

ABSTRAK

ANALISIS PENGARUH REKAYASA VENTILASI TERHADAP DISTRIBUSI ALIRAN UDARA DAN *HEAT STRESS INDEX* PADA TAMBANG BAWAH TANAH KENCANA PT NHM

Oleh
Puteri Humairrah Fajr
NIM: 112220230
Program Studi Sarjana Teknik Pertambangan

Tambang Bawah Tanah Kencana yang dioperasikan oleh PT Nusa Halmahera Minerals menggunakan metode *Underhand Cut and Fill* di Pulau Halmahera, Maluku Utara. Kemajuan penambangan pada *heading* KN 14C menyebabkan jarak antara *auxiliary fan* dan *heading* melebihi 500 meter, melampaui standar perusahaan. Kondisi ini mengakibatkan berkurangnya suplai udara segar dan memburuknya kondisi termal pada *heading*, sehingga diperlukan rekayasa ventilasi berupa pembuatan *shaft* VD10 sebagai jalur *exhaust* baru dan pemindahan *auxiliary fan* sejauh 200 m mendekati *heading*.

Penelitian ini menganalisis pengaruh rekayasa ventilasi tersebut terhadap distribusi aliran udara dan kondisi termal lingkungan kerja menggunakan dua indikator *heat stress index*, yaitu Temperatur Efektif (T_e) dan *Thermal Work Limit* (TWL). Pengukuran dilakukan pada beberapa *vent station* di Area KN menggunakan TSI *VelociCalc Air Velocity Meter* dengan Metode *Traversing* untuk pengukuran debit aliran udara, dan Kestrel 5500 *Weather Meter* untuk pengukuran parameter psikometri pada *heading* KN 14C. Penelitian mencakup tiga tahapan kondisi yaitu kondisi awal sebelum pembuatan *shaft* VD10, kondisi transisi saat kedua jalur *exhaust* terbuka secara bersamaan, dan kondisi akhir setelah VD9 ditutup serta *auxiliary fan* dipindahkan. Evaluasi kesesuaian debit dan pola distribusi aliran udara dilakukan menggunakan simulasi *software* VentSim Design 5.4.

Hasil pengukuran menunjukkan bahwa terjadi perubahan distribusi debit dan pola aliran udara *return*. Pada kondisi awal, seluruh *return air* sebesar 116,80 m³/s mengalir melalui VD9 sebagai jalur *exhaust* tunggal. Pada kondisi transisi, *return air* terbagi menjadi dua jalur *exhaust*, dengan debit sebesar 91,89 m³/s mengalir melalui VD9 dan 23,24 m³/s mengalir melalui *shaft* VD10. Pada kondisi akhir, *return air* terpusat menuju *shaft* VD10 dengan debit sebesar 109,50 m³/s, dengan kebocoran pada VD9 sebesar 19,44 m³/s. Perubahan distribusi aliran udara berdampak terhadap perbaikan kondisi termal lingkungan kerja. Nilai T_e menurun dari 31,6°C menjadi 27,7°C, sedangkan TWL meningkat dari 114 W/m² pada *Withdrawal Zone*–137 W/m² pada *Buffer Zone* menjadi 188–200 W/m² pada *Acclimatization Zone*. Pola distribusi aliran udara hasil pengukuran lapangan menunjukkan kesesuaian dengan hasil simulasi VentSim Design 5.4.

Kata Kunci: Distribusi Aliran Udara, *Heat Stress Index*, Temperatur Efektif, *Thermal Work Limit*, Ventilasi Tambang Bawah Tanah.

ABSTRACT

ANALYSIS OF THE EFFECT OF VENTILATION ENGINEERING ON AIRFLOW DISTRIBUTION AND HEAT STRESS INDEX IN KENCANA UNDERGROUND MINE OF PT NHM

By

Puteri Humairrah Fajr

Student ID: 112220230

Undergraduate Program in Mining Engineering

The Kencana Underground Mine, operated by PT Nusa Halmahera Minerals, applies the Underhand Cut and Fill mining method on Halmahera Island, North Maluku. Mining advancement at the KN 14C heading caused the distance between the auxiliary fan and the heading to exceed 500 m, surpassing the company standard. This condition reduced the supply of fresh air and deteriorated the thermal environment at the heading, necessitating ventilation engineering through the construction of shaft VD10 as a new exhaust airway and the relocation of the auxiliary fan 200 m closer to the heading.

This study analyzed the effect of the ventilation engineering on airflow distribution and workplace thermal conditions using two heat stress indices, namely Effective Temperature (T_e) and Thermal Work Limit (TWL). Measurements were conducted at several vent stations in the KN Area using a TSI VelociCalc Air Velocity Meter with the Traversing Method to determine airflow quantity, and a Kestrel 5500 Weather Meter to measure psychrometric parameters at the KN 14C heading. The study covered three stages: the initial condition before the construction of shaft VD10, the transition condition when both exhaust airways were open simultaneously, and the final condition after the closure of VD9 and the relocation of the auxiliary fan. Evaluation of airflow quantity and airflow distribution patterns was carried out using VentSim Design 5.4 simulation software.

The measurement results indicated changes in airflow quantity distribution and return airflow patterns. Under the initial condition, the entire return airflow of $116.80 \text{ m}^3/\text{s}$ was discharged through VD9 as the sole exhaust airway. During the transition condition, the return airflow was divided into two exhaust airways, with $91.89 \text{ m}^3/\text{s}$ flowing through VD9 and $23.24 \text{ m}^3/\text{s}$ flowing through shaft VD10. Under the final condition, the return airflow was concentrated toward shaft VD10 with a flow quantity of $109.50 \text{ m}^3/\text{s}$, while leakage through VD9 amounted to $19.44 \text{ m}^3/\text{s}$. The changes in airflow distribution improved the thermal conditions of the working environment. The ET value decreased from 31.6°C to 27.7°C , while TWL increased from 114 W/m^2 in the Withdrawal Zone– 137 W/m^2 in the Buffer Zone to $188\text{--}200 \text{ W/m}^2$ in the Acclimatization Zone. The airflow distribution pattern obtained from field measurements showed good agreement with the results of the VentSim Design 5.4 simulation.

Keywords: Airflow Distribution, Heat Stress Index, Effective Temperature, Thermal Work Limit, Underground Mine Ventilation.