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Research Article

OPTIMIZATION OF LIPASE ENZYMES FOR ENVIRONMENTALLY FRIENDLY HANDLING OF STICKIES ON RECYCLED PAPER

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Abstract

Stickies are contaminants in recycled paper that often cause problems in paper making equipment. Problems caused by stickies include the appearance of spots, holes and broken paper. The usual way to deal with these contaminants is a kneading machine which involves the surfactant. **Aim:** The enzymatic process is an environmentally friendly alternative way to deal with stickies. Research was conducted to determine the optimal ability of the lipase enzyme to degrade stickies and its impact on the physical properties of paper. **Methods:** The variation in lipase dosage used was 0.1%, 0.3%, and 0.5% with mixing times of 30 and 50 minutes. **Result:** The results showed that lipase could reduce the number of stickies with an optimum dose of 0.5% and a mixing time of 50 minutes. **Conclusion:** The use of lipase can increase the physical properties of recycled paper.

Keywords: Stickies, Lipase, Degradation agent, Recycled paper.

INTRODUCTION

Stickies are contaminants that often found in the paper recycling process.[1] Stickies are deposits produced by organic materials used in the paper industry.[2] The presence of stickies in waste paper processing causes problems in stock supply equipment and in paper machines.[3] Dealing with these contaminants is usually carried out through chemical and physical processes.[4]Chemically processes are done by adding materials such as talc, dispersants and polymer[5]while physically processes are done through the fiber decomposition, fiber washing and fiber filtering process.[6]In supporting government programs regarding environmentally friendly industries, it is necessary to reduce the use of chemicals that can pollute.[7] An alternative method is to use the lipase enzyme as a stickies degrading agent.[8] Lipase is an enzyme that catalyzes the hydrolysis of triacylglycerol into glycerol and fatty acids by releasing acid and alcohol groups.[9]Lipase can catalyze reactions such as esterification and transesterification.[10] Lipase can degrade triglycerides thereby reducing downtime, cleaning frequency, reducing stains and increasing the strength of the paper produced.[11]Specifically, the lipase enzyme can break down the ester bonds which make up the majority of the adhesive content in the stickies material.[12] The broken down ester bonds make the size of the stickies smaller and reduce the possibility of the stickies sticking to parts of the paper machine.[13]Based on the above background, it is necessary to optimize the dose and contact time of the lipase enzyme for application in the paper recycling industry.

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METHODS

Sample Preparation

The sample was divided into 4 parts with 1 part without adding enzymes. A dose of 0.1%, 0.3% and 0.5% lipase was added to the sample then heated until it reached 50°C. After that, the samples were varied in mixing time of 30 minutes and 50 minutes.

Making Paper Sheets

700 g of sample was washed then filtered using a Somerville Shive Content Analyzer (plate screen), according to the TAPPI T277[14] standard procedure. The contaminants on the plate screen are taken. The procedure for calculating stickies content and the average size of stickies was carried out in accordance with the TAPPI T213[15]standard. Then, paper sheets are made using a handset mold.

Testing Paper Sheets

Physical tests for tensile, ring crush and bursting index of paper sheets follow Indonesian national standards (SNI) 14-0493-1998.

RESULTS AND DISCUSSION

Stickies Number Calculation

The result (Table 1) showed that adding lipase can degrade stickies. The number of degraded stickies with enzyme mixing times of 30 and 50 minutes showed differences. The addition 0.1% lipase enzyme with a contact time of 30 minutes, the number of stickies was 380. The addition 0.3% and 0.5%

enzyme, the number of stickies increased by 485 and 520.The addition a dose of 0.1% with a contact time of 50 minutes, the number of stickies degraded was 420. The addition enzyme doses of 0.3% and 0.5% resulted in 515 and 620 stickies.

Table 1. The effect of Lipase enzyme on the stickies number

Lipase Dose	Degraded Stickies Number	
	Mixing time 30 minutes	Mixing time 50 minutes
Blank	263	263
0,1%	380	420
0,3%	485	515
0,5%	520	620

The addition of the lipase enzyme at a higher dose and a longer mixing time caused an increase in the number of degraded stickies.

Stickies Size Measurement

Table 2 is the result of the influence of the lipase enzyme on the size of stickies was carried out. The addition dose of 0.1% lipase enzyme resulted in a stickies size of 1.23 mm^2. With additional doses of 0.3% and 0.5%, stickies sizes were 1.81 mm^2 and 1.9 mm^2. Adding a dose of 0.1% resulted in a stickies size of 1.42 mm^2. Adding enzyme doses of 0.3% and 0.5% resulted in stickies sizes of 2.5 mm^2 and 2.8 mm^2.

Table 2. The Effect of Lipase Enzyme on Stickies Size

Lipase Dose	Degraded Stickies Number	
	Mixing time 30 minutes	Mixing time 50 minutes
Blank	0,98 mm^2	0,98 mm^2
0,1%	1,23 mm^2	1,42 mm^2
0,3%	1,81 mm^2	2,50 mm^2
0,5%	1,90 mm^2	2,80 mm^2

The size of the stickies was taken also increased with increasing doses of the lipase enzyme.Mixing time of 50 minutes produces stickies that are larger than 30 minutes.

Tensile Index Testing

The results of the influence of the lipase enzyme on the paper tensile index test can be seen in Figure 1.

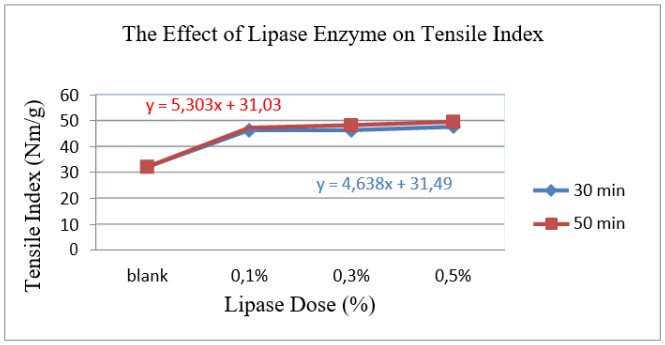

Fig. 1.The Effect of Lipase Enzyme on Tensile Index

The blue line shows the effect of mixing the enzyme lipase with a mixing time of 30 minutes. The use of 0.1% enzyme lipase can increase the tensile index value from 32.14 Nm/g to 46.30 Nm/g. After adding 0.3% Lipase enzyme, there was no visible increase in the tensile index value. The tensile index value increased with the addition of lipase by 0.5% with a result of 47.60 Nm/g. The red line shows the effect of mixing enzyme lipase for 50 minutes. The use of 0.1% enzyme lipase can increase the tensile index value from 32.14 Nm/g to 47.29 Nm/g. When adding 0.3% enzyme lipase the tensile index increased from the previous dose, namely to 48.21 Nm/g. The tensile index value increased with the addition of 0.5% lipase with a result of 49.51 Nm/g. The more stickies that are successfully degraded, the tensile index value increases. The stirring time does not have a significant effect on the tensile index value

Ring Crush Testing

The effect of adding lipase on the ring crush value can be seen in Figure 2. The blue line shows the effect of mixing enzyme lipase for 30 minutes on the ring crush value. The use of 0.1% lipase can increase the ring crush value from 10.60 kgf to 14.68 kgf.When adding a dose of 0.3%, the ring crush value increased to 15.40 kgf. At a dose of 0.5% the ring crush value continues to increase to 16.30 kgf. The red line shows the effect time of 50 minutes of enzyme lipase mixing on the ring crush value. The use of 0.1% lipase can increase the ring crush value to 4.79 kgf. The additional doses of 0.3% and 0.5%, the ring crush value increased to 15.80 kgf and 16.60 kgf.

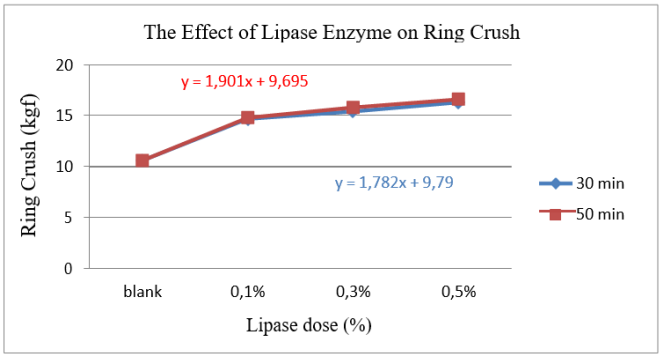

Fig 2. The Effect of Lipase Enzyme on Ring Crush

The test results showed that the addition of enzyme was proportional to the increase in the ring crush value, while the length of stirring time did not have a significant effect on the ring crush value

Bursting Index Test

The results obtained (Figure 3) showed the effect of using the lipase enzyme on the bursting index. The blue line shows the effect of using lipase with a mixing time of 30 minutes on the bursting index value.

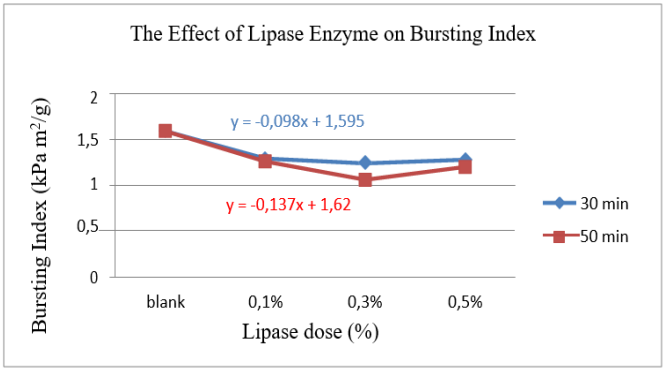

Fig 3. The Effect of Lipase Enzyme on Bursting Index

The addition lipase doses of 0.1% and 0.3% reduced the bursting index value from 1.59 kpa.m2/g to 1.29 kpa.m2/g and 1.24 kpa.m2/g. The additional lipase dose of 0.5%, the bursting index value increased to 1.28 kpa.m2/g. The red line shows the effect of mixing lipase for 50 minutes on the bursting index value. The use of 0.1% and 0.3% lipase reduced the bursting index value from 1.59 kpa.m2/g to 1.26 kpa.m2/g and 1.06 kpa.m2/g. At a dose of 0.5% the bursting index increased to a value of 1.20 kpa.m2/g.

Conclusion

The addition of a 0.5% lipase enzyme dose gives better results compared to a 0.3% lipase dose as seen from the number and size of stickies that can be removed from the paper, as well as the tensile index, ring crush and bursting index values. The mixing time of 50 minutes degrades stickies better than 30 minutes. Variations in mixing time do not have a significant effect on physical properties of paper such as the tensile index, ring crush and bursting index values. The Lipase enzymes can be a more environmentally friendly alternative to degrading stickies to replacing chemicals commonly used in the waste paper industry.

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Competing interests: The authors have declared that no competing interests exist

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