SINTESIS KOMPOSIT $Fe_3O_4/SiO_2/TiO_2$ TERDOPING SULFUR DAN UJI AKTIVITASNYA UNTUK DEGRADASI FOTOKATALITIK ASAM SALISILAT

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INTISARI

Sintesis komposit $Fe_3O_4/SiO_2/TiO_2$ terdoping sulfur sebagai fotokatalis magnetik untuk degradasi fotokatalitik asam salisilat telah dilakukan. Tujuan utama penelitian ini yaitu memperoleh material fotokatalis $Fe_3O_4/SiO_2/TiO_2$-S yang memiliki aktivitas fotokatalitik pada paparan radiasi sinar tampak dan sifat magnetik sehingga mudah dipisahkan dari medium cair. Sintesis material fotokatalis $Fe_3O_4/SiO_2/TiO_2$-S diawali dengan preparasi Fe_3O_4 melalui metode sonokopresipitasi dengan prekursor garam $FeCl_3 \bullet 6H_2O$ dan $FeSO_4 \bullet 7H_2O$, serta natrium sitrat sebagai *capping agent*. Selanjutnya pelapisan SiO_2 pada Fe_3O_4 mengunakan tetraetil ortosilikat dan pelapisan TiO_2-S pada material Fe_3O_4/SiO_2 menggunakan metode sol-gel dengan prekursor titanium tetraisopropoksida dan tiourea sebagai sumber sulfur. Material hasil sintesis dikarakterisasi menggunakan *Fourier Transform Infra-Red Spectrometer* (FTIR), *X-Ray Diffractometer* (XRD), *Transmission Electron Microscope* (TEM), Spektrofotometer Difusi Reflektansi UV-tampak (DRUV), *Scanning Electron Microscope with Energy Dispersi X-Ray* (SEM-EDX), *Vibrating Sample Magnetometer* (VSM) dan *Surface Area Analyzer* (SAA). Uji aktivitas fotokatalitik dilakukan dengan sistem *batch* pada reaktor tertutup dengan paparan radiasi sinar UV dan tampak untuk degradasi fotokatalitik asam salisilat. Konsentrasi asam salisilat yang terdegradasi dianalisis menggunakan metode spektrofotometri UV-tampak.

Hasil penelitian menunjukkan bahwa $Fe_3O_4/SiO_2/TiO_2$-S merupakan fotokatalis yang responsif terhadap paparan sinar tampak dan memiliki sifat magnetik. Material komposit $Fe_3O_4/SiO_2/TiO_2$-S dengan variasi konsentrasi dopan sulfur 1, 3, 5, dan 7% memiliki energi celah pita berturut-turut sebesar 2,85; 2,77; 2,98; dan 3,05 eV. Hasil uji aktivitas fotokatalitik menunjukkan bahwa material fotokatalis $Fe_3O_4/SiO_2/TiO_2$-S 3% mampu mendegradasi asam salisilat 91,6% pada paparan radiasi sinar tampak dan 45,8% pada paparan radiasi sinar UV dengan massa fotokatalis 20 mg pada larutan asam salisilat dengan konsentrasi 20 ppm, pada pH 3, dan waktu penyinaran 60 menit. Degradasi asam salisilat mengikuti model kinetika Ho dan McKay dengan tetapan laju reaksi sebesar 0,0909 g mg^{-1} $menit^{-1}$ pada paparan sinar tampak dan 0,0076 g mg^{-1} $menit^{-1}$ pada paparan sinar UV.

Kata kunci: $Fe_3O_4/SiO_2/TiO_2$-S, fotokatalis magnetik, asam salisilat, degradasi fotokatalitik, sinar tampak.

SYNTHESIS OF SULFUR DOPED $Fe_3O_4/SiO_2/TiO_2$ *COMPOSITE AND ITS ACTIVITY FOR THE PHOTOCATALYTIC DEGRADATION OF SALICYLIC ACID*

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ABSTRACT

Synthesis of sulfur doped $Fe_3O_4/SiO_2/TiO_2$ composite as a magnetic photocatalyst for photocatalytic degradation of salicylic acid has been investigated. The main objective of this research was to obtain $Fe_3O_4/SiO_2/TiO_2$-S photocatalyst material which has both photocatalytic activity under visible light irradiation and magnetic properties so it is easily separated from the liquid medium. Synthesis of $Fe_3O_4/SiO_2/TiO_2$-S photocatalyst was started by the preparation of Fe_3O_4 by sono-coprecipitation method using $FeCl_3 \bullet 6H_2O$ and $FeSO_4 \bullet 7H_2O$ as precursor, and sodium citrate as a capping agent. Next, the as prepared Fe_3O_4 was coated with SiO_2 using tetraethyl orthosilicate and finally TiO_2-S was coated on Fe_3O_4/SiO_2 material using the sol-gel method with titanium tetraisopropoxide as precursor and thiourea as sulfur sources. The synthesized materials were characterized using fourier transform infrared spectrometer, X-ray diffractometer, vibrating sample magnetometer, transmission electron microscope, scanning electron microscope-energy dispersive X-ray, diffuse reflectance UV-visible spectrophotometer, and surface area analyzer. The photocatalytic activity was conducted in a batch system using a closed reactor under UV and visible light irradiration for photocatalytic degradation of salicylic acid. Concentration of the degraded salicylic acid was analyzed using UV-visible spectrophotometry method.

Results showed that $Fe_3O_4/SiO_2/TiO_2$-S photocatalysts are responsive to visible light with good magnetic properties. The $Fe_3O_4/SiO_2/TiO_2$-S composite materials with various concentrations of sulfur dopant 1, 3, 5, and 7% have band gap energy of 2.85, 2.77, 2.98, and 3.05 eV, respectively. The photocatalytic activity results showed that the $Fe_3O_4/SiO_2/TiO_2$-S 3% photocatalyst material with a mass of 20 mg in the 20 ppm of salycylic acid solution at pH 3, with the irradiation time of 60 minutes was able to degrade salicylic acid 91.6 and 45.8% under visible and UV light irradiation, respectively. The photocatalytic degradation kinetics of salicylic acid followed the Ho and McKay kinetic model with a reaction rate constant of 0.0909 g mg^{-1} $minute^{-1}$ under visible light irradiation and 0.0076 g mg^{-1} $minute^{-1}$ under exposure to UV light.

Keywords: $Fe_3O_4/SiO_2/TiO_2$-S, magnetic photocatalyst, salicylic acid, photocatalytic degradation, visible light.