



Technology News

From the Bureau of Mines, United States Department of the Interior



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Prevent Highwall Mining Machine Explosions With Inert Gas

Objective

Prevent the explosion of methane gas or coal dust by replacing air with inert gas inside highwall mine excavations.

Approach

Use combustion gases as a source of inert gas with low oxygen content to blanket the cutting head of highwall mining machines. This gas is placed strategically at the collar of the excavation where it enters the hole to replace the mined coal volume. The elimination of oxygen from the hole prevents explosions of gas or dust.

How It Works

Highwall mining methods are used when surface mining becomes uneconomical. One method of highwall mining involves use of a horizontal auger to enter the coalbed from a surface mine bench. The coal is mined in a series of horizontal, parallel, and large-diameter holes. Historically, little methane has been associated with auger mining. However, mining technology has extended the reach of auger mining, which can increase the occurrence of methane. Methane explosions at auger mining operations have been increasing. Methane has been the primary fuel source of these ignitions, but coal dust also may have been involved.

The standard way to eliminate a methane hazard is to ventilate the area with air to dilute and carry the methane away. In auger mining, nearly the entire cross-sectional area of the hole is filled by the auger, which prevents ventilation over or around the augers. Alternatively, ventilation through the center of the auger steel has several drawbacks, such as limited cross-sectional area for air flow, numerous air connections between auger sections, and no method of determining if the air reaches the face.

Explosions of methane or dust also can be prevented by reducing oxygen levels below explosive limits. This can be done by replacing the oxygen with an inert gas consisting primarily of nitrogen and carbon dioxide. Inert gas may be obtained from several sources, but on highwalls the simplest approach is to generate the gas on-site using combustion processes to burn oxygen from the air. For this system a combination of gasoline and diesel combustion engine exhaust gases are used to achieve the correct inert gas quality and quantity. Alternatively, catalytic or furnace type technologies also could be used to produce the correct inert gas.

Delivery of the inert gas into the hole and up to the cutting head is accomplished easily. As coal is cut and removed from the hole, the volume occupied by the cut material must be replaced with an equal volume of gas. Normally this gas is air that enters from the collar of the hole. The inert gas approach places inert gas at the collar of the hole so that only this gas is available to replace the removed coal. By replacing oxygen with inert gas, both methane and dust ignitions are prevented.

Operation

An inert gas system was installed and tested on a highwall auger mining machine powered with a 270-horsepower turbocharged diesel engine. The machine cut a 39-inch-diameter hole and used 24-inch-diameter auger sections to convey the coal. Inert gas was obtained by combining the exhaust from a 305-cubic-inch gasoline engine with a portion of the diesel engine exhaust. This combination was necessary to produce the correct inert gas concentration and volume.

The combined engine exhaust flows were piped along the roof of the machine and down to the collar of the hole as seen in figure 1. Two methods successfully placed the inert gas at the hole collar. Initially, a conveyor belt shroud contained the inert gas at the hole collar. In subsequent testing, the reduced auger size of the conveying augers allowed the use of a simpler stub pipe, which was inserted several feet into and near the roof of the hole. The collar area was filled with a volume of inert gas in excess of the quantity of coal removed so that inert gas always flowed out from the hole, even during maximum penetration by the cutting head.

Test Results

Inert gas concentrations were monitored continuously in the exhaust gas stream. Auger operations were interrupted periodically, and a remote probe was extended over the top of the auger to the cutting head, or to a maximum distance of 230 feet. Gas samples were removed through the probe and monitored using real-time infrared gas detection instrumentation. Evacuated bottle samples also were taken for laboratory confirmation by gas chromatography.

Results showed that for all samples taken, gas concentrations remained nonexplosive. In fact, during testing, methane concentrations of 9% were encountered but oxygen levels were below 10%, leaving the

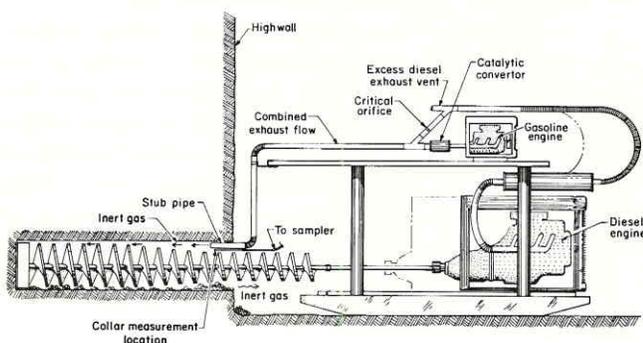


Figure 1.—Inert gas system.

mixture nonexplosive. These results confirmed the fact that inert gas at the collar followed the cutting head into the hole. A similar movement of methane occurred, which means that methane generated during penetration followed the cutting head into the hole and may not have been apparent at the hole collar during operation.

Using this machine, over 50,000 tons of coal have been safely mined in gassy coal. At least three additional systems have been built and more are planned using this technology.

Patent Status

The U.S. Department of the Interior has applied for a patent on the inert gas system. Additional patent information may be obtained by contacting the U.S. Bureau of Mines, Office of Technology Transfer, 801 Seventh St. NW, Washington, DC 20241 (telephone: 202-501-9323).

For More Information

Additional information on the system may be obtained by requesting U.S. Bureau of Mines Report of Investigation "A Method To Eliminate Explosion Hazards in Auger Highwall Mining." This may be obtained by writing to the technical project officer for this research:

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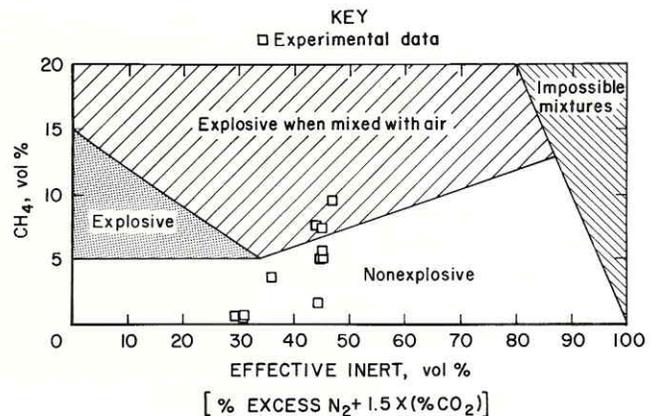


Figure 2.—Explosive diagram with experimental data from four holes.