PEMODELAN DISPERSI CO DAN NO_2 SERTA SIMULASI O_3 TROPOSFER UNTUK ANALISIS REZIM FOTOKIMIA DI TOL LAYANG SOLO-YOGYAKARTA

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INTISARI

Pembangunan Jalan Tol Solo-Yogyakarta-NYIA berpotensi meningkatkan pencemaran udara akibat emisi kendaraan. Penelitian ini bertujuan memodelkan sebaran NO_2, CO, dan O_3 di koridor jalan tol, mengevaluasi pengaruh lalu lintas terhadap emisi dan pembentukan O_3, serta merumuskan implikasi kebijakan pengelolaan kualitas udara.

Pemodelan NO_2 dan CO menggunakan AERMOD dengan input meteorologi (2014-2023), data lalu lintas, dan faktor emisi. Pemodelan O_3 menggunakan box model fotokimia 0-D di MATLAB yang dikalibrasi dengan data lapangan. Validasi model menggunakan metrik statistik. Analisis risiko kesehatan dan life cycle impact assessment dilakukan untuk evaluasi kebijakan.

Hasil menunjukkan AERMOD mampu merepresentasikan magnitudo konsentrasi (FAC2 = 1,00) namun terbatas pada dinamika temporal. Proyeksi 2032 menunjukkan konsentrasi maksimum 1 jam NO_2 mencapai 780 µg/m³ dan CO 32400 µg/m³ pada kecepatan rendah, melampaui baku mutu. Pada kecepatan operasional tol (65-70 km/jam), konsentrasi NO_2 turun drastis (8,79-22,44 µg/m³). Simulasi ozon mengidentifikasi rezim VOC-limited dengan konsentrasi VOC optimal 29 µg/m³, di mana peningkatan NO_x justru menurunkan O_3 melalui titrasi (O_3 maksimum 62,9 µg/m³, di bawah baku mutu). Analisis risiko menunjukkan nilai RQ NO_2 > 1 pada 9 dari 10 titik di tahun 2032, sementara CO aman. Skenario EURO 5 dan manajemen kecepatan terbukti efektif menurunkan beban emisi.

Kata kunci : Jalan tol, AERMOD, dispersi polutan, ozon troposfer, VOC-limited, analisis risiko kesehatan

CO AND NO_2 DISPERSION MODELING AND TROPOSPHERIC O_3 SIMULATION FOR PHOTOCHEMICAL REGIME ANALYSIS AT SOLO-YOGYAKARTA ELEVATED TOLL ROAD

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ABSTRACT

The construction of the Solo-Yogyakarta-NYIA Toll Road has the potential to increase air pollution due to vehicle emissions. This study aims to model the dispersion of NO_2, CO, and O_3 in the toll road corridor, evaluate the influence of traffic on emissions and O_3 formation, and formulate policy implications for air quality management.

NO_2 and CO dispersion were modeled using AERMOD with meteorological data (2014-2023), traffic data, and emission factors. O_3 modeling employed a 0-D photochemical box model in MATLAB calibrated with field observations. Model validation utilized statistical metrics. Health risk assessment and life cycle impact assessment were conducted for policy evaluation.

Results indicate AERMOD adequately represents concentration magnitudes (FAC2 = 1.00) but is limited in temporal dynamics. 2032 projections show maximum 1-hour NO_2 reaching 780 µg/m³ and CO 32400 µg/m³ under low-speed scenarios, exceeding ambient air quality standards. At toll road operational speeds (65-70 km/h), NO_2 concentrations drop significantly (8.79-22.44 µg/m³). Ozone simulation identified a VOC-limited regime with optimal VOC concentration of 29 µg/m³, where increased NO_x decreases O_3 through titration (maximum O_3 62.9 µg/m³, below the air quality standard). Health risk analysis shows the hazard quotient (RQ) for NO_2 exceeding 1 at 9 out of 10 locations in 2032, while CO remains safe. The EURO 5 scenario and speed management proved effective in reducing emission loads.

Keywords : Toll road, AERMOD, pollutant dispersion, tropospheric ozone, VOC-limited, health risk assessme