INTISARI

Sektor industri merupakan salah satu penyumbang utama pencemaran udara yang berpotensi menimbulkan dampak terhadap kesehatan masyarakat. Salah satu pendekatan yang dapat digunakan untuk menganalisis dan memitigasi penyebaran polutan adalah melalui pemodelan dispersi emisi. Penelitian ini bertujuan untuk mengevaluasi akurasi model AERMOD terhadap hasil pengukuran lapangan serta menganalisis pola persebaran, distribusi, dan area berpotensi terpapar emisi SO_2, NH_3, dan TSP dari PT X di Kabupaten Gresik. Studi ini juga bertujuan untuk menilai pengaruh variasi jumlah data meteorologi, tinggi cerobong, dan debit emisi terhadap konsentrasi dispersi.

Pemodelan dilakukan menggunakan *software* AERMOD yang berbasis pada *Gaussian Plume Model*, dengan data meteorologi periode 1 bulan, 1 tahun, dan 3 tahun. Setiap skenario pemodelan dihitung pada tiga skala waktu (rata-rata 1 jam, 24 jam, dan 1 tahun) untuk masing-masing parameter polutan. Validasi hasil simulasi terhadap data pengukuran lapangan dilakukan menggunakan *Root Mean Square Error (RMSE)* untuk menilai akurasi model, sedangkan pengujian sensitivitas antarvariabel dilakukan menggunakan Uji ANOVA Tiga Arah guna mengetahui signifikansi pengaruh dari setiap variabel bebas.

Hasil validasi menunjukkan bahwa akurasi model tergolong rendah dengan nilai error antara 58–100% dan RMSE 2,85–257,155 akibat keterbatasan nilai observasi yang masih berupa pendekatan. Pola persebaran emisi menunjukkan variasi sesuai skala waktu: pola radial pada rata-rata 1 jam, pola bercabang acak pada 24 jam, dan pola elips horizontal pada 1 tahun. Konsentrasi tertinggi umumnya terjadi pada radius 140–835 meter dari sumber, sedangkan konsentrasi terendah berada pada radius sekitar 4–7 km. Area yang paling berpotensi terpapar emisi berada di Kecamatan Gresik (Desa Tlogopojok dan Desa Lumpur) serta Kecamatan Manyar (Desa Romo). Hasil uji statistik menunjukkan bahwa tinggi cerobong berpengaruh signifikan terhadap konsentrasi emisi, sedangkan jumlah data meteorologi tidak signifikan. Secara keseluruhan, penelitian ini memberikan gambaran pola dispersi emisi industri yang dapat menjadi acuan dalam mitigasi pencemaran udara dan perencanaan tata ruang berbasis kesehatan lingkungan.

Kata kunci: Dispersi, AERMOD, Konsentrasi, Emisi, Gresik

ABSTRACT

The industrial sector is one of the major contributors to air pollution, which poses potential risks to public health. One effective approach to anticipate and mitigate pollutant dispersion is through emission dispersion modeling. This study aims to evaluate the accuracy of the AERMOD model compared with field measurements and to analyze the dispersion patterns, distribution, and areas potentially exposed to SO_2, NH_3, and TSP emissions from PT X, located in Gresik Regency, Indonesia. In addition, this research assesses the influence of variations in meteorological data, stack height, and emission flow rate on pollutant concentration distribution.

The emission dispersion modeling was conducted using AERMOD *software*, which is based on the *Gaussian Plume Model*, with meteorological data 1-month, 1-year, and 3-year periods. Simulations were performed for three pollutants under varying stack heights and emission flow rates to obtain average concentrations over 1-hour, 24-hour, and 1-year intervals. Model validation was carried out by comparing simulation results with field measurements using the Root Mean Square Error (RMSE) method to evaluate model accuracy, while the Three-Way ANOVA Test was employed to analyze the statistical significance of each independent variable.

The validation results indicated that the model accuracy was relatively low, with error values ranging from 58% to 100% and RMSE values between 2,85 and 257,155 primarily due to the limitations of observational data, which were partly based on estimation. The dispersion patterns varied according to the temporal scale, forming a radial pattern for 1-hour averages, irregular branching for 24-hour averages, and horizontal ellipses for annual averages. The highest emission concentrations generally occurred within a radius of 140–835 meters from the stack, while the lowest concentrations were found at approximately 4–7 km. The areas most affected by emissions were identified in Gresik District (Tlogopojok and Lumpur Villages) and Manyar District (Romo Village). The ANOVA test showed that stack height had a significant effect on emission concentration, whereas the amount of meteorological data did not. Overall, this study provides an overview of industrial emission dispersion patterns that can serve as a reference for air pollution mitigation and environmentally oriented spatial planning.

Keywords: Disperse, AERMOD, Concentration, Emission, Gresik