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Establishing Pollution Levels and Monitoring Air Quality in Eastern Indonesian Mining Areas

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ABSTRACT

This study aims to measure pollution levels and track the state of the air in Eastern Indonesia's major mining districts. Eastern Indonesia's mining industry has significantly boosted the local economy in the area. But this also brings up environmental issues, particularly with relation to pollution and air quality. The level of sulfur dioxide (SO2), nitrogen dioxide (NO2), and other pollutants is measured using the EPM-Manual 42iQ Continuous Air Quality monitoring tool in this air quality inspection method. Our research reveals higher than expected pollution levels around mining activities, sur-passing both national and international air quality regulations. The study also shows that pollution concentrations vary seasonally, with higher levels during the dry season. Furthermore, health risk assessments show possible negative effects on locals.

Keywords: Pollution level, eastern Indonesia, mining

Introduction

Rapid economic growth has been fueled by the expansion of mining operations in Eastern Indonesia, particularly in the industry that exploits natural resources like copper and gold (Adventia et al., 2023; Manggala et al., 2024). These mining operations are now a significant factor in the growth of local revenue and jobs, as well as infrastructure. Air pollution is one of the major environmental effects that lie behind these economic gains. The concentration of contaminants in the atmosphere has increased as a result of emissions from mining operations, including the extraction, transportation, and processing of ore. This presents a severe risk to the environment and public health (Haya & Firman, 2022).

However, the impact of these mining activities has a major impact on air quality in the surrounding area (Haya & Firman, 2022; Purba & Irawan, 2024; Putri, 2023). Nitrogen oxides (NOx), which are composed of nitrogen monoxide (NO) and nitrogen dioxide, are among the many air pollutants produced throughout the mining production process, which also includes blasting, mineral processing, and the burning of fossil fuels (NO2). Long-term exposure to NOx can result in a number of health issues, from irritation of the respiratory system to chronic lung illness.

As conducted by Raihan et.al. in 2023 to determine the quantity of air at PT. Bukit Emas was obtained by searching for wind speed data and hole dimensions (Raihan et al., 2023). In addition, Rusdianasari has succeeded in mapping the air quality around the mine in the South Sulawesi region and the results show a fairly high nitrogen oxide content (Rusdianasari, 2015). Furthermore, Wulandar in 2024 has obtained results that then the results of air quality and noise levels will be analyzed and obtained at 369.2 μg/Nm^3, which results exceed the parameter quality standard of 230 μg/Nm^3 (Wulandar, 2024). From this basis, to monitor air quality and ensure

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compliance with the established quality standards, regular monitoring of NOx concentrations is very important.

The purpose of this study is to assess how well air monitoring instruments function in detecting NO and NO2 concentrations in the vicinity of the mining operation. This study will specifically examine data accuracy and efficacy in identifying concentration changes. It is intended that by comprehending how well air monitoring equipment performs, more precise and trustworthy information on the state of the air around the mining area would become available. It is anticipated that the findings of this study will support regional efforts to reduce air pollution and safeguard human health.

Material and Methods

Preparation of sample

This research was conducted in the Mining District of PT. X which is one of the largest mining areas in Eastern Indonesia. Air sampling was carried out using the Thermo Scientific EPM Manual 42iQ tool, which functions to continuously monitor the concentration of pollutants such as NO, NO_2, and NOx.

Preparation of measurement tools

Before taking air samples, the Thermo Scientific 42iQ instrument must go through a series of preparations and calibrations to ensure measurement accuracy:

1. Zero and SPAN Calibration: Zero calibration is done to set the zero point for measuring certain gases, while SPAN calibration is done to measure the response of the instrument to a standard gas with a known concentration. In this study, SPAN for NO was set at 200 ppb and for NO_2 at 80 ppb. The Zero and Span calibration process using the EPM Manual 42iQ instrument can be seen in Figure 1.

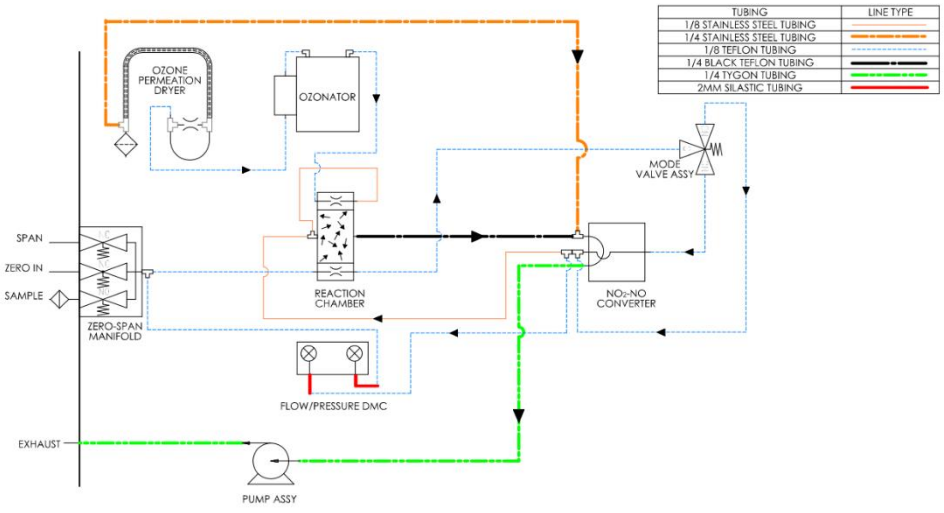

Figure 1. 42iQ Flow Schematic with Zero Span (source: Manual book 41Q Series)

2. Equipment Inspection: Before use, check important components such as pumps, hoses, solenoids, capillaries, and ozonators to ensure there are no leaks or damage that could affect the measurement results.
3. Component Replacement: If a component is found to be not functioning properly, such as a pump, capillary, or permeation dryer, then it must be replaced in accordance with applicable standard procedures.

Sampling

Air sampling is carried out continuously over a period of time to obtain representative data on variations in pollutant concentrations. The 42iQ Manual EPM tool is programmed to take air samples at specific time intervals, usually every hour, for 24 hours a day. The air sampling process using the Thermo Scientific tool can be seen in Figure 1. Some things to pay attention to when taking samples are:

a. Instrument Parameter Setting: The instrument is set to monitor and record NO, NO_2, and NOx pollutant data at specified time intervals.
b. Continuous Monitoring: The instrument continuously monitors air quality and data is automatically stored in a logger system connected to data processing software.
c. Temperature Control: The room where the instrument is placed is maintained at a constant temperature of 22 degrees Celsius to avoid data distortion due to temperature fluctuations.
d. Periodic Inspection: Routine checks are performed daily to ensure the equipment is operating properly. This includes checking gas flow, pressure, and the physical condition of the equipment.
e. Troubleshooting: If a problem occurs, such as unattained calibration or abnormal measurement values, actions such as cleaning the hose, replacing the capillary, or checking the solenoid connection and other components are taken.

Results and Discussion

Over the course of five days, measurements of the concentrations of air pollutants in mining area PT. X was carried out. Two distinct times per day, namely in the morning (09.00) and evening, were sampled (21.00). The purpose of this measurement is to find patterns of daily variation in the amounts of pollutants caused by mining operations. Significant variations in pollutant concentration readings are observed between morning and evening, according to data gathered using the Thermo Scientific EPM Manual 42iQ instrument. The following table displays the findings from the measurements of pollutant concentrations (in specific units) conducted on June 20–24, 2024. (Table 1).

Table 1. EPM Manual 42iQ Series sample results

Date	Time	NOx values (µg/m³)
20-Jun-2024	09.00	25,4
20-Jun-2024	21.00	0,8
21-Jun-2024	09.00	36,3
21-Jun-2024	21.00	0,8
22-Jun-2024	09.00	28,2
22-Jun-2024	21.00	1,0
23-Jun-2024	09.00	1,5
23-Jun-2024	21.00	0,8
24-Jun-2024	09.00	4,4
24-Jun-2024	21.00	0,8

Table 1 shows the NOx content around the mining area through measurements taken at 09.00 (morning) and at 21.00 (evening). In general, the NOx content is higher in the morning than in the evening. For example, on June 20, 2024, at 09.00, the NOx value was 25.4 µg/m³, while at 21.00 it was 0.8 µg/m³. This pattern repeats every day during the observation period. The highest value was recorded on June 21, 2024, at 09.00 with a value of 36.3 µg/m³. Numerous variables contribute to the higher concentration of NOx (nitrogen oxide) in the mining region during the day than at night. According to the Ambient Air Quality Standard on the NOx gas parameter, the measurement for 1 hour is 230 µg/Nm3. The ambient quality standard is a measure of the limits

or levels of substances, energy, and/or components that exist or should exist and/or pollutant elements whose presence is tolerated in ambient air (PP Government Regulation of the Republic of Indonesia Number 41 of 1999 article 1 paragraph 7) (Ali et al., 2024; Rosdiana et al., 2023). During the day, mining operations—which involve the use of large machinery and cars that emit NOx into the atmosphere—tend to be more intense. Exhaust emissions from heavy machinery, like excavators and dump trucks, are often produced throughout the day when they are operating at maximum capacity.

Furthermore, elevated air temperatures during the day contribute to rising NOx levels. Higher temperatures quicken chemical processes in the environment that result in NOx emissions, such as the reaction that occurs when oxygen and airborne nitrogen combine to burn in car engines or mining machinery. Furthermore, during the day, when the atmosphere is more stable, pollutants may become trapped close to the ground, raising local NOx concentrations.

Pollutant distribution may be slower at night due to weaker air or wind motions, but there is also a large reduction in the quantity of NOx created because fewer vehicles and miners operate at night. Therefore, fewer emission sources lead to lower NOx concentrations at night than during the day, even if pollutant dilution can be slower.

All things considered, the key reasons why NOx levels in mining locations are higher during the day than at night include a combination of greater mining activity intensity, higher temperatures, and more stable air conditions. NOx gas is usually in the form of NO and NO2. This gas usually comes from the combustion process at high temperatures of approximately 800 degrees Celsius in the air so that a reaction occurs between O2 and N2, besides that it also comes from the chemical industry process. Actually, NO gas is not a pollutant element but this NO gas has a tendency to become NO2. No2 gas is a very toxic gas.

Conclusion

The level of NOx content at PT. X located in the Eastern Indonesia region still meets the threshold set by environmental regulations. This shows that NOx emissions from mining and industrial activities at PT. X is within safe limits and in accordance with applicable standards, as stipulated in the Government Regulation on Air Pollution Control. PT. X routinely checks air quality to ensure that emission levels remain under control and do not exceed the established limits. This effort is part of the company's commitment to protecting the environment and maintaining the health of the surrounding community. With continuous monitoring and the application of environmentally friendly technology, PT. X strives to minimize the negative impacts of industrial activities on air quality and ensure compliance with applicable environmental regulations.

References

Adventia, M. N., Santoso, D. H., Wicaksono, A. P., Anasstasia, T. T., & Utami, A. (2023). Analisis kualitas udara ambien pada area tambang batubara jenis terbuka (Open Pit) PT XX di Desa Sungai Payang, Kecamatan Loa Kulu, Kabupaten Kutai Kartanegara, Provinsi Kalimantan Timur. *Prosiding Seminar Nasional Teknik Lingkungan Kebumian SATU BUMI*, *4*(1). https://doi.org/10.31315/psb.v4i1.8823

Ali, S., Nugroho, A., Pandapotan, J. D., & Triadi, I. (2024). Efektivitas penegakan sanksi hukum terhadap pelanggaran baku mutu udara di wilayah industri. *Jembatan Hukum : Kajian Ilmu Hukum, Sosial Dan Administrasi Negara*, *1*(3), 195–211. https://doi.org/10.62383/jembatan.v1i3.527

Haya, A., & Firman, F. (2022). Kajian kualitas lingkungan kawasan pertambangan di Kabupaten Halmahera Tengah. *Jurnal GEOMining*, *3*(1), 25–32

Manggala, G. A., Irawan, A. B., Nugroho, N. E., Anasstasia, T. T., & Utami, A. (2024). Analisis kualitas udara ambien berdasarkan indeks Standar Pencemar Udara (ISPU) di area tambang tanah liat PT X, Kabupaten Tuban, Jawa Timur. *Prosiding Seminar Nasional Teknik Lingkungan Kebumian SATU BUMI*, *5*(1). https://doi.org/10.31315/psb.v5i1.11658

Purba, H. K., & Irawan, A. B. (2024). Pengendalian kualitas udara ambien berdasarkan parameter Pm 2,5 Dan Pm 10 di area tambang batubara PT.XXX Di Lebak Budi, Kecamatan Merapi Barat, Kabupaten Lahat, Sumatera Selatan. *Prosiding Seminar Nasional Teknik Lingkungan Kebumian SATU BUMI*, *5*(1). https://doi.org/10.31315/psb.v5i1.11654

Putri, S. E. (2023). *Analisis pajanan debu batubara terhadap gangguan kesehatan para pekerja tambang batubara di area stockpile berdasarkan masa kerja* [Masters, Universitas Negeri Padang]. http://repository.unp.ac.id/50371/

Raihan, M. A., Heriyadi, B., Gusman, M., & Prabowo, H. (2023). Analisis kuantitas dan kualitas udara pada sistem ventilasi untuk keamanan dan kenyamanan pengunjung di lubang pendidikan PT. Bukit Asam Tbk. UPO Sawahluwung Talawi Sawahlunto Sumatera Barat. *Bina Tambang*, *8*(2), 60–69.

Rosdiana, D., Hastiaty, I. A., Hartomy, E., Kango, I., Simbolon, P. T., Pradapaningrum, P. G., Indriasih, M., & Paramasatya, A. (2023). Kontaminasi kimia dan biologi pada air dan udara dengan ARKM: Analisis risiko kesehatan masyarakat. *Public Health Risk Assessment Journal*, *1*(1). https://doi.org/10.61511/phraj.v1i1.2023.222

Rusdianasari, R. (2015). Pemetaan kualitas udara di lingkungan stockpile batubara. *Prosiding Seminar Nasional Forum in Research, Science, And Technology (FIRST) 2015*. http://eprints.polsri.ac.id/2531/

Wulandar, W. (2024). Kajian kualitas udara dan kebisingan dari kegiatan penambangan batuan (Sirtu) oleh PT Korsa Merah Putih, Desa Gemampir, Kecamatan Karangnongko, Kabupaten Klaten, Jawa Tengah. *PhD Thesis.* UPN Veteran Yogyajarta]. http://eprints.upnyk.ac.id/38823/1/Abstrak.pdf