SINTESIS KOMPOSIT LDH/BAYERIT/MnO_2 SECARA *IN SITU* DALAM TRIMETALIK LAYERED DOUBLE HYDROXIDE (LDH) NiMn/Al SEBAGAI CO_2 *CAPTURE*

SKRIPSI

diajukan untuk memenuhi sebagian syarat untuk memperoleh gelar Sarjana Sains pada Program Studi Kimia

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SINTESIS KOMPOSIT LDH/BAYERIT/MnO_2 SECARA *IN SITU* DALAM TRIMETALIK LAYERED DOUBLE HYDROXIDES (LDH) NiMn/Al SEBAGAI CO_2 *CAPTURE*

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Sebuah skripsi yang diajukan untuk memenuhi salah satu syarat memperoleh gelar Sarjana Sains pada Program Studi Kimia Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam

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ABSTRAK

Peningkatan suhu global rata-rata yang diakibatkan oleh perubahan iklim disebabkan oleh produksi *greenhouse gases* dengan gas CO_2 sebagai penyumbang utama. Salah satu teknologi yang baik, efektif, dan banyak diusulkan untuk menguranginya adalah *Carbon Capture Storage* yang melibatkan penangkapan gas CO_2. *Layered Double Hydroxide*s (LDH) merupakan salah satu material anorganik yang dapat dimanfaatkan sebagai adsorben. Penelitian ini bertujuan melakukan sintesis LDH NiMnAl dengan 3 variasi molar pada Ni, Mn, dan Al untuk menangkap CO_2 dengan metode sintesis hidrotermal. LDH kemudian dikarakterisasi lebih lanjut menggunakan instrumen XRD, FTIR, BET, FE-SEM, dan XPS. Pola XRD menunjukkan terbentuknya LDH, ditunjukkan dengan puncak simetris bidang (003), (006), dan (009) pada sudut 2θ disertai terbentuknya bayerit dan MnO_2 secara *in situ*. Spektra FTIR menunjukkan vibrasi dari O-H *stretching*, vibrasi $-NO_3$, dan vibrasi pada ikatan logam oksida. Hasil karakterisasi dengan BET menunjukkan diameter pori ketiga variasi komposit termasuk kelompok mesopori dengan diameter lebih dari 5 nm. Karakterisasi dengan FESEM menunjukkan komposit NiMnAl LDH/bayerit/MnO_2 berbentuk seperti pelat atau lempengan yang saling bertumpuk serta tambahan MnO_2 yang bermorfologi jarum. Spektrum XPS menunjukkan puncak pada Ni 2p, Mn 2p, Al 2p, Al 2s, N 1s, dan O 1s, mengonfirmasi keberadaan komposit. Penangkapan CO_2 pada ketiga variasi komposit dilakukan menggunakan instrumen TPD yang mendeteksi keberadaan beberapa puncak dan menandakan adanya interaksi yang lemah (CO_2 dengan -OH), serta interaksi berkekuatan sedang-tinggi (logam oksida dengan CO_2). Kapasitas adsorpsi CO_2 tertinggi dicapai pada komposit dengan rasio molar Ni terbesar, yang mengindikasikan bahwa peningkatan komposisi Ni dalam struktur komposit berperan dalam meningkatkan kapasitas adsorpsi CO_2.

Kata kunci: adsorpsi CO_2, komposit, LDH, NiMnAl LDH/bayerit/MnO_2, TPD-CO_2.

ABSTRACT

The increase in average global temperature caused by climate change is caused by the production of greenhouse gases with CO_2 gas as the main contributor. One of the good, effective, and widely proposed technologies to reduce it is Carbon Capture Storage which involves capturing CO_2 gas. Layered Double Hydroxides (LDH) is one of the inorganic materials that can be used as an adsorbent. This study aims to synthesize NiMnAl LDH with 3 molar variations in Ni, Mn, and Al to capture CO_2 by the hydrothermal synthesis method. LDH was then further characterized using XRD, FTIR, BET, FE-SEM, and XPS instruments. The XRD pattern shows the formation of LDH, indicated by symmetric peaks of the (003), (006), and (009) planes at an angle of 2θ accompanied by the in situ formation of bayerite and MnO_2. The FTIR spectra show vibrations of O-H stretching, $-NO_3$ vibrations, and vibrations in metal oxide bonds. The results of BET characterization show that the pore diameter of the three composite variations belongs to the mesoporous group with a diameter of more than 5 nm. FESEM characterization shows that the NiMnAl LDH/bayerite/MnO_2 composite is shaped like a plate or a stacked plate with additional MnO_2 having a needle morphology. The XPS spectrum shows peaks at Ni 2p, Mn 2p, Al 2p, Al 2s, N 1s, and O 1s, confirming the presence of the composite. CO_2 capture on the three composite variations was carried out using a TPD instrument that detects the presence of several peaks and indicates the presence of weak interactions (CO_2 with -OH), as well as medium-high strength interactions (metal oxide with CO_2). The highest CO_2 adsorption capacity was achieved in the composite with the largest Ni molar ratio, indicating that increasing the Ni composition in the composite structure plays a role in increasing the CO_2 adsorption capacity.

Keywords: *CO_2 adsorption, composite, LDH, NiMnAl LDH/bayerite/MnO_2, TPD-CO_2.*

DAFTAR ISI

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DAFTAR GAMBAR

DAFTAR LAMPIRAN

DAFTAR SINGKATAN

BET = Brunauer-Emmett-Teller

CCS = Carbon Capture Storage

CCUS = Carbon Capture Utilization Storage

FE-SEM = Field Emission Scanning Electron Microscopy

FTIR = Fourier Transform Infrared Spectroscopy

GHG = Greenhouse Gases

IPCC = Intergovernmental Panel on Climate Change

LDH = Layered Double Hydroxide

MOF = Metal–organic frameworks

TPD = Temperature-Programmed Desorption

XPS = X-ray Photoelectron Spectroscopy

XRD = X-Ray Diffraction

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