



INTISARI

Air limpasan tambang batu bara umumnya memiliki kandungan ion logam dan kekeruhan yang tinggi, sehingga mengancam kesehatan masyarakat dan lingkungan. Namun, jika dilakukan proses pengolahan yang efektif air limpasan tambang batu bara dapat menjadi alternatif sumber air bersih. Penelitian ini bertujuan untuk menganalisis pengaruh *oxidation-reduction potential* (ORP) sebagai parameter kunci dalam mengontrol proses ozonisasi dalam menyisihkan ion besi dan kekeruhan. Pemilihan proses ozonisasi yang disertai kontrol ORP dinilai menjadi strategi yang efektif, sebab ORP memberikan indikasi kondisi oksidatif dalam sistem, yang memungkinkan pengaturan suplai ozon sesuai dengan kebutuhan aktual.

Proses ozonisasi dilakukan dalam reaktor *batch* selama 1 jam dengan variasi rentang nilai ORP 400-500 mV, 500-600 mV, 600-700 mV, 700-800 mV, dan 800-900 mV. Pengambilan sampel dilakukan pada menit ke-30 dan ke-60. Selain itu, perubahan karakteristik fisik kimia (pH, *electrical conductivity*, dan *total dissolved solids*) juga dievaluasi untuk memberikan pemahaman yang lebih komprehensif terkait pengaruh ORP terhadap hasil proses ozonisasi. Uji ANOVA *single factor* dilakukan untuk menganalisis pengaruh ORP secara statistik.

Hasil penelitian menunjukkan efisiensi penyisihan ion besi dan kekeruhan serta perubahan karakteristik fisik kimia selama proses ozonisasi dipengaruhi oleh ORP. Pengaturan ORP rentang 400-500 mV memberikan hasil pengolahan paling optimum dengan nilai efisiensi penyisihan besi sebesar 81% di waktu 30 menit dan 92% setelah sistem bekerja selama 60 menit. Proses ozonisasi dengan pengaturan ORP 400-500 mV mampu menyisihkan kandungan besi hingga memenuhi standar baku mutu kualitas air bersih menurut Permenkes Nomor 2 Tahun 2023. Sementara pada proses penurunan kekeruhan, pengaturan ORP 400-500 mV dan 500-600 mV menghasilkan pengolahan terbaik dengan nilai efisiensi penurunan sebesar 53% saat sistem bekerja selama 60 menit. Namun pada semua pengaturan ORP, ozonisasi belum mampu menurunkan kekeruhan hingga memenuhi standar baku kualitas air bersih sesuai yang disyaratkan pada Permenkes Nomor 2 Tahun 2023, sehingga diperlukan pengolahan tambahan.

Kata kunci: Air Limpasan Tambang Batu Bara, *Oxidation Reduction Potential* (ORP), Ozonisasi, Ion besi, Kekeruhan

ABSTRACT

Coal mining runoff usually contains high metal ions and turbidity, which threatens the environment and public health. However, if effective treatment were conducted, coal mining runoff could be an alternative to clean water sources. This research is conducted to analyze the oxidation-reduction potential (ORP) effect as a key parameter in controlling the ozonation process for removing iron ions and turbidity. Choosing an ozonation process-based ORP control system is assessed as an effective strategy because ORP indicates the oxidative condition in the system, which allows the ozone supply to be set according to the actual needs.

The ozonation process was done in batch reactor for 1 hour with ORP set points range variations 400-500 mV, 500-600 mV, 600-700 mV, 700-800 mV, and 800-900 mV, with sampling conducted at 30 and 60 minutes. In addition, changes in physical-chemical characteristics (pH, electrical conductivity, and total dissolved solids) were also evaluated to provide a more comprehensive understanding of the effect of ORP on the results of the ozonation process. A single-factor ANOVA test was conducted to analyze the effect of ORP statistically.

Research findings indicate that the removal efficiency of iron ions and turbidity, as well as the changes in physical-chemical characteristics during the ozonation process, are influenced by ORP. ORP set point 400-500 mV gives the most optimum result with 81% of the system working within 30 minutes and 92% removal efficiency value after the system was working for 60 minutes. The ozonation process with ORP set point 400-500 mV able to remove iron to meet the clean water quality standard as required by the Minister of Health Regulation Number 2 of 2023. Meanwhile, in the process of decreasing turbidity, ORP set points 400-500 and 500-600 mV, resulting in the best processing with removal efficiency values of 53%. However, in all ORP set points, ozonation is not able yet to decrease turbidity to meet the clean water quality standards as required by the Minister of Health Regulation Number 2 of 2023, so it needs additional treatment.

Keywords: Coal mining runoff, oxidation reduction potential, ozonation, iron, kekeruhan