

ABSTRAK

STUDI PENGARUH SUHU PEMANASAN PADA PROSES PIROLISIS ASAP CAIR DARI TEMPURUNG KELAPA SEBAGAI INHIBITOR KERAK KALSIUM FOSFAT ($\text{Ca}_3(\text{PO}_4)_2$) MENGGUNAKAN METODE *UNSEEDED EXPERIMENT*

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Pembentukan kerak kalsium fosfat ($\text{Ca}_3(\text{PO}_4)_2$) merupakan masalah serius pada industri minyak dan gas, desalinasi, serta ketel uap karena dapat menurunkan efisiensi dan merusak peralatan. Penelitian ini bertujuan mengkaji pengaruh variasi suhu pirolisis (300, 400, dan 500 °C) asap cair tempurung kelapa sebagai inhibitor kerak $\text{Ca}_3(\text{PO}_4)_2$ serta menentukan suhu pirolisis yang menghasilkan inhibitor paling efektif.

Penelitian ini menggunakan metode *unseeded experiment* dengan konsentrasi larutan pertumbuhan $\text{Ca}_3(\text{PO}_4)_2$ yaitu 0,0003; 0,0004; 0,0005; dan 0,0010 M serta variasi konsentrasi inhibitor 5; 10; 15; dan 20 ppm. Pembuktian lebih lanjut dilakukan melalui pengujian pada kupon logam pada konsentrasi larutan 0,0003 M dan 0,0010 M dengan penambahan inhibitor 20 ppm.

Hasil penelitian menunjukkan bahwa nilai efektivitas inhibisi tertinggi diperoleh asap cair dengan suhu pirolisis 400 °C sebesar 94,12%, pada konsentrasi larutan $\text{Ca}_3(\text{PO}_4)_2$ 0,0003 M dengan penambahan inhibitor 20 ppm, dengan urutan efektivitas 400 °C > 300 °C > 500 °C. Pengujian kupon logam memperkuat hasil tersebut dengan efektivitas sebesar 95,45%. Analisis *Scanning Electron Microscopy* (SEM) menunjukkan bahwa penambahan inhibitor menyebabkan agregat partikel menjadi lebih renggang dan tidak menyatu. Analisis *Particle Size Analyzer* (PSA) menunjukkan peningkatan nilai *Polydispersity Index* (PDI) dari 0,460 tanpa inhibitor menjadi 0,665 dengan inhibitor yang mengindikasikan distribusi ukuran partikel menjadi lebih heterogen. Analisis *X-Ray Diffraction* (XRD) menunjukkan fase hidroksiapatit monoklinik tanpa inhibitor berubah menjadi heksagonal dengan inhibitor, yang mengindikasikan perubahan keteraturan struktur kristal.

Kata kunci: inhibitor, kerak $\text{Ca}_3(\text{PO}_4)_2$, asap cair, pirolisis, tempurung kelapa

ABSTRACT

STUDY ON THE EFFECT OF HEATING TEMPERATURE IN THE PYROLYSIS PROCESS OF LIQUID SMOKE FROM COCONUT SHELL AS AN INHIBITOR OF CALCIUM PHOSPHATE ($\text{Ca}_3(\text{PO}_4)_2$) SCALE USING THE *UNSEEDED EXPERIMENT* METHOD

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The formation of calcium phosphate ($\text{Ca}_3(\text{PO}_4)_2$) scale is a serious problem in the oil and gas, desalination, and boiler industries because it can reduce efficiency and damage equipment. This study aimed to investigate the effect of pyrolysis temperature variations (300, 400, and 500 °C) of coconut shell liquid smoke as a $\text{Ca}_3(\text{PO}_4)_2$ scale inhibitor and to determine the pyrolysis temperature that produces the most effective inhibitor. This study employed the unseeded experiment method using $\text{Ca}_3(\text{PO}_4)_2$ growth solution concentrations of 0.0003, 0.0004, 0.0005, and 0.0010 M, with inhibitor concentrations of 5, 10, 15, and 20 ppm. Further verification was carried out using metal coupon tests at solution concentrations of 0.0003 M and 0.0010 M with the addition of 20 ppm inhibitor. The results showed that the highest inhibition efficiency was obtained from liquid smoke produced at a pyrolysis temperature of 400 °C, reaching 94.12% at a $\text{Ca}_3(\text{PO}_4)_2$ solution concentration of 0.0003 M with the addition of 20 ppm inhibitor, with the effectiveness order of 400 °C > 300 °C > 500 °C. Metal coupon testing further confirmed these results with an inhibition efficiency of 95.45%. Scanning Electron Microscopy (SEM) analysis showed that the addition of inhibitor caused the particle aggregates to become more loosely packed and less agglomerated. Particle Size Analyzer (PSA) analysis showed an increase in the Polydispersity Index (PDI) value from 0.460 without inhibitor to 0.665 with inhibitor, indicating that the particle size distribution became more heterogeneous. X-Ray Diffraction (XRD) analysis showed that the monoclinic hydroxyapatite phase without inhibitor transformed into a hexagonal phase after inhibitor addition, indicating changes in the crystal structure ordering.

Keywords: inhibitor, $\text{Ca}_3(\text{PO}_4)_2$ scale, liquid smoke, pyrolysis, coconut shell