

ABSTRAK

ANALISIS INVENTARISASI EMISI *TOTAL SUSPENDED PARTICULATE* (TSP) DENGAN PEMODELAN AERMOD PADA KEGIATAN PERTAMBANGAN BATUGAMPING DI AREA PT SEMEN GROBOGAN

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Kegiatan pertambangan batugamping PT Semen Grobogan di Blok Watudukun berada sangat dekat dengan permukiman, sehingga berpotensi menurunkan kualitas udara ambien, khususnya parameter *Total Suspended Particulate* (TSP). Kajian inventarisasi emisi pada area pertambangan di Indonesia masih terbatas, sehingga diperlukan analisis mendalam sebagai dasar pengelolaan lingkungan. Penelitian ini bertujuan untuk melakukan inventarisasi emisi yang meliputi analisis sumber emisi TSP, beban emisi TSP, dan mutu udara ambien TSP, serta memberikan arahan pengelolaan yang efektif.

Inventarisasi emisi dilakukan melalui identifikasi sumber dan perhitungan beban emisi dengan metode *bottom-up* dan *Tier 2* berdasarkan faktor emisi US EPA AP-42. Mutu udara ambien dianalisis melalui pemodelan dispersi AERMOD dengan empat uji validasi. Hasil pemodelan dibandingkan dengan Baku Mutu Udara Ambien (BMUA) TSP nasional sebesar $230 \mu\text{g}/\text{m}^3$ untuk memastikan pentaatan, kemudian dikonversi menjadi estimasi nilai Indeks Standar Pencemaran Udara (ISPU) sebagai gambaran informasi umum. Arahan pengelolaan disusun melalui analisis efektivitas vegetasi sebagai *wind barrier*.

Hasil penelitian menunjukkan bahwa sumber emisi berasal dari aktivitas *crushing*, *dumping*, *bulldozing*, *grading*, *loading*, *wind erosion*, dan *hauling*. Total beban emisi sebesar 88,8399 kg/hari dengan kontribusi terbesar dari aktivitas *hauling* pada jalan nonperkerasan. Hasil pemodelan menunjukkan konsentrasi emisi di seluruh titik pemantauan masih memenuhi BMUA dengan estimasi nilai ISPU berkisar 21,61 - 64,64 dalam kategori baik-sedang. Hasil uji validasi menunjukkan *Root Mean Square Error* (RMSE) sebesar $10,32 \mu\text{g}/\text{m}^3$ yang menandakan hasil pemodelan cukup akurat. Vegetasi yang berfungsi sebagai *wind barrier* menunjukkan efektivitas penjerapan debu maksimum sebesar 214,885 kg/hari dan menurunkan kecepatan angin dengan zona perlindungan $\pm 14\text{H}$ di sisi utara dan $\pm 6\text{H}$ di sisi selatan. Vegetasi tersebut ditanam dengan metode tumpang sari yang diisi *Zea mays* diantara *Muntingia calabura*, *Hibiscus tiliaceus*, dan *Albizia chinensis*.

Kata kunci: AERMOD, Inventarisasi Emisi, Pertambangan, Kualitas Udara, TSP

ABSTRACT

EMISSION INVENTORY ANALYSIS OF TOTAL SUSPENDED PARTICULATE (TSP) USING AERMOD MODELING IN LIMESTONE MINING ACTIVITIES AT PT SEMEN GROBOGAN AREA

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Limestone mining activities at PT Semen Grobogan in the Watudukun Block are located in close proximity to residential areas, creating the potential to reduce ambient air quality, particularly Total Suspended Particulate (TSP). Emission inventory studies in Indonesian mining areas remain limited, requiring further analysis to support environmental management. This study aims to analyze TSP emission sources, emission loads, ambient air quality, and appropriate environmental management measures.

The emission inventory was conducted through source identification and emission load estimation using the bottom-up and Tier 2 methods based on US EPA AP-42 emission factors. Ambient air quality was analyzed using AERMOD dispersion modeling and evaluated through four validation tests. The modeling results were compared with the Indonesian National Ambient Air Quality Standard (NAAQS) for TSP of 230 $\mu\text{g}/\text{m}^3$ to assess compliance. Furthermore, the modeled TSP concentrations were converted into estimated ISPU values to represent ambient air quality conditions. Environmental management recommendations were developed through an effectiveness analysis of vegetative wind barriers.

The results indicate that TSP emissions originate from crushing, dumping, bulldozing, grading, loading, wind erosion, and hauling activities. The total emission load was estimated at 88.8399 kg/day, with the largest contribution coming from hauling activities on unpaved roads. TSP concentrations at all monitoring locations complied with the national ambient air quality standard, with estimated ISPU values ranging from 21.61 to 64.64 (good-moderate). The validation results yielded an RMSE of 10.32 $\mu\text{g}/\text{m}^3$, indicating satisfactory model accuracy. The vegetative wind barrier demonstrated a maximum dust interception capacity of 214.885 kg/day and provided protection zones of approximately $\pm 14H$ on the northern side and $\pm 6H$ on the southern side. The vegetation was arranged using an intercropping system consisting of Zea mays planted between Muntingia calabura, Hibiscus tiliaceus, and Albizia chinensis.

Keywords: AERMOD, Emission Inventory, Mining, Air Quality, TSP