ABSTRAK

PELUNAKAN AIR SADAH DENGAN PERTUKARAN ION OLEH RESIN Na^+ DAN ZEOLIT ALAM TERAKTIVASI DI MATA AIR SULU, KABUPATEN GUNUNG KIDUL

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Mata Air Sulu di Dusun Gedaren 2, Kelurahan Sumbergiri, Kecamatan Ponjong, Kabupaten Gunungkidul dimanfaatkan masyarakat untuk keperluan higiene dan sanitasi. Namun, kondisi geologi karst Formasi Wonosari menyebabkan air memiliki tingkat kesadahan yang tinggi. Penelitian ini bertujuan menganalisis karakteristik Mata Air Sulu, menentukan fasies kimia air, mengevaluasi efektivitas pelunakan air sadah dengan metode pertukaran ion menggunakan resin Na^+ dan zeolit alam teraktivasi (ZAT) NaOH 1 N, serta merumuskan arahan pengelolaan air. Penelitian menggunakan metode kuantitatif dan kualitatif melalui survei lapangan, wawancara, analisis laboratorium, dan eksperimen kolom packing bed aliran downflow pada variasi media ZAT dan RNa^+ serta EBCT 15 dan 30 menit dengan waktu operasi selama 1 jam. Parameter yang dianalisis meliputi debit, kontinuitas, kualitas air berupa ion mayor, kekeruhan, TDS, pH, dan kesadahan. Hasil penelitian menunjukkan Mata Air Sulu memiliki debit rata-rata 0,9792 L/det dengan kontinuitas aliran yang stabil. Kualitas Mata Air Sulu belum sepenuhnya memenuhi baku mutu untuk keperluan higiene dan sanitasi berdasarkan Permenkes RI No. 2 Tahun 2023, yang ditunjukkan oleh nilai TDS yang masih melebihi baku mutu. Selain itu, air memiliki nilai kesadahan sebesar 381,09 mg/L yang tergolong sangat sadah berdasarkan klasifikasi Todd (2005). Fasies kimia air didominasi tipe kalsium–bikarbonat ($Ca–HCO_3$), yang mencerminkan pengaruh pelarutan batuan karbonat pada akuifer karst berdasarkan dominasi zona interaksi batuan-air. Hasil pelunakan air menunjukkan mekanisme pertukaran ion Ca^{2+} dengan Na^+ yang efektif menurunkan kesadahan hingga 98%, meskipun diikuti peningkatan beberapa parameter seperti TDS, pH, dan natrium akibat proses substitusi ion. Resin Na^+ dan ZAT efektif dengan kisaran penurunan kesadahan 94%–98%, namun resin Na^+ pada EBCT 15 menit menunjukkan kinerja paling optimal dan lebih stabil dibandingkan zeolit yang cenderung fluktuatif. Oleh karena itu, metode yang direkomendasikan untuk pengelolaan air adalah pertukaran ion menggunakan kolom downflow packing bed dengan media resin penukar ion Na^+.

Kata kunci: EBCT, Mata Air Sulu, fasies kimia air, pelunakan air, pertukaran ion, resin Na^+, zeolit alam teraktivasi.

ABSTRACT

HARD WATER SOFTENING BY ION EXCHANGE USING Na^+ RESIN AND ACTIVATED NATURAL ZEOLITE AT SULU SPRING, GUNUNGKIDUL REGENCY

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Sulu Spring in Gedaren 2 Hamlet, Sumbergiri Village, Ponjong District, Gunungkidul Regency, is utilized by the local community for hygiene and sanitation purposes. However, the karst geological conditions of the Wonosari Formation result in high water hardness. This study aims to analyze the characteristics of Sulu Spring, determine the hydrochemical facies, evaluate the effectiveness of hardness removal using ion exchange methods with Na^+ resin and NaOH 1 N–activated natural zeolite, and formulate water management recommendations. The study employed quantitative and qualitative methods through field surveys, interviews, laboratory analysis, and downflow packed bed column experiments with different media and EBCT variations of 15 and 30 minutes with a total operating time of 1 hour. The analyzed parameters include discharge, continuity, water quality parameters consisting of major ions, turbidity, TDS, pH, and hardness. The results show that Sulu Spring has an average discharge of 0.9792 L/s with stable flow continuity. The water quality generally meets the clean water standards for hygiene and sanitation based on the Indonesian Minister of Health Regulation No. 32 of 2017; however, the hardness value of 381.09 mg/L as $CaCO_3$ is classified as very hard, and TDS still exceeds the standard. The hydrochemical facies is dominated by the calcium–bicarbonate ($Ca–HCO_3$) type, indicating the influence of carbonate rock dissolution in the karst aquifer, as reflected by the dominance of the rock–water interaction zone. The ion exchange process effectively reduces hardness through the exchange of Ca^{2+} with Na^+, achieving up to 98% removal, although it is accompanied by increases in TDS, pH, and sodium due to ion substitution mechanisms. Both Na^+ resin and natural zeolite are effective, with hardness reduction ranging from 94% to 98%, while the Na^+ resin at 15-minute EBCT shows the best performance and greater stability compared to zeolite, which tends to be more fluctuating. Therefore, the recommended treatment method is ion exchange using a downflow packed bed column with Na^+ resin as the exchange media.

Keywords: *EBCT, Sulu Spring, hydrochemical facies, water softening, ion exchange, Na^+ resin, activated natural zeolite.*