Heat study for Potash mine with recently commissioned cooling plant September 2023

dello VENTILATION

Problematic

- A potash mine recently commissioned a surface cooling plant.
- The impact from the cooling plant at the working face was not noticed by the underground workers.
  - It was neccessary-to understand the actual impact and effect over time on the strata heat.
- Other means that can be implemented to reduce the temperature at the working face.

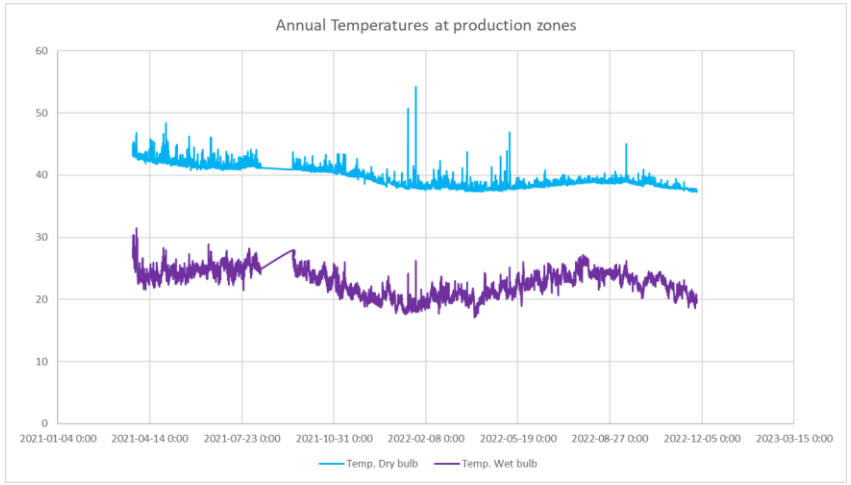
Project parameters

- 7.5 MW surface cooling plant
- The mine had several temperature and humidity data loggers installed at many locations that provided a good overview of the temperature fluctuations throughout the year.
- Total airflow of 300 m^3/s (635 kcfm) delivered by the main intake underground fans, total installed power of 2,000 kW (2,680 HP).
- Once the air comes out of the intake shafts, there is a distance of about 6 km (3.7 miles) before it reaches the working face.
- Mine Depth of 800 m (2,600 ft).
- They are using continuous miners at the working face with trucks to discharge the ore in the conveyor belt.
- Measured geothermal gradient of 1.5°C/100 m
- Virgin rock temperatures of 45°C at the working faces.
- Rock type is salt in the intake drifts and potash in the production zones.

Analysis of strata heat loads fluctuations annually post cooling plant commissioning

- The strata heat load fluctuations result in fairly constant air conditions at the production zones throughout the year.

Point	Sensible heat summer (MW)	Latent heat summer (MW)	Sensible heat Winter (MW)	Latent heat Winter (MW)
Intake shafts	-2.1	1.4	0.5	0.7
Intake drifts	0.6		4.3	

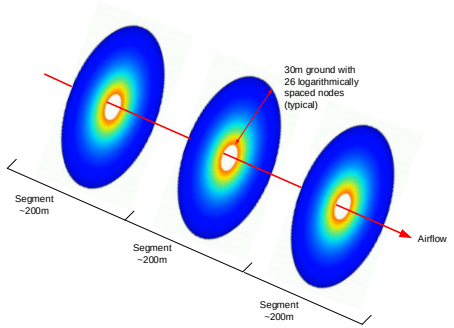


Immediate Impact of cooling plant on working face temperatures

- The data analyzed following the commissioning of the cooling plant demonstrated that 95% of the sensible (dry) cooling of air would get offset by the strata heat.
- However the latent cooling of air (condensation of water vapour) was providing useful cooling to the working faces.
- The latent cooling occurred only during the warm humid days of the year.
  - When it is most needed
  - Averages of 1.8 MW and reaching a maximum of 3.8 MW.

Long-term effect of the cooling plant

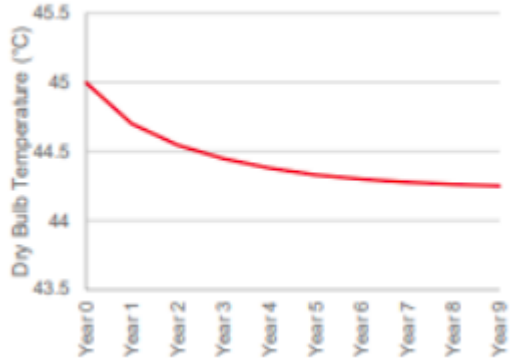
- To understand the effect of the of the cooling plant over the years on the strata heat:
  - A radial finite difference model that calculates the temperature within a single tunnel was used, the sofware is called Dynamo and is developed and owned WSP. The model provides outputs for 8,760 hours a year.



Season	Peak (High and Low) dry bulb temperature model (°C)	Peak (High and Low) dry bulb temperature measured (°C)	Difference (°C)	Difference (%)
Summer	38.7	38.0	0.7	2%
Winter	34.1	35.1	-1.0	-3%

Long-term effect of the cooling plant

- Results demonstrated that the long-term effect of the cooling plant on the strata heat would impact the dry bulb temperature by less than 1°C over the course of several years.

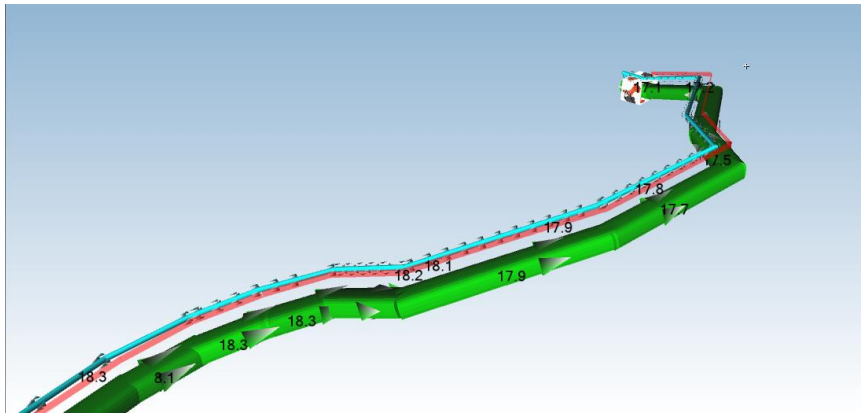


Heat load from working face

- A data logger was installed at the inlet of the heading and another at the outlet to measure the heat load from an active heading.
- The time when the continuous miner was cutting, and the exit and entry of the trucks was logged.
- A Continuous miner of 500 kW (670 HP) with two trucks of 300 kW (400 HP) were operating in the heading.
- The heat generated by the mining activity was found to be as follows:
  - 400 kW (536 HP) on average of total heat generated, 50 kW (67 HP) sensible and 350 kW (469 HP) latent.
  - The latent heat is distributed as follows:
    - 200 kW (268 HP) of the continuous miners
    - 75 kW (100 HP) from the two trucks
    - 75 kW (100 HP) from strata

Thermal modelling of working face

- The heat loads found from the analysis were then input into Ventsim
- Continuous miner was set as a fixed heat source at the working face.
- Trucks and strata were set as activity tracks along the heading.
- The cooling was simulated by inputting latent cooling load from surface, the maximum and average values were used.
- Summer conditions were assumed.



Thermal modelling results

- The results are shown in wet bulb temperatures.

Latent cooling load at refrigeration plant (MW)	Airflow supplied by the auxiliary fan in m^3/s (kcfm)	Wet bulb temperature at the working face (°C)
0	15 (32)	29.0
1.8	15 (32)	28.4
3.8	15 (32)	27.6
0	30 (64)	27.6
1.8	30 (64)	24.9
3.8	30 (64)	23.9

Conclusions

- The geothermal heat offsets 95% the sensible cooling load from the plant.
- The equivalent cooling that is offset by the geothermal heat is between 4.0 and 6.0 MW.
- In the hot humid days of the year, the cooling plant will result in a decrease of the working faces wet bulb temperatures from 0.6 to 1.4°C.
- In the hot humid days, increasing the airflow supplied from the fan from 15 to 30 m^3/s will result in a decrease of the wet bulb temperature of 1.4°C without any cooling;
- Augmenting the airflow at the face is better or equivalent than the cooling plant.
- In the hot humid days, increasing the airflow supplied from the fan from 15 to 30 m^3/s combined with cooling will decrease the working faces wet bulb temperatures from 4.1 to 5.1°C.

Acknowledgement

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