SINTESIS NANOKOMPOSIT Fe_3O_4/ZnO-Ni DAN UJI AKTIVITASNYA SEBAGAI FOTOKATALIS PADA DEGRADASI METIL JINGGA

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INTISARI

Sintesis material nanokomposit Fe_3O_4/ZnO-Ni sebagai fotokatalis pada degradasi metil jingga telah dilakukan. Penelitian diawali dengan sintesis material magnetit (Fe_3O_4) dengan metode kopresipitasi dan sonikasi, kemudian dilakukan proses pelapisan material magnetit menggunakan seng oksida (ZnO) melalui metode sol-gel dengan memvariasikan massa ZnO. Selanjutnya dilakukan doping menggunakan logam Ni yang bervariasi secara *in situ*. Material hasil sintesis dikarakterisasi dengan Spektrofotometer Inframerah (FT-IR), Difraktometer sinar-X (XRD), *Scanning Electron Microscope-Energy Dispersive X-ray* (SEM-EDX), *Diffuse Reflectance UV-Visible Spectrophotometer* (SR-UV)**,** *Vibrating Sample Magnetometer* (VSM)**, dan** *Transmission Electron Microscope* (TEM). Uji aktivitas fotokatalis dilakukan dengan sistem *batch* dalam reaktor tertutup yang dilengkapi dengan sumber sinar UV dan sinar tampak.

Hasil penelitian menunjukkan bahwa nanokomposit Fe_3O_4/ZnO-Ni telah berhasil disintesis dan responsif terhadap sinar tampak dibuktikan oleh spektra SR UV-visibel. Sifat magnet terbaik diperoleh pada rasio massa Fe_3O_4/ZnO 1:5 dengan nilai momen magnet masing-masing sebesar 5,21 dan 9,33 emu/g untuk Fe_3O_4/ZnO dan Fe_3O_4/ZnO-Ni 3% (m/m). Energi celah pita mengalami penurunan dengan penambahan dopan Ni. Penurunan terjadi hingga 2,94 Ev setelah penambahan logam Ni sebanyak 3%. Material Fe_3O_4/ZnO-Ni 3% menunjukkan aktivitas fotokatalitik optimum pada paparan sinar tampak dan sinar UV terhadap degradasi metil jingga (30 ppm), masing-masing sebesar 86,93 dan 82,87% pada pH 2 dengan massa fotokatalitis 20 mg selama 45 menit. Material nanokomposit Fe_3O_4/ZnO-Ni menunjukkan aktivitas fotokatalitik yang masih sangat baik pada 3 kali penggunaan ulang. Studi kinetika degradasi metil jingga menunjukkan bahwa proses degradasi metil jingga secara fotokatalitik mengikuti model kinetika orde kedua semu dengan nilai konstanta laju degradasi sebesar 0.0095 g mg^{-1} $menit^{-1}$ pada paparan sinar UV dan 0.0176 g mg^{-1} $menit^{-1}$ pada paparan sinar tampak.

Kata Kunci: fotokatalis, Fe_3O_4/ZnO-Ni, degradasi, metil jingga.

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SYNTHESIS OF Fe_3O_4/ZnO-Ni NANOCOMPISITE AND ITS ACTIVITY TEST AS PHOTOCATALYST ON THE DEGRADATION OF METHYL ORANGE

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ABSTRACT

The synthesis of Fe_3O_4/ZnO-Ni nanocomposite material as a photocatalyst for methyl orange degradation has been conducted. The study was initiated with the synthesis of the magnetite material (Fe_3O_4) using the co-precipitation and sonication methods, then the magnetite material coating was carried out using zinc oxide (ZnO) by the sol-gel method with varying amount mass of ZnO. The doping of Fe_3O_4/ZnO was then conducted *in-situ* using various concentration of Ni. The synthesized material was characterized by Fourier-transform Infrared Spectrometer (FTIR), X-ray Diffractometer (XRD), Scanning Electron Microscope-Energy Dispersive X-ray (SEM-EDX), Diffuse Reflectance UV-Visible Spectrophotometer (SR-UV), Vibrating Sample Magnetometer (VSM), and Transmission Electron Microscope (TEM). Photocatalytic activity test of the photocatalyst was carried out in a batch system, in closed reactor equipped with UV and visible light sources.

The result of the study indicated that Fe_3O_4/ZnO-Ni nanocomposites have been successfully synthesized and responsive to visible light as evidenced by the SR UV-Vis spectra. The best magnetic property was obtained at Fe_3O_4/ZnO with ratio mass of 1:5 with the magnetic moments of 5.21 and 9.33 emu/g for Fe_3O_4/ZnO and Fe_3O_4/ZnO-Ni 3% (m/m) materials, respectively. The band gap energy decreases with increasing concentration of Ni and reached up to 2.94 Ev after the addition of 3% of Ni dopant. The Fe_3O_4/ZnO-Ni 3% material showed the optimum photocatalytic activity toward methyl orange (30 ppm) degradation under visible light and UV irradiation which are 86.93 and 82.87%, respectively, at pH 2 with 20 mg of photocatalyst materials for 45 min irradiation. The Fe_3O_4/ZnO-Ni nanocomposite still showed a good photocatalytic activity toward methyl orange degradation after three times reuse. The kinetic study showed that the photocatalytic degradation of methyl orange followed the pseudo-second-order kinetic model with a rate constant value were 0.0095 and 0.0176 g mg^{-1} $menit^{-1}$ on the UV and visible light exposure, respectively.

Keywords: photocatalyst, Fe_3O_4/ZnO-Ni, degradation, methyl orange.