

ABSTRAK

STUDI POTENSI ZEOLIT ALAM ASAL KECAMATAN CIPATUJAH TASIKMALAYA SEBAGAI FORMULASI PUPUK LEPAS LAMBAT

Urea merupakan pupuk nitrogen yang banyak digunakan karena memiliki kandungan nitrogen tinggi, tetapi mudah larut dalam air sehingga mengalami kehilangan hara melalui pencucian dan volatilisasi. Penelitian ini bertujuan untuk menganalisis karakteristik zeolit alam asal Kecamatan Cipatujah, Tasikmalaya setelah aktivasi menggunakan HCl, NaCl, dan NaOH, menentukan kapasitas tukar kation (KTK), serta mengevaluasi pola pelepasan amonium dari formulasi pupuk urea-zeolit. Zeolit alam dipreparasi melalui pencucian, pengeringan, penumbukan, dan pengayakan, kemudian diaktivasi menggunakan larutan HCl, NaCl, dan NaOH. Karakterisasi dilakukan melalui pengujian KTK, *X-Ray Diffraction* (XRD), perhitungan ukuran kristalit menggunakan persamaan Debye-Scherrer, *Fourier Transform Infrared* (FTIR) untuk mendeteksi gugus fungsi dan analisis pelepasan amonium menggunakan metode indofenol dengan spektrofotometer UV-Vis pada panjang gelombang 640 nm. Hasil penelitian menunjukkan bahwa aktivasi HCl menghasilkan nilai KTK tertinggi sebesar 204 meq/100 g, sehingga dipilih sebagai zeolit terbaik untuk tahap impregnasi urea. Hasil XRD menunjukkan bahwa zeolit didominasi oleh klinoptilolit, dengan adanya kuarsa atau mineral silikat sebagai fase minor. Ukuran kristalit rata-rata zeolit aktivasi HCl diperoleh sebesar 17,07 nm. Hasil karakterisasi FTIR menunjukkan adanya gugus fungsi khas zeolit berupa O-H, H-O-H, dan Si-O-T yang ditunjukkan oleh pita serapan pada daerah sekitar 3413–3625 cm^{-1} , 1633–1638 cm^{-1} , 1045–1049 cm^{-1} , dan 794–795 cm^{-1} . Uji pelepasan amonium menunjukkan bahwa urea konvensional mengalami pelepasan awal yang tinggi, sedangkan formulasi urea-zeolit 25°C menunjukkan pelepasan yang lebih stabil dan bertahap dibandingkan urea-zeolit 70°C. Dengan demikian, zeolit alam asal Cipatujah berpotensi digunakan sebagai bahan pembawa dalam formulasi pupuk urea lepas lambat, terutama melalui impregnasi pada suhu ruang 25°C.

Kata kunci: amonium; urea; kapasitas tukar kation; pupuk lepas lambat; zeolit alam.

ABSTRACT

A STUDY OF THE POTENTIAL OF NATURAL ZEOLITE FROM THE CIPATUJAH DISTRICT, TASIKMALAYA, AS A SLOW-RELEASE FERTILIZER FORMULATION

Urea is a widely used nitrogen fertilizer because it has a high nitrogen content, but it is highly soluble in water, leading to nutrient loss through leaching and volatilization. This study aims to analyze the characteristics of natural zeolite from Cipatujah Subdistrict, Tasikmalaya, after activation using HCl, NaCl, and NaOH; to determine its cation exchange capacity (CEC); and to evaluate the ammonium release pattern from urea-zeolite fertilizer formulations. The natural zeolite was prepared through washing, drying, grinding, and sieving, then activated using HCl, NaCl, and NaOH solutions. Characterization was performed through CEC testing, X-ray diffraction (XRD), crystallite size calculation using the Debye-Scherrer equation, Fourier transform infrared (FTIR) spectroscopy to detect functional groups, and ammonium release analysis using the indophenol method with a UV-Vis spectrophotometer at a wavelength of 640 nm. The results showed that HCl activation yielded the highest KTK value of 204 meq/100 g, making it the best zeolite for the urea impregnation stage. XRD results indicated that the zeolite was dominated by clinoptilolite, with quartz or silicate minerals present as minor phases. The average crystallite size of the HCl-activated zeolite was determined to be 17.07 nm. FTIR characterization results revealed the presence of characteristic zeolite functional groups, namely O-H, H-O-H, and Si-O-T, as indicated by absorption bands in the regions around 3413–3625 cm^{-1} , 1633–1638 cm^{-1} , 1045–1049 cm^{-1} , dan 794–795 cm^{-1} . The ammonium release test showed that conventional urea exhibited a high initial release, whereas the 25°C urea-zeolite formulation exhibited a more stable and gradual release compared to the 70°C urea-zeolite formulation. Thus, natural zeolite from Cipatujah has the potential to be used as a carrier in slow-release urea fertilizer formulations, particularly through impregnation at room temperature (25°C).

Keywords: ammonium; urea; cation exchange capacity; slow-release fertilizer; natural zeolite.