

SINTESIS NANOKOMPOSIT PATI SINGKONG/GELATIN/HAp/Fe₃O₄ DAN APLIKASINYA PADA ADSORPSI SONOKIMIA TERHADAP METILEN BIRU

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INTISARI

Penelitian tentang sintesis nanokomposit pati singkong/gelatin/HAp/Fe₃O₄ dan aplikasinya pada adsorpsi sonokimia terhadap metilen biru telah dilakukan. Penelitian diawali dengan preparasi material pati singkong, gelatin, dan hidroksiapatit dengan metode sonokimia. Selanjutnya dilakukan penambahan Fe₃O₄ yang telah disintesis dengan metode kopresipitasi sehingga terbentuk komposit yang memiliki sifat magnetik. Komposit disintesis dengan variasi rasio massa HAp 0,1; 0,3; dan 0,5 g terhadap massa total adsorben. Material hasil sintesis dikarakterisasi dengan FTIR, XRD, SEM, TEM, SAA, dan VSM. Studi adsorpsi dilakukan dengan sistem *batch* dengan mencampurkan adsorben dalam larutan metilen biru. Parameter adsorpsi seperti pH larutan, waktu kontak dan konsentrasi awal metilen biru diuji untuk menentukan kapasitas adsorpsi maksimum larutan metilen biru. Selain itu, kajian desorpsi metilen biru dengan berbagai eluen (akuades, etanol, NaCl, HCl, dan NaOH) dilakukan untuk mengevaluasi potensi regenerasi adsorben.

Hasil penelitian menunjukkan bahwa material nanokomposit pati/gel/HAp/Fe₃O₄ berhasil disintesis melalui metode sonokimia. Material komposit hasil sintesis memiliki sifat magnetik sehingga mudah dipisahkan dari medium cair menggunakan magnet eksternal sehingga dapat digunakan kembali untuk pengujian aktivitas adsorpsi berikutnya. Material nanokomposit pati/gel/HAp/Fe₃O₄ dapat mengadsorpsi metilen biru secara optimum pada pH 8, dengan konsentrasi awal larutan metilen biru 130 mg L⁻¹, menggunakan massa adsorben 20 mg, dengan waktu kontak adsorpsi selama 60 menit. Studi kinetika adsorpsi menunjukkan bahwa proses adsorpsi mengikuti orde dua semu model Ho-McKay dengan konstanta laju adsorpsi sebesar 0,0198 g mg⁻¹ menit⁻¹. Studi isoterm adsorpsi menunjukkan proses adsorpsi yang terjadi mengikuti model Freundlich dengan nilai K_F = 19,561 L mol⁻¹ dan n = 2,121. Larutan metilen biru yang teradsorpsi pada nanokomposit dapat terdesorpsi dengan baik menggunakan larutan NaOH 0,01 M. Material komposit pati/gel/HAp/Fe₃O₄ cukup stabil dan dapat digunakan kembali sampai 5 kali tanpa penurunan kemampuan adsorpsi yang signifikan.

Kata kunci: adsorben, isoterm adsorpsi, kinetika adsorpsi, nanokomposit pati/gel/HAp/Fe₃O₄, metilen biru

**SYNTHESIS OF CASAVA STARCH/GELATIN/HAp/ Fe₃O₄
NANOCOMPOSITE AND ITS APPLICATION IN SONO-ASSISTED
ADSORPTION OF METHYLENE BLUE**

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ABSTRACT

Research on the synthesis of cassava starch/gelatin/HAp/Fe₃O₄ nanocomposite and its application in sono-assisted adsorption of methylene blue has been conducted. The study commenced with the preparation of cassava starch, gelatin, and hydroxyapatite materials using a sonochemical method. The synthesis involved initial sonochemical preparation of starch, gelatin, and hydroxyapatite components, followed by incorporation of co-precipitated Fe₃O₄ to impart magnetic properties. The composites were synthesized with varying HAp mass ratios 0.1, 0.3, and 0.5 g relative to total adsorbent mass to optimize their performance. The synthesized materials were characterized by using FTIR, XRD, SEM, TEM, SAA, and VSM. Adsorption studies were conducted through batch experiments where the composite adsorbent was dispersed in methylene blue solutions at varying concentrations. The adsorption parameters including solution pH, contact time, and initial methylene blue concentration systematically investigated to maximize adsorption capacity. The composite reusability was demonstrated through desorption studies employing multiple elution systems (deionized water, ethanol, NaCl, HCl, and NaOH)

This study successfully fabricated starch/gelatin/hydroxyapatite/Fe₃O₄ composites using a sonochemical approach. The synthesized nanocomposite material possesses magnetic properties, making it easily separable from the liquid medium using an external magnet, allowing it to be reused for subsequent adsorption activity tests. The starch/gel/HAp/Fe₃O₄ composite material can optimally adsorb methylene blue at pH 8, using an initial methylene blue concentration of 130 mg L⁻¹, an adsorbent mass of 20 mg, and a contact time of 60 minutes. The adsorption kinetics study indicates that the adsorption process follows the pseudo-second-order Ho-McKay model with an adsorption rate constant of 0.0198 g mg⁻¹ min⁻¹. The adsorption isotherm study showed that the adsorption process follows the Freundlich model with K_F = 19.561 L mol⁻¹ and n = 2.121. The adsorbed methylene blue solution can be effectively desorbed using a 0.01 M NaOH solution. The starch/gel/HAp/Fe₃O₄ composite material is relatively stable and can be reused up to five times without a significant decrease in adsorption capacity.

Keywords: adsorbent, adsorption isotherm, adsorption kinetics, methylene blue, starch/gel/HAp/Fe₃O₄ nanocomposite