

ABSTRAK

STUDI PENGARUH SUHU PEMANASAN PADA PROSES PIROLISIS ASAP CAIR DARI CANGKANG KELAPA SAWIT SEBAGAI INHIBITOR KERAK KALSIMUM SULFAT (CaSO₄) MENGUNAKAN METODE *UNSEEDED* *EXPERIMENT*

Oleh

Kadek Wendi Septiani

Kerak kalsium sulfat (CaSO₄) merupakan salah satu permasalahan utama dalam sistem perpipaan industri karena dapat menurunkan efisiensi perpindahan panas dan menghambat laju aliran fluida, sehingga diperlukan inhibitor yang efektif dan ramah lingkungan. Penelitian ini bertujuan untuk mengevaluasi efektivitas asap cair cangkang kelapa sawit sebagai *green inhibitor* pembentukan kerak CaSO₄ menggunakan metode *unseeded experiment* dengan variasi suhu pirolisis 300, 400, dan 500 °C, konsentrasi larutan pertumbuhan 0,02; 0,03; 0,04; dan 0,05 M, serta konsentrasi inhibitor 100, 125, dan 150 ppm. Karakterisasi kerak CaSO₄ dilakukan menggunakan SEM, XRD, dan PSA.

Hasil penelitian menunjukkan bahwa asap cair hasil pirolisis pada suhu 400 °C memberikan efektivitas penghambatan tertinggi sebesar 91,54% pada konsentrasi larutan 0,02 M dengan inhibitor 150 ppm, dengan urutan performa inhibisi 400 °C > 500 °C > 300 °C. Hasil ini semakin diperkuat melalui pengujian kupon logam dengan nilai efektivitas mencapai 97,80%, mengonfirmasi potensi asap cair cangkang kelapa sawit sebagai inhibitor kerak yang signifikan.

Analisis SEM menunjukkan bahwa kerak CaSO₄ dengan penambahan inhibitor berubah menjadi lebih kecil, rapuh, dan tidak beraturan dibandingkan kerak tanpa inhibitor. Analisis XRD mengonfirmasi bahwa fase gipsum dan bassanit tetap terbentuk pada kedua kondisi tanpa dan dengan inhibitor, namun intensitas puncak difraksi menurun pada sampel dengan inhibitor. Analisis PSA menunjukkan adanya penurunan ukuran partikel kerak setelah penambahan inhibitor, yakni nilai rata-rata (*mean*) menurun dari 7470,2 nm menjadi 6699,8 nm dan nilai tengah (*median*) menurun dari 7031,8 nm menjadi 6730,2 nm, sehingga disimpulkan bahwa inhibitor asap cair cangkang kelapa sawit mampu menghambat pertumbuhan kerak kalsium sulfat CaSO₄.

Kata Kunci: asap cair, cangkang kelapa sawit, CaSO₄, inhibitor, kerak

ABSTRACT

STUDI OF THE EFFECT OF HEATING TEMPERATURE ON THE PYROLYSIS PROCESS LIQUID SMOKE FROM PALM OIL SHELLS AS A CALCIUM SULPHATE (CaSO₄) SCALE INHIBITOR USING THE SEEDLESS METHOD EXPERIMENT

By

Kadek Wendi Septiani

Calcium sulfate (CaSO₄) scale is one of the major problems in industrial piping systems as it can reduce heat transfer efficiency and impede fluid flow rates, necessitating the use of effective and environmentally friendly inhibitors. This study aims to evaluate the effectiveness of palm shell liquid smoke as a green inhibitor for CaSO₄ scale formation using the unseeded experiment method with variations in pyrolysis temperature of 300, 400, and 500 °C, growth solution concentrations of 0.02, 0.03, 0.04, and 0.05 M, and inhibitor concentrations of 100, 125, and 150 ppm. Characterization of CaSO₄ scale was carried out using SEM, XRD, and PSA. The results showed that liquid smoke produced at a pyrolysis temperature of 400 °C provided the highest inhibition effectiveness of 91.54% at a solution concentration of 0.02 M with 150 ppm inhibitor, with the inhibition performance order of 400 °C > 500 °C > 300 °C. These results were further confirmed through metal coupon testing, with an effectiveness value reaching 97.80%, confirming the significant potential of palm shell liquid smoke as a scale inhibitor. SEM analysis revealed that CaSO₄ scale with the addition of inhibitor transformed into smaller, more brittle, and irregular morphology compared to scale formed without inhibitor. XRD analysis confirmed that gypsum and bassanite phases continued to form under both conditions, with and without inhibitor; however, the diffraction peak intensities decreased in the inhibitor-added samples. PSA analysis showed a reduction in scale particle size after the addition of inhibitor, with the mean value decreasing from 7470.2 nm to 6699.8 nm and the median value decreasing from 7031.8 nm to 6730.2 nm, leading to the conclusion that palm shell liquid smoke inhibitor is capable of inhibiting the growth of calcium sulfate (CaSO₄) scale.

Keywords: liquid smoke, palm kernel shell, CaSO₄, inhibitor, scale