INTISARI

Air sumur merupakan salah satu sumber air bersih utama masyarakat Indonesia, namun sering dijumpai mengandung logam besi (Fe) dan mangan (Mn) dengan konsentrasi melebihi ambang batas baku mutu. Kandungan Fe dan Mn yang tinggi tidak hanya menimbulkan masalah estetika seperti warna kekuningan, bau logam, dan noda pada peralatan rumah tangga, tetapi juga dapat membahayakan kesehatan manusia. Oleh karena itu, diperlukan teknologi pengolahan sederhana, efektif, dan ramah lingkungan. Salah satu metode yang potensial adalah adsorpsi menggunakan karbon aktif berbasis limbah organik seperti ampas teh dan ampas kopi, yang kaya akan lignoselulosa dan berpotensi besar sebagai bahan baku adsorben alternatif.

Penelitian ini bertujuan untuk menentukan kondisi optimum proses adsorpsi karbon aktif dari ampas teh dan ampas kopi dalam menurunkan kadar logam Fe dan Mn pada air sumur sintetis. Variabel penelitian meliputi variasi dosis adsorben (0,2–0,8 gram), waktu kontak (15–60 menit), dan kecepatan pengadukan (260–700 rpm). Karakterisasi adsorben dilakukan menggunakan *Fourier Transform Infrared Spectroscopy* (FTIR) untuk mengidentifikasi gugus fungsional aktif pada permukaan karbon aktif.

Hasil penelitian menunjukkan bahwa kondisi optimum diperoleh pada dosis 0,8 gram, waktu kontak 60 menit, dan kecepatan pengadukan pada rentang 430-600 rpm. Pada kondisi tersebut, karbon aktif dari ampas teh mampu menurunkan kadar Fe sebesar 99,36 – 99,78% dan Mn sebesar 80,56 – 94,12%, sedangkan karbon aktif dari ampas kopi menunjukkan kinerja lebih tinggi dengan penurunan Fe mencapai 99,42 – 99,60% dan Mn sebesar 80,00 – 84,62%. Analisis FTIR memperlihatkan peningkatan intensitas gugus –OH, –COOH, dan C=C aromatik setelah aktivasi NaOH 0,1 N yang berperan penting dalam proses adsorpsi. Selain itu, hasil uji kinetika menunjukkan bahwa proses adsorpsi mengikuti model pseudo-orde dua, yang mengindikasikan mekanisme *chemisorption*. Analisis isoterm adsorpsi mengungkapkan bahwa ion Mn teradsorpsi pada permukaan heterogen (sesuai model Freundlich), sedangkan adsorpsi ion Fe tidak mengikuti pola kedua model tersebut.

Secara keseluruhan, hasil penelitian ini menunjukkan bahwa karbon aktif dari ampas teh dan ampas kopi memiliki efektivitas tinggi dalam menurunkan logam Fe dan Mn pada air sumur, dengan kinerja optimum dicapai pada dosis 0,8 gram dan waktu kontak 60 menit. Pemanfaatan limbah organik ini diharapkan dapat menjadi solusi berkelanjutan untuk pengolahan air bersih yang efisien dan ramah lingkungan.

Kata kunci: air sumur, adsorpsi, karbon aktif, ampas teh, ampas kopi, logam berat.

ABSTRACT

Groundwater wells are one of the main sources of clean water for Indonesian communities: however, they are often contiminated with heavy metals such as iron (Fe) and manganese (Mn) at concentrations exceeding the quality standards. High levels of Fe and Mn not only cause aesthetic problems such as yellowish color, metallic odor, and stains on household equipment but also pose significant health risks. Therefore, a simple, effective, and environmentally friendly treatment technology is required. Adsorption using activated carbon derived from organic waste, such as tea and coffee grounds, offers great potential as an alternative adsorbent due to its lignocellulosic content and porous structure.

The study aimed to analyze the effectiveness of activated carbon produced from tea and coffee grounds in reducing Fe and Mn concentrations in synthetic well water. The research variables included adsorbent dosage (0,2–0,8 g), contact time (15–60 minutes), and stirring speed (260–700 rpm). The adsorbents were characterized using Fourier Transform Infrared Spectroscopy (FTIR) to identify active functional groups. Batch adsorption experiments were conducted to evaluate adsorption effectiveness, adsorption capacity, and adsorption kinetics based on pseudo-first-order and pseudo-second-order models.

The results showed that the optimum conditions were obtained at a dosage of 0.8 g, a contact time of 60 minutes, and a stirring speed ranging from 430 to 600 rpm. Under these conditions, activated carbon derived from tea grounds was able to reduce Fe concentrations by 99,36 – 99,78% and Mn by 80,56 – 94,12%, while activated carbon from coffee grounds demonstrated slightly higher performance, achieving Fe removal efficiencies of 99,42 – 99,60% and Mn of 80,00 – 84,62%. FTIR analysis revealed an increase in the intensity of –OH, –COOH, and aromatic C=C functional groups after activation with 0,1 N NaOH, which play a crucial role in the adsorption process. Furthermore, kinetic analysis indicated that the adsorption process followed the pseudo-second-order model, suggesting that the dominant mechanism involved chemisorption. The adsorption isotherm analysis revealed that Mn ions were adsorbed onto a heterogeneous surface (following the Freundlich model), whereas Fe adsorption did not conform to the pattern of either model.

Overall, this study demonstrates that tea and coffee grounds can be utilized as promising raw materials for activated carbon to reduce heavy metal concentrations in well water. The findings highlight their potential as eco-friendly and practical adsorbents for household-scale water treatment applications.

Keywords: well water, adsorption, activated carbon, tea ground, coffee ground, heavy metal.