

ABSTRAK

KAJIAN EFEKTIVITAS METODE *FIXED BED ADSORPTION* DENGAN MEDIA ZEOLIT AKTIF DAN KARBON AKTIF DALAM UPAYA REMEDIASI AIR LUMPUR SIDOARJO

Oleh :

B. Prasanna Yefta Muliari

114210043

(Program Studi Sarjana Teknik Lingkungan)

Lumpur Sidoarjo dikenal sebagai bencana lumpur panas yang tidak hanya mengeluarkan material padatan saja, melainkan juga material air. Air lumpur Sidoarjo direncanakan akan dibuang ke dalam sungai Ketapang, namun air lumpur ini memiliki kadar klorida yang melebihi ambang baku mutu. Tujuan penelitian terdiri dari mengetahui karakteristik air lumpur Sidoarjo; mengetahui kualitas air sungai Ketapang; menganalisis kemampuan unit *fixed bed adsorption* berdasarkan nilai efektivitasnya dan pengaruh variasi waktu operasional terhadap penurunan parameter terkait; serta memberikan rekomendasi arahan pengelolaan agar dapat memenuhi baku mutu air kelas II dan dapat dibuang ke sungai Ketapang.

Penelitian dilakukan dengan metode kuantitatif. Pengumpulan data terdiri dari pengamatan langsung dan analisis data sekunder. Penentuan titik *sampling* dilakukan dengan metode *purposive sampling*, sedangkan pengambilan sampel air sungai Ketapang dan air lumpur Sidoarjo dilakukan dengan *grab sampling*. Metode analisis data dan evaluasi dilakukan dengan perhitungan kapasitas adsorpsi, analisis matematis dengan regresi linear sederhana, dan analisis statistik deskriptif. Uji percobaan dilakukan dengan kolom *fixed bed adsorption* skala laboratorium menggunakan Reaktor 1 dengan komposisi zeolit aktif 75%: karbon aktif 25% dan Reaktor 2 dengan komposisi zeolit aktif 25% : karbon aktif 75%. Masing-masing dilakukan dengan variasi waktu operasional 1 jam; 2 jam; 3 jam; 4 jam; 5 jam; dan 6 jam.

Hasil uji laboratorium kualitas air lumpur Sidoarjo menunjukkan kadar TDS sebesar 20.280 mg/L dan klorida sebesar 16.262,2 mg/L yang masih melebihi batas baku mutu menurut PP RI Nomor 22 Tahun 2021 tentang Baku Mutu Air Nasional (Baku Mutu air Sungai dan sejenisnya) Kelas III. Dari hasil penelitian diketahui bahwa Reaktor 1 dengan komposisi zeolite dominan (zeolit aktif 75% dan karbon aktif 25%) mempunyai nilai efektivitas pengolahan yang paling tinggi dibandingkan Reaktor 2, yaitu mampu menurunkan kadar TDS dan klorida secara berturut-turut sebesar 60,631% dan 61,963%. Uji regresi linear sederhana untuk pengolahan pada reaktor 1 menunjukkan pengaruh variasi waktu operasional pada penurunan kadar TDS sebesar 92,4% dan kadar klorida sebesar 91,4%. Arahan pengelolaan direkomendasikan berupa desain unit kolom *fixed bed adsorption* bermedia karbon aktif dan zeolit aktif diameter 60 cm dan tinggi media 160 cm dengan debit inlet 0,3 L/s, berjumlah 5 unit kolom *fixed bed adsorption* yang disusun secara seri agar proses pengolahan lebih optimal.

Kata kunci: air lumpur Sidoarjo, adsorpsi, *fixed bed adsorption*, *Total Dissolved Solids* (TDS), Klorida (Cl⁻)

ABSTRACT

STUDY ON THE EFFECTIVENESS OF THE FIXED BED ADSORPTION METHOD USING ACTIVATED ZEOLITE AND ACTIVATED CARBON MEDIA FOR THE REMEDIATION OF SIDOARJO MUDWATER

By :

B. Prasanna Yefta Muliari

114210043

(Environmental Engineering Undergraduated Program)

The Sidoarjo mudflow is recognized as a mud volcano disaster that discharges not only solid material but also water. The water from the Sidoarjo mudflow is planned to be discharged into the Ketapang River; however, it contains chloride levels that exceed the quality standard threshold. The objectives of this study are to determine the characteristics of Sidoarjo mud water, assess the water quality of the Ketapang River, analyze the performance of a fixed-bed adsorption unit based on its effectiveness and the influence of operational time variation on the reduction of related parameters, and provide management recommendations to meet Class II water quality standards so that it can be discharged into the Ketapang River.

The research was conducted using a quantitative method. Data collection consisted of direct observation and secondary data analysis. Sampling points were determined using the purposive sampling method, while water samples from the Ketapang River and Sidoarjo mud were collected using grab sampling. Data analysis and evaluation were carried out through adsorption capacity calculation, mathematical analysis using simple linear regression, and descriptive statistical analysis. Laboratory-scale fixed-bed adsorption column experiments were conducted using two reactors: Reactor 1 (75% activated zeolite and 25% activated carbon) and Reactor 2 (25% activated zeolite and 75% activated carbon). Each reactor was operated with varying operational times of 1, 2, 3, 4, 5, and 6 hours.

Laboratory test results of Sidoarjo mud water quality showed TDS levels of 20,280 mg/L and chloride levels of 16,262.2 mg/L, both exceeding the quality standards according to Government Regulation of the Republic of Indonesia (PP RI) Number 22 of 2021 on National Water Quality Standards (River and similar water bodies) Class III. The findings revealed that Reactor 1, dominated by zeolite composition (75% activated zeolite and 25% activated carbon), achieved the highest treatment effectiveness compared to Reactor 2, reducing TDS and chloride concentrations by 60.631% and 61.963%, respectively. Simple linear regression analysis for Reactor 1 showed that operational time variation significantly affected TDS reduction (92.4%) and chloride reduction (91.4%). The management recommendation is to design a fixed-bed adsorption column unit with activated carbon and activated zeolite media, 60 cm in diameter and 160 cm in media height, with an inlet flow rate of 0.3 L/s, consisting of five fixed-bed adsorption columns arranged in series to optimize the treatment process.

Keywords: *Sidoarjo mudwater, adsorption, fixed bed adsorption, Total Dissolved Solids (TDS), Chloride (Cl⁻)*