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Potential Sources of Heat in Underground Mines-A Review

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Abstract

Heat is an integral part of all the mining activities. Not only activities but different conditions are also responsible for emission of heat in an underground as well as opencast mine. In opencast mine the heat produced is dissipated in the environment not creating much problem to the working conditions, unlike in underground mines where proper ventilation provisions are made to eliminate the produced heat to improve the working conditions. In this review paper we will discuss the potential sources of heat in underground mines which deeply affects the working condition and ultimately working efficiency of the workers.

*Keywords:*Heat; workers health; working condition.

1. Introduction

In simple physics, spontaneous transfer of energy from one body to another, other than by work or transfer of matter is called heat. Heat is said to transfer from hotter body to the comparatively colder body same is the case with hotter medium to colder medium. In opencast working the main source of heat is the sun. Unlike in underground working the heat adds due to various reasons like geothermal gradient, spontaneous heating, autocompression, machinery, blasting, etc.

2. Basic heat transfer mechanism

As shown in figure 1 the mechanism of heat transfer is governed by three basic principles. Namely:

- Conduction: When heat is transferred from one body to other body while they are physically connected to each other.
- Convection: When heat is transferred from one body to another without any physical contact between the bodies.
- Radiation: When the heat is transferred from one body to another through a medium where the medium itself doesn't get heated.

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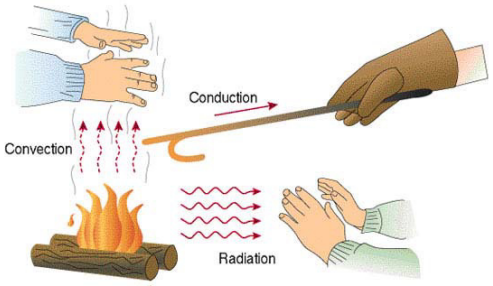

Fig.1. Mechanism of heat transfer

3. Sources of heat in mines

Table 1. Major sources of heat in mines

Opencast mines	Underground mines
Sun light	Geothermal gradient
Working machines	Autocompression
Blasting	Mechanized equipment
Spontaneous heating (in case of coal mining)	Explosives and blasting
	Mechanical processes and light

While in opencast mines the main source of heat is the sun, and the amount of heat generated by other sources is almost negligible as the heat generated by these sources is immediately dissipated in the environment not increasing the surrounding temperature to an uncomfortable level. Unlike in underground mines the heat released gets confined to the working area, if proper care is not taken the temperature of the working area can increase to an uncomfortable level. Below some such sources are discussed in brief.

3.1. Geothermal gradient

The increase in strata temperature with respect to depth is known as geothermal gradient (McPherson 1993). In other words geothermal gradient is the rate of increase in temperature with the increase in depth in the Earth's interior. Table 1 shows the variation in temperature as we move down the depth.

Table 2.Variation in temperature with increasing depth

Depth	Effect on temperature	Cause
Within 50 m	Almost equal to the temperature of the ambient air	
50m-100m	Variable	Affected by the atmospheric changes and circulating ground water
Below 100m	Almost always increases	Due to tectonic settings and thermal properties of the rock

For dry airways, the flow of heat from the surrounding rock to the ventilation airways is proportional to the difference between the virgin rock temperature and the air temperature. In case of wet airways the heat flow rate from the rock to the air increases.

3.2. Autocompression

When the surface air is sent down the workings, either naturally or through man-made ventilation, it will experience a compression. This means that although the volume of air while going down reduces but, the amount of heat remains the same resulting in hotter air. Thermodynamically, this phenomenon is very similar to the way gas reacts in a compressor, air entering in a mine through shaft is compressed and heated as it flows in a downward direction. If there is no interchange in the heat or moisture content of the air in the shaft, the compression takes place adiabatically, with the attendant temperature rise following the adiabatic law: