EFEKTIVITAS METODE *FIXED BED ADSORPTION* ARANG AKTIF DAN ZEOLIT AKTIF PADA PENGOLAHAN AIR TERPRODUKSI SUMUR TUA MINYAK BUMI WONOCOLO, JAWA TIMUR

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INTISARI

Air terproduksi dari aktivitas sumur tua minyak bumi di kawasan Wonocolo, Bojonegoro, merupakan limbah dengan kandungan pencemar organik dan anorganik yang berpotensi mencemari lingkungan apabila dibuang tanpa pengolahan. Penelitian ini bertujuan untuk mengkaji kadar kualitas air terproduksi berdasarkan parameter minyak lemak, TDS, dan amonia, mengkaji kualitas dan status mutu air Anak sungai Bengawan Solo, mengevaluasi efektivitas media adsorben arang aktif dan zeolit aktif dalam menurunkan konsentrasi parameter pencemar utama yaitu minyak dan lemak, TDS, dan amonia, menganalisis pengaruh waktu detensi terhadap kinerja sistem *fixed bed adsorption*, menganalisis kapasitas adsorpsi dari zeolit aktif dan arang aktif dan menganalisis rekomendasi arahan pengelolaan terkait upaya pemenuhan kebutuhan air sungai kelas III pada sungai outlet air terproduksi di sumur tua minyak bumi Wonocolo. Percobaan dilakukan pada skala laboratorium menggunakan dua reaktor yang masing-masing diisi dengan media arang aktif dan zeolit aktif, dengan variasi waktu tinggal dari 0 hingga 4 jam.

Pengumpulan data terdiri dari metode observasi lapangan dan analisis data sekunder. Metode analisis dan evaluasi dilakukan dengan menggunakan metode analisis matematis yakni perhitungan indeks pencemaran, perhitungan efisiensi, regresi linear sederhana, dan perhitungan kapasitas adsorpsi. Rancangan percobaan dilakukan secara eksperimental menggunakan unit adsorpsi yakni sistem *fixed bed adsorption* skala laboratorium yang terdiri atas dua reaktor adsorpsi. Sampel air terproduksi dialirkan ke masing reaktor dengan variasi waktu detensi selama 0 jam; 1 jam; 2 jam; 3 jam; dan 4 jam. Parameter yang dianalisis meliputi konsentrasi minyak dan lemak, TDS, serta amonia, yang diukur sebelum dan sesudah perlakuan adsorpsi.

Hasil uji laboratorium menunjukan kualitas air terproduksi berdasarkan parameter minyak lemak, dan TDS menunjukkan kadar TDS sebesar 5125 mg/L; amonia sebesar 4,402 mg/L; dan minyak lemak sebesar 80,8 mg/L. Sedangkan, kualitas air dan status mutu Anak sungai Bengawan Solo menunjukkan hasil tercemar sedang pada ketiga titik sampling. Berdasarkan hasil rancangan percobaan, adsorpsi dengan arang aktif efektif dalam menurunkan minyak dan lemak dengan efisiensi penurunan mencapai 99,89%. Zeolit aktif menunjukkan efektivitas tinggi terhadap amonia (hingga 99,798%) dan TDS (hingga 57,854%). Selain itu, waktu detensi ikut serta mempengaruhi penurunan parameter minyak lemak, TDS, dan ammonia. Berdasarkan analisis kapasitas adsorpsi, zeolit aktif lebih baik dalam menurunkan TDS dan ammonia dengan kapasitas adsorpsi tertinggi bernilai 12,863 mg/g, sedangkan parameter minyak dan lemak memiliki sifat hidrofobik, sehingga memiliki karakteristik adsorpsi yang berbeda dibandingkan parameter lainnya. Arahan pengelolaan yang direkomendasikan pada penelitian ini berupa desain instalasi pengelolaan air limbah dengan 3 bak utama yakni bak grease trap, bak pengumpul, dan 2 bak adsorpsi bertingkat dengan adsorben arang pada bak pertama, dan zeolit pada bak kedua. Arahan pengelolaan ini direkomendasikan untuk menunjang kualitas air agar dapat memenuhi baku mutu sungai III.

Kata kunci: air terproduksi, arang aktif, zeolit aktif, *Fixed Bed Adsorption*

EFFECTIVENESS OF FIXED BED ADSORPTION METHOD OF ACTIVATED CHARCOAL AND ACTIVATED ZEOLITE IN PRODUCED WATER TREATMENT OF OLD OIL WELLS IN WONOCOLO, EAST JAVA

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ABSTRACT

Produced water from old oil wells in the Wonocolo area of Bojonegoro is waste containing organic and inorganic pollutants that have the potential to pollute the environment if discharged without treatment. This study aims to assess the quality of produced water based on oil and fat parameters, TDS, and ammonia; assess the water quality status of Bengawan Solo tributaries; evaluate the effectiveness of activated charcoal and activated zeolite adsorbents in reducing the concentrations of key pollutant parameters, namely oil and fat, TDS, and ammonia; analyze the effect of detention time on the performance of the fixed bed adsorption system; analyze the adsorption capacity of activated zeolite and activated charcoal; and analyze management recommendations related to efforts to meet the needs of Class III river water at the outlet river of produced water from the old Wonocolo oil well. Experiments were conducted at a laboratory scale using two reactors, each filled with activated charcoal and activated zeolite, with varying retention times ranging from 0 to 4 hours.

Data collection consisted of field observation and secondary data analysis. The analysis and evaluation methods were conducted using mathematical analysis, including pollution index calculations, efficiency calculations, simple linear regression, and adsorption capacity calculations. The experimental design was conducted using an adsorption unit, a laboratory-scale fixed-bed adsorption system consisting of two adsorption reactors. Produced water samples were flowed through each reactor with varying detention times of 0 hour, 1 hour, 2 hours, 3 hours, and 4 hours. Parameters analyzed included oil and grease concentration, TDS, and ammonia, which were measured before and after the adsorption treatment.

Laboratory test results showed produced water quality based on oil and grease parameters, with TDS levels of 5125 mg/L, ammonia levels of 4,402 mg/L, and oil and grease levels of 80.8 mg/L. Meanwhile, the water quality and quality status of the Bengawan Solo tributary indicated moderate pollution at all three sampling points. Based on the experimental design results, adsorption with activated charcoal was effective in reducing oil and grease, with a reduction efficiency of 99.89%. Active zeolite shows high effectiveness against ammonia (up to 99.798%) and TDS (up to 57.854%). In addition, detention time also affects the reduction of oil, fat, TDS, and ammonia parameters. Based on the adsorption capacity analysis, active zeolite is better at reducing TDS and ammonia with the highest adsorption capacity of 12.863 mg/g, while oil and fat parameters have hydrophobic properties, so they have different adsorption characteristics compared to other parameters. The recommended management direction in this study is the design of a wastewater treatment installation with 3 main tanks, namely a grease trap tank, a collection tank, and 2 tiered adsorption tanks with charcoal adsorbent in the first tank, and zeolite in the second tank. This management direction is recommended to support water quality so that it can meet river quality standards III.

Keywords: *produced water, activated carbon, activated zeolit, Fixed Bed Adsorption*