

APLIKASI METODE PERMUKAAN RESPON UNTUK OPTIMASI PENGUATAN KERTAS MENGGUNAKAN *CELLULOSE NANOFIBERS* (CNF) DAN NATRIUM HIDROKSIDA

Ratri Dwi Hastuti
20/462243/PA/20215

INTISARI

Optimasi penguatan mekanik kuat tarik dan kelenturan kertas dengan penambahan *cellulose nanofiber* (CNF) dan perendaman dalam natrium hidroksida telah dilakukan menggunakan metode permukaan respon (*Response Surface Methodology*, RSM). Penelitian ini memiliki tujuan yakni mengetahui pengaruh dari perlakuan perendaman kertas dalam NaOH terhadap efektivitas CNF dalam penguatan mekanik kertas dan mengetahui pengaruh dari variasi konsentrasi CNF, konsentrasi NaOH, dan waktu untuk memperoleh titik optimum. Penguatan mekanik kertas dioptimasi dengan *Central Composite Design* (CCD) menggunakan 3 variabel bebas yakni konsentrasi CNF, konsentrasi NaOH, dan waktu. Kondisi optimum ditentukan dengan menganalisis variabel respon pada penelitian yakni kuat tarik dan kelenturan kertas. Analisis dilakukan dengan menggunakan perangkat lunak Minitab 22. Sampel yang berada pada kondisi optimum kemudian dikarakterisasi dengan *Fourier Transform Infra Red* (FTIR) dan *Scanning Electron Microscopy* (SEM).

Hasil penelitian menunjukkan kondisi optimum untuk kuat tarik dan kelenturan kertas. Nilai optimum kuat tarik kertas sebesar 3,6364 MPa dicapai pada kondisi konsentrasi CNF 0,46% (b/b), konsentrasi NaOH 7,06% (b/v), dan waktu 147 menit. Selain itu, kertas mencapai kelenturan optimum dengan nilai regangan sebesar 4,177% diperoleh pada kondisi konsentrasi CNF 0,32% (b/b), konsentrasi NaOH 7,38% (b/v), dan waktu 82 menit. FTIR pada kertas blanko dengan kertas yang diberi perlakuan menunjukkan gugus fungsi yang sama yakni gugus fungsi selulosa. Adapun SEM menunjukkan kertas dengan perlakuan alkali lebih berrongga dan tampak kasar bergelombang.

Kata kunci: *Central Composite Design*, *Cellulose Nanofibers*, metode permukaan respon, kuat tarik, kelenturan kertas

APPLICATION OF THE RESPONSE SURFACE METHOD TO OPTIMIZE THE INCREASE OF THE PAPER STRENGTH USING CELLULOSE NANOFIBERS (CNF) AND NATRIUM HYDROXIDE

Ratri Dwi Hastuti

20/462243/PA/20215

ABSTRACT

Optimization of paper's mechanical reinforcement, specifically tensile strength and flexibility with addition of cellulose nanofibers (CNF) and immersion in sodium hydroxide (NaOH), was conducted using *Response Surface Methodology* (RSM). The research aimed to determine the effect of the NaOH immersion treatment on the effectiveness of CNF in mechanically reinforcing the paper and to identify the optimum conditions by varying the concentrations of CNF and NaOH, as well as the immersion time. The optimization was performed by a Central Composite Design (CCD) with three independent variables there are CNF concentration, NaOH concentration, and time. Optimum conditions were determined by analyzing the research's response variables: paper tensile strength and flexibility. Analysis was performed using Minitab 22 software. Samples obtained under optimum conditions were then characterized using Fourier Transform Infra Red (FTIR) and Scanning Electron Microscopy (SEM).

The results showed that an optimum tensile strength value of 3.6364 MPa was achieved under the conditions of 0.46 wt% CNF, 7.06% (w/v) NaOH concentration, and 147 minutes of time. In addition, the paper achieved optimum flexibility with a strain value of 4.177%, obtained at a CNF concentration of 0.32 wt%, NaOH concentration of 7,38% (w/v), and 82 minutes of time. FTIR analysis compared the blank and treated papers, revealing identical function groups characteristic of cellulose. Meanwhile, SEM micrographs showed that the alkali-treated paper exhibited a more porous structure with a rough and wavy surface morphology.

Keywords: Central Composite Design, Cellulose Nanofibers, Response Surface Methodology, Tensile Strength, Paper Flexibility.