

ABSTRAK

KAJIAN POTENSI KONTAMINASI AIR TANAH PADA PROSES *PRETREATMENT* BATUBARA MENGGUNAKAN H_2O_2 DALAM TEKNOLOGI *SUBSURFACE CULTIVATION* and *GASIFICATION*

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Pemanfaatan batubara peringkat rendah melalui teknologi *Surface Coal Gasification* (SCG) memerlukan tahap *pretreatment* untuk meningkatkan reaktivitas batubara, akan tetapi tahap *pretreatment* berpotensi mempengaruhi kondisi kimia dan kualitas air tanah. Penggunaan hidrogen peroksida (H_2O_2) sebagai agen *pretreatment* dapat menyebabkan perubahan pH, peningkatan *total dissolved solids* (TDS), serta mobilisasi logam berat. Penelitian ini bertujuan untuk menganalisis pengaruh penggunaan H_2O_2 dengan konsentrasi 3% dibandingkan kontrol (0%) terhadap perubahan pH, TDS, dan sisa H_2O_2 selama proses *pretreatment* batubara, mengidentifikasi logam berat yang berpotensi mempengaruhi kualitas air tanah, serta mengevaluasi efektivitas proses *leaching* dan kesesuaiannya terhadap baku mutu air limbah pertambangan batubara. Penelitian dilakukan menggunakan sampel batubara yang berasal dari Kecamatan Busang, Kabupaten Kutai Timur, Prov. Kalimantan Timur.

Penelitian ini menggunakan metode eksperimen laboratorium dengan variasi konsentrasi H_2O_2 (3% dan 0%), ukuran butir batubara 40, 60, dan 100 mesh, serta waktu reaksi selama 10 hari. Parameter yang dianalisis meliputi pH, TDS, sisa H_2O_2 , serta kadar logam berat Fe dan Mn pada larutan hasil *pretreatment* dan *leaching*. Analisis statistik dilakukan menggunakan regresi linier untuk mengevaluasi pengaruh variabel perlakuan terhadap perubahan parameter kualitas air, sedangkan hasil *leaching* dibandingkan dengan baku mutu air limbah pertambangan batubara berdasarkan Permen LHK Nomor 5 Tahun 2022.

Hasil penelitian menunjukkan bahwa penggunaan H_2O_2 3% secara signifikan menurunkan pH dan meningkatkan TDS akibat reaksi oksidatif dan pelepasan material terlarut dari matriks batubara, sementara sisa H_2O_2 menurun seiring bertambahnya waktu reaksi. Logam berat yang paling berpotensi mempengaruhi kualitas air tanah adalah Fe dan Mn, dengan mobilisasi Fe yang lebih dominan pada kondisi *pretreatment* menggunakan H_2O_2 . Proses *leaching* efektif dalam menurunkan TDS dan sisa H_2O_2 , namun belum efektif dalam memulihkan pH dan menurunkan konsentrasi Fe hingga memenuhi baku mutu pada variasi *pretreatment* 3% H_2O_2 , khususnya pada ukuran butir 40 dan 60 mesh, sementara konsentrasi Mn masih berada di bawah ambang batas baku mutu.

Kata kunci: Hidrogen Peroksida; Kualitas Air Tanah; *Leaching*; *Pretreatment* Batubara; *Subsurface Cultivation and Gasification*.

ABSTRACT

ASSESSMENT OF GROUNDWATER CONTAMINATION POTENTIAL IN COAL PRETREATMENT USING H_2O_2 IN SUBSURFACE CULTIVATION AND GASIFICATION TECHNOLOGY

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The utilization of low-rank coal through Surface Coal Gasification (SCG) technology requires a pretreatment stage to enhance coal reactivity; however, this stage may affect groundwater chemical conditions and quality. The use of hydrogen peroxide (H_2O_2) as a pretreatment agent can alter pH, increase total dissolved solids (TDS), and mobilize heavy metals. This study aims to analyze the effects of H_2O_2 at a concentration of 3% compared to a control (0%) on changes in pH, TDS, and residual H_2O_2 during coal pretreatment, identify heavy metals with the potential to affect groundwater quality, and evaluate the effectiveness of the leaching process and its compliance with coal mining wastewater quality standards. The study was conducted using coal samples from Busang District, East Kutai Regency, East Kalimantan Province.

This research employed a laboratory experimental method with variations in H_2O_2 concentration (3% and 0%), coal particle sizes of 40, 60, and 100 mesh, and a reaction time of 10 days. The analyzed parameters included pH, TDS, residual H_2O_2 , and concentrations of Fe and Mn in solutions obtained from pretreatment and leaching. Statistical analysis using linear regression was applied to evaluate the influence of treatment variables on water quality changes, while leaching results were compared with coal mining wastewater standards stipulated in the Decree of the Minister of Environment and Forestry of Indonesia (Permen LHK) No. 5 of 2022.

The results show that the use of 3% H_2O_2 significantly decreased pH and increased TDS due to oxidative reactions and the release of dissolved materials from the coal matrix, while residual H_2O_2 declined with increasing reaction time. The heavy metals with the greatest potential impact on groundwater quality were Fe and Mn, with Fe showing more dominant mobilization under H_2O_2 pretreatment conditions. The leaching process was effective in reducing TDS and residual H_2O_2 but was not effective in restoring pH or reducing Fe concentrations to meet regulatory standards under the 3% H_2O_2 condition, particularly for particle sizes of 40 and 60 mesh, whereas Mn concentrations remained below the regulatory threshold.

Keywords: Coal Pretreatment; Groundwater Quality; Hydrogen Peroxide; Leaching; Subsurface Cultivation and Gasification.