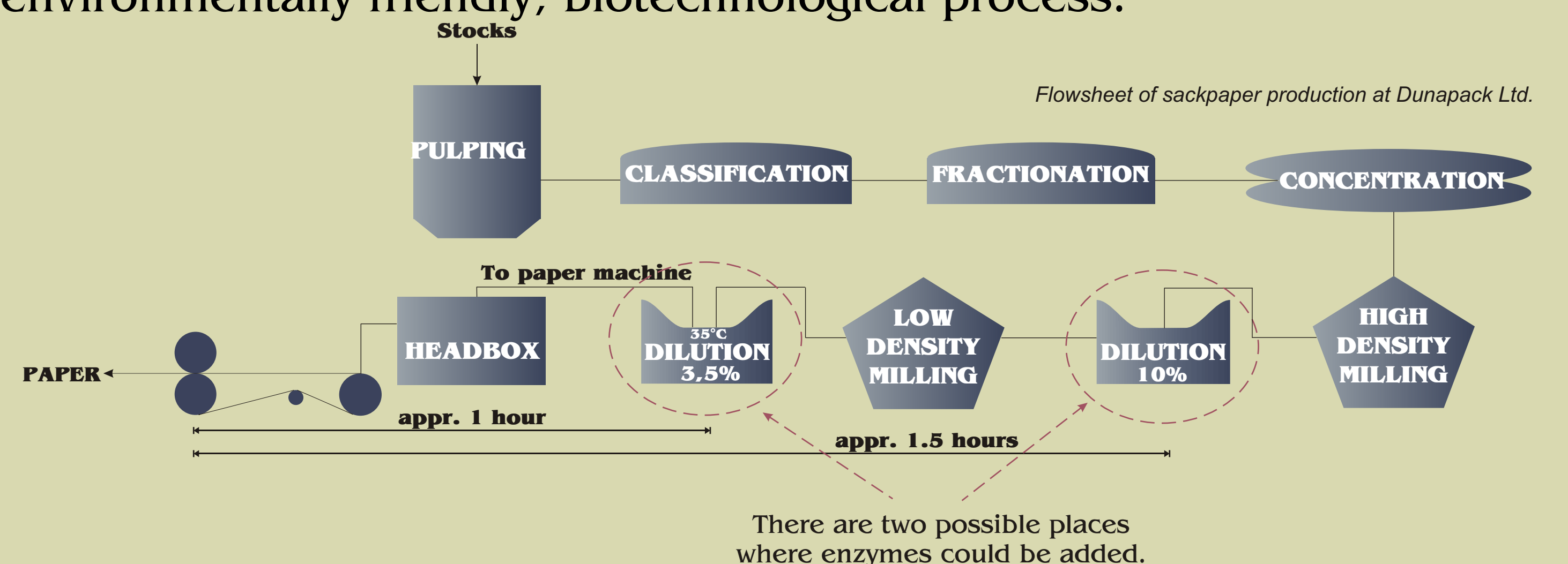
Cellobiohydrolases are exoenzymes and hydrolyze crystalline cellulose, release cellobiose (glucose dimer).

Both types of enzymes hydrolyze β -1,4-glycosidic bonds.

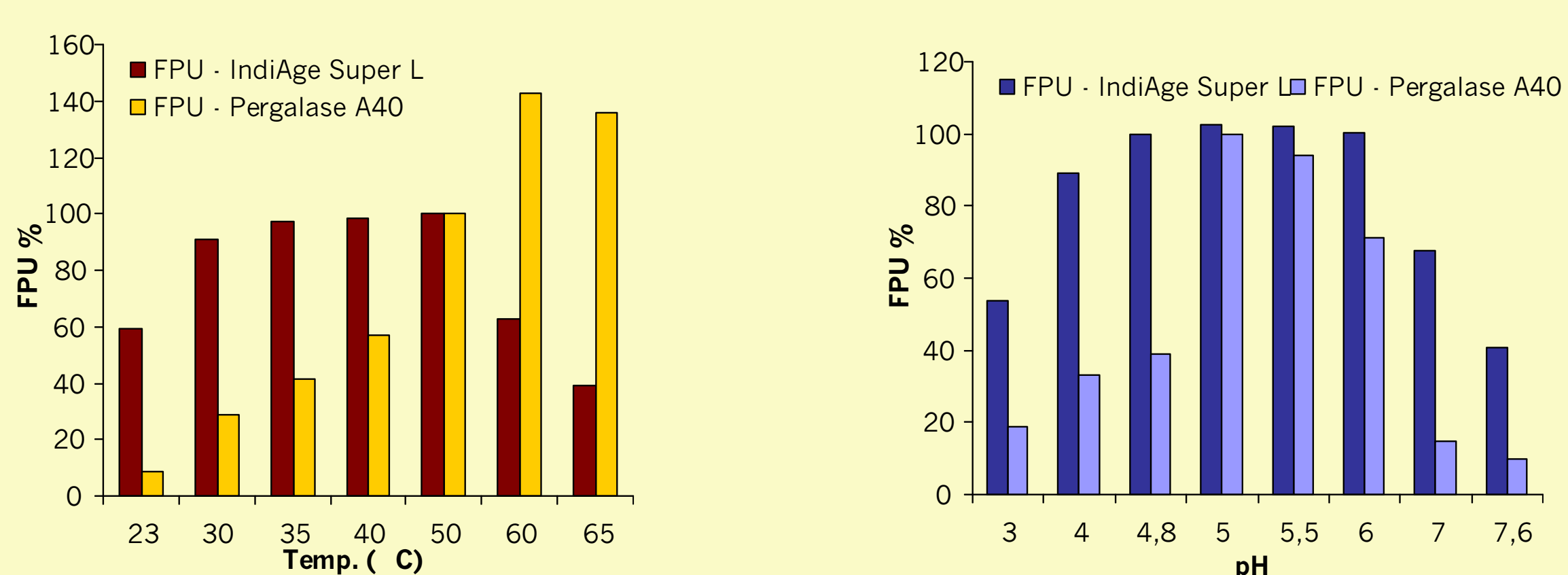
β -D-glucosidase or cellobiase converts cellobiosaccharides and cellobiose to glucose.

The three different types of cellulases can hydrolyze insoluble cellulose in synergism. This enhancement of single effects is highest on crystalline cellulose.

Using enzymatic treatment, the drainage could be improved in an environmentally friendly, biotechnological process.

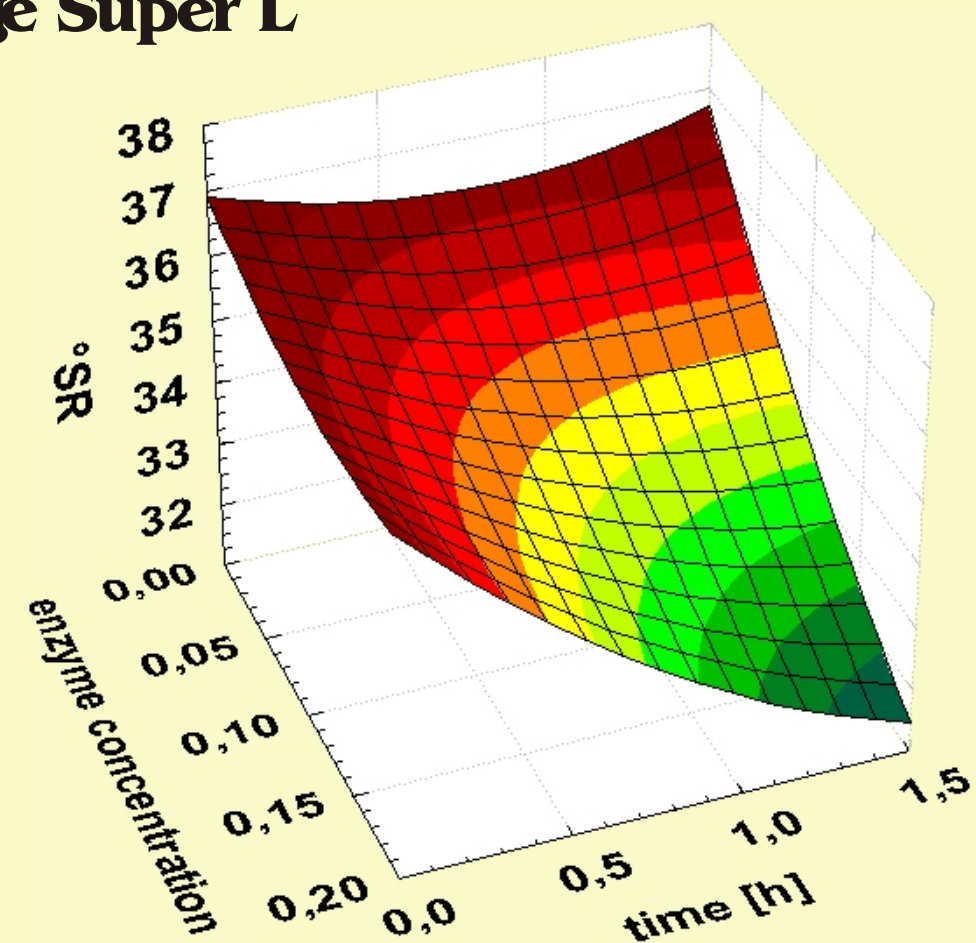


Results

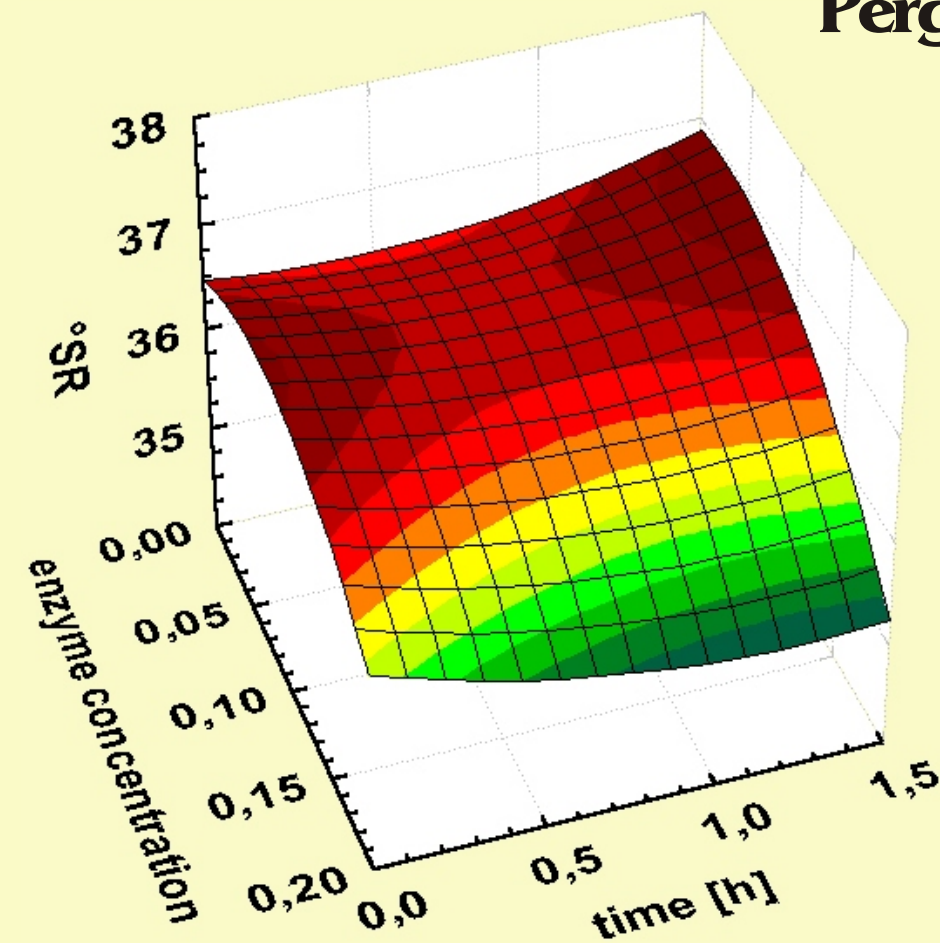


IndiAge Super L works with 100% activity in the pH range 4.5-6.2. In the temperature range 30-50°C there is only a slight decrease towards the lower temperature.

IndiAge Super L



Pergalase A40



Freeness is a measure of pulp drainability and it was determined by Schopper-Riegler freeness ($^{\circ}$ SR) test. Lower value indicates better drainage.

In the range 0-0.2% enzyme loading and 0-1.5h reaction time optimal drainage was obtained after 1.5h reaction time with IndiAge Super L and 1.0h when Pergalase A40 was used. For both enzymes the highest enzyme loading (0.2%) proved to be the best.

Treatment of recycled sackpaper with commercial enzymes

Applied amounts and activities of enzyme solutions

Enzyme	% of dry wt	FPU/g dry wt	CMCase/g dry wt	g protein/g dry wt
IndiAge Super L	0.2	0.01	0.53	0.46
Pergalase A40	0.2	0.08	1.51	75.8

Effect of enzymatic treatment on pulp drainage and paper properties

Enzyme	Freeness		Air perm. ml/sec	Burst index kPa m ² /g	Tear index Nm ² /kg	Tensile index Nm/g
	$^{\circ}$ SR	CSF				
Untreated	37	340	2.99	3.06	10.81	51.4
IndiAge Super L	31	414	3.79	3.23	8.06	52.2
Pergalase A40	35	364	3.70	3.21	9.49	53.9

Discussion

In all cases Schopper-Riegler value decreased indicating that under these industrial conditions (reaction time: 1.0, 1.5h; temperature: 35°C; initial pH: 4.5; pulp consistency: 3.5%) cellulases can act on fiber surfaces and modify the structure to a good tendency.

Efficiency of commercial preparations (Pergalase A40 - mixture of cellulases and hemicellulases, IndiAge Super L - pure endoglucanase III) according to drainage shows significant difference.

Although both of them were used in 0.2% (based on dry weight) the applied protein content was much lower in case of IndiAge Super L and even so it proved to be more efficient in improvement of drainage.

In secondary fibers the fines and fibrils that cause lower rate of drainage consist decisively amorphous cellulose. Since amorphous cellulose is more accessible it is not necessary to hydrolyze with the whole cellulase system, endoglucanases are effective. It means that endoglucanases might play the main role in drainage improvement.