

SINTESIS SILIKA GEL TERIMOBILISASI DITIZON DARI BAHAN DASAR PASIR PANTAI PARANGKUSUMO SEBAGAI ADSORBEN LOGAM Ni(II)

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INTISARI

Penelitian mengenai aktivitas adsorben silika gel dari pasir Pantai Parangkusumo yang dimodifikasi ditizon dalam mengadsorpsi ion Ni(II) telah dilakukan. Penelitian ini bertujuan untuk mengoptimalkan proses ekstraksi silika gel dari pasir pantai serta memodifikasinya dengan ditizon, yang selanjutnya dilakukan karakterisasi, optimasi kondisi, dan kajian terhadap model kinetika dan isoterm adsorpsi. Sintesis silika gel dilakukan melalui aktivasi pasir pantai dengan HCl, pembentukan larutan natrium silikat, dan proses sol-gel dengan titrasi HCl hingga terbentuk gel. Modifikasi dilakukan dengan mengimobilisasi ditizon pada silika gel melalui reaksi refluks dalam larutan NaOH. Adsorben silika gel dan silika gel terimobilisasi ditizon (SGD) dikarakterisasi menggunakan FTIR, XRD, XRF, dan SEM-EDX. Optimasi kondisi yang dilakukan meliputi pH, massa adsorben, waktu kontak, dan konsentrasi awal adsorbat yang diolah lebih lanjut untuk menentukan model kinetika dan isoterm adsorpsi.

Hasil penelitian mengindikasikan bahwa sintesis silika gel dari pasir Pantai Parangkusumo telah berhasil dilakukan, ditunjukkan oleh peningkatan kadar SiO_2 dari 54,1% (pasir pantai) menjadi 93,8% (silika gel) berdasarkan XRF, serta dikonfirmasi oleh kemunculan gugus silanol dan siloksan pada FTIR dan transisi struktur kristalin menjadi amorf pada XRD. Modifikasi dengan ditizon juga berhasil dilakukan, ditandai munculnya gugus khas ditizon pada FTIR, unsur C dan N pada SEM-EDX, serta puncak baru pada XRD. Adsorben optimum dari 25 mL larutan Ni diperoleh pada pH 6, massa adsorben 7,5 mg, waktu kontak 75 menit, dan konsentrasi awal 75 ppm, dengan kapasitas adsorpsi SGD ($85,73 \text{ mg g}^{-1}$) yang selalu lebih tinggi dibandingkan silika gel tanpa modifikasi ($75,43 \text{ mg g}^{-1}$). Kajian model kinetika dan isoterm adsorpsi yang dilakukan pada penelitian ini menunjukkan proses adsorpsi mengikuti model kinetika pseudo-orde dua dan isoterm Langmuir, yang mengindikasikan bahwa adsorpsi dikendalikan oleh interaksi kimia (kemisorpsi) pada permukaan adsorben yang homogen membentuk lapisan tunggal (monolayer).

Kata kunci: adsorben, adsorpsi, ditizon, ion nikel, pasir pantai, silika gel

***SYNTHESIS OF DITIZON-IMMOBILIZED SILICA GEL FROM
PARANGKUSUMO BEACH SAND STARTING MATERIAL AS AN
ADSORBENT FOR Ni(II) METALS***

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ABSTRACT

A study was conducted on the adsorption activity of silica gel derived from Parangkusumo Beach sand, modified with dithizone, in the adsorption of Ni(II) ions. The objective of this study was to optimize the extraction of silica gel from beach sand and modify it with dithizone, followed by characterization, optimization of conditions, and an analysis of the adsorption kinetics and isotherm models. Silica gel synthesis was carried out by activating beach sand with HCl, preparing a sodium silicate solution, and performing a sol-gel process with HCl titration until a gel formed. Modification was performed by immobilizing ditizon on the silica gel through a reflux reaction in a NaOH solution. The silica gel adsorbent and the ditizon-immobilized silica gel (SGD) were characterized using FTIR, XRD, XRF, and SEM-EDX. The optimization of conditions included pH, adsorbent mass, contact time, and initial adsorbate concentration, which were further analyzed to determine the adsorption kinetics and isotherm models.

The research results indicate that the synthesis of silica gel from Parangkusumo Beach sand was successful, as evidenced by an increase in the SiO₂ content from 54.1% (beach sand) to 93.8% (silica gel) based on XRF analysis, and confirmed by the appearance of silanol and siloxane groups in FTIR and the transition from a crystalline to an amorphous structure in XRD. Modification with ditizone was also successfully carried out, as indicated by the appearance of characteristic ditizone groups in FTIR, the presence of C and N elements in SEM-EDX, and new peaks in XRD. The optimal adsorbent for 25 mL of Ni solution was obtained at pH 6, an adsorbent mass of 7.5 mg, a contact time of 75 minutes, and an initial concentration of 75 ppm, with an SGD adsorption capacity (85.73 mg g⁻¹) that was consistently higher than that of unmodified silica gel (75.43 mg g⁻¹). The kinetic and adsorption isotherm model analyses conducted in this study indicate that the adsorption process follows a pseudo-second-order kinetic model and the Langmuir isotherm, suggesting that adsorption is controlled by chemical interactions (chemisorption) on the homogeneous adsorbent surface, forming a monolayer.

Keywords: adsorbent, adsorption, ditizone, nickel ions, beach sand, silica gel