

ABSTRAK

PENGARUH *FLY ASH* BATUBARA TERHADAP PERBAIKAN KARAKTERISTIK TANAH DI LAHAN REKLAMASI TAMBANG NIKEL SULAWESI TENGGARA

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Kegiatan pertambangan nikel di Sulawesi Tenggara mengakibatkan tanah terdegradasi, yang dicirikan oleh pH yang asam, rendahnya ketersediaan unsur hara, CEC yang rendah, serta tingginya kelarutan aluminium (Al-dd) yang berpotensi toksik bagi tanaman, sehingga sulit direvegetasi secara alami. Penelitian ini bertujuan untuk mengevaluasi karakteristik kimia tanah untuk reklamasi tambang nikel dan *fly ash* batubara, serta menganalisis pengaruh *fly ash* sebagai bahan amelioran terhadap perbaikan pH, CEC, P-Tersedia, dan Al-dd pada tanah tersebut. Penelitian ini dilakukan menggunakan metode eksperimental skala laboratorium dengan Rancang Acak Kelompok (RAK). Perlakuan terdiri dari lima variasi dosis pencampuran *fly ash* (FA) terhadap tanah zona pengakaran, yaitu 0% (kontrol), 5%, 10%, 20%, dan 50%. Analisis data mencakup karakterisasi kimia, analisis unsur menggunakan *X-Ray Fluorescence* (XRF), serta analisis morfologi dan sebaran unsur menggunakan *Scanning Electron Microscope - Energy Dispersive X-ray Spectrometry* (SEM-EDS). Data kuantitatif dianalisis menggunakan uji ANOVA dan uji lanjut *Duncan Multiple Range Test* (DMRT).

Hasil karakterisasi awal menunjukkan tanah zona pengakaran bersifat asam (pH H₂O 5,64 dan pH KCl 5,45) dengan dominasi senyawa Fe₂O₃, sedangkan *fly ash* bersifat alkalis (pH H₂O 8,52) dan kaya akan oksida basa (CaO, MgO). Hasil eksperimen menunjukkan bahwa penambahan *fly ash* dengan dosis 5% hingga 20% berpengaruh nyata terhadap perbaikan sifat kimia tanah. Peningkatan pH, CEC, dan P-Tersedia terjadi seiring penambahan dosis hingga batas tertentu, serta mampu menekan Al-dd hingga tidak terdeteksi (0,00 cmol/kg). Dosis optimum diperoleh pada perlakuan 10% FA, yang menghasilkan pH H₂O 8,21, P-Tersedia 43,01 ppm, dan CEC 45,86 cmol/kg. Sebaliknya, pemberian dosis berlebih sebesar 50% menyebabkan penurunan kembali nilai pH, CEC, dan P-Tersedia, serta memicu munculnya kembali Al-dd. Analisis SEM-EDS pada komposit 10% FA mengonfirmasi adanya perbaikan morfologi tanah melalui pembentukan agregat yang lebih stabil serta distribusi unsur Ca dan Si yang merata, yang mendukung mekanisme netralisasi asam dan fiksasi fosfor.

Kata Kunci: *Fly Ash Batubara*, Nikel Laterit, pH, CEC, P-Tersedia, Al-dd.

ABSTRACT

INFLUENCE OF COAL FLY ASH ON SOIL CHARACTERISTICS IMPROVEMENT IN NICKEL MINE RECLAMATION LAND OF SOUTHEAST SULAWESI

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Nickel mining activities in Southeast Sulawesi have resulted in soil degradation, characterised by acidic pH, low nutrient availability, low CEC, and high aluminium solubility (Al-dd) that is potentially toxic to plants, making natural revegetation difficult. This study aims to evaluate the chemical characteristics of soil for nickel mine reclamation and coal fly ash, as well as to analyse the effect of fly ash utilisation as an ameliorant on improving pH, CEC, available P, and Al-dd in the soil. This study was conducted using a laboratory-scale experimental method with a Randomised Block Design (RBD). The treatment consisted of five variations of fly ash (FA) mixing doses to the root zone soil, namely 0% (control), 5%, 10%, 20%, and 50%. Data analysis included chemical characterisation, elemental analysis using X-Ray Fluorescence (XRF), and morphological and elemental distribution analysis using Scanning Electron Microscope - Energy Dispersive X-ray Spectrometry (SEM-EDS). Quantitative data were analysed using ANOVA and Duncan's Multiple Range Test (DMRT).

Initial characterisation results showed that the root zone soil was acidic (pH H₂O 5.64 and pH KCl 5.45) with a predominance of Fe₂O₃ compounds, while fly ash was alkaline (pH H₂O 8.52) and rich in basic oxides (CaO, MgO). The experimental results showed that the addition of fly ash at doses of 5% to 20% had a significant effect on improving soil chemical properties. Increases in pH, CEC, and available P occurred with increasing doses up to a certain limit, and were able to suppress Al-dd to undetectable levels (0.00 cmol/kg). The optimum dosage was obtained at 10% FA treatment, which resulted in pH H₂O 8.21, available P 43.01 ppm, and CEC 45.86 cmol/kg. Conversely, an excessive dosage of 50% caused a decrease in pH, CEC, and available P values, as well as triggering the reappearance of Al-dd. SEM-EDS analysis of the 10% FA composite confirmed improvements in soil morphology through the formation of more stable aggregates and uniform distribution of Ca and Si elements, supporting the mechanisms of acid neutralisation and phosphorus fixation.

Keywords: Fly ash, Reclamation Soil, Nickel, pH, CEC, Available P, Exchangeable Al.