CDC NIOSH Technology News
SAFER • HEALTHIER • PEOPLE™
No. 490 Milestones in Mining Safety and Health Technology June 2001

An Inexpensive Device for Monitoring Explosions in Sealed Areas of Underground Mines

Objective

To develop a passive, inexpensive technique for monitoring explosion overpressures within sealed areas in underground coal mines.

Background

From 1994 to 2000, seven explosions of methane and/or coal dust occurred within the worked-out, sealed areas (gobs) of underground U.S. coal mines. These explosions, believed to have been started by lightning, destroyed many seals and caused much damage external to the sealed area. One gob explosion went undetected until the mine operator reopened the sealed area and discovered the damage. Fortunately, these gob explosions did not cause any fatalities or injuries.

Because lightning occurs in just about all mining areas, several questions arise. Could gob gas explosions be occurring in other sealed areas and going undetected? If so, what is the magnitude of the resulting explosion overpressures? The Pittsburgh Research Laboratory (PRL) of the National Institute for Occupational Safety and Health (NIOSH) undertook a study to identify and evaluate passive measuring devices to monitor and quantify the overpressures associated with such explosions. This work was done in parallel with full-scale explosion experiments for evaluating the strength characteristics of seals used for isolating areas in underground coal mines.

Approach

Evaluation studies were done in PRL's 20-liter explosion test chamber and in the full-scale Experimental Mine at Lake Lynn Laboratory to evaluate the response and accuracy of various commercially available automobile tire pressure gauges to overpressures generated from gas and dust explosions. The first series of tests was done in the 20-liter chamber, which is used to study the explosibility and inerting of fuel dusts and gases. Data from the tire pressure gauge tests were compared to the pressure-time data obtained from the 20-liter chamber 's traditional electronic strain gauge pressure transducer recorded on a high-speed data acquisition system. To evaluate the tire pressure gauges, the valved inlet (tip) of the candidate pressure gauge was removed and the body of the gauge was cemented with epoxy into a 0.25-in pipe elbow and attached to the outside of the test chamber.

A second series of tire gauge evaluation tests was done at Lake Lynn during explosion-resistance testing of seals used in underground coal mines. Full-scale seals (20 ft wide by 8 ft high) were constructed as one wall of a 2,000-ft^3 chamber and exposed to a series of methane explosions. Average overpressures ranged from 20 to 80 psi. The seals were built with various strength materials ranging from 7 to 48 in thick. The modified tire gauges are attached on the outside of the chamber to a 0.25-in NPT pipe that extends into the chamber (figure 1). The axis of the gauge is mounted at a right angle to the plane of the seal to minimize the coupling of any seal movement to the stem of the gauge that may cause inaccurate readings. The internal explosion pressure history is recorded with a strain gauge pressure transducer mounted inside the chamber. Methane is injected into the chamber, mixed with air, and ignited with an electric spark located at the geometric center of the chamber. Maximum explosion overpressures are recorded and compared with the tire gauge pressure.

Results

Several constant volume explosions were conducted in the 20-liter chamber in order to vary the maximum pressure and the time-to-peak pressure. The comparison between the maximum pressure measured by the strain gauge and that determined by the tire

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

pressure gauge is shown in figure 2. There is fairly good agreement over the pressure range from 5.9 to 18.7 psi. Maximum pressure comparisons from large-scale chamber tests are also very encouraging. Maximum pressures recorded with internal electronic strain pressure gauge agreed within 1 psi of the tire gauge reading for all tests without seal failure. Results show that this simple, inexpensive, passive device can be used to monitor overpressures contained within sealed areas of underground mines or to record the gob explosion overpressures if one or more seals fail during the explosion.

For in-mine use, a single pressure gauge could be installed on one seal in a set of two to six seals. If desired, two gauges covering different ranges could be attached to the same seal. Existing sampling tubes could be used to attach the gauge where seals are already built. During the construction of a new seal, a dedicated or additional 0.25-in-diam pass-through tube could be installed. Any pressure rise can be identified during routine weekly examinations of the seals or shortly after a lightning strike in the area. Such an inexpensive device is useful as part of a surveillance study on the number and magnitude of undetected explosion events that occur in sealed areas of underground coal mines.

For More Information

For more information on this study, contact Michael J. Sapko or Eric S. Weiss, NIOSH Pittsburgh Research Laboratory, Cochrans Mill Rd., P.O. Box 18070, Pittsburgh, PA 15236-0070, phone: (412) 386-6619 or (412) 386-5050, fax: (412) 386-6718, e-mail: **MSapko@cdc.gov** or **EWeiss@cdc.gov**.

Figure 1.—Tire gauge installed on mine solid block seal.

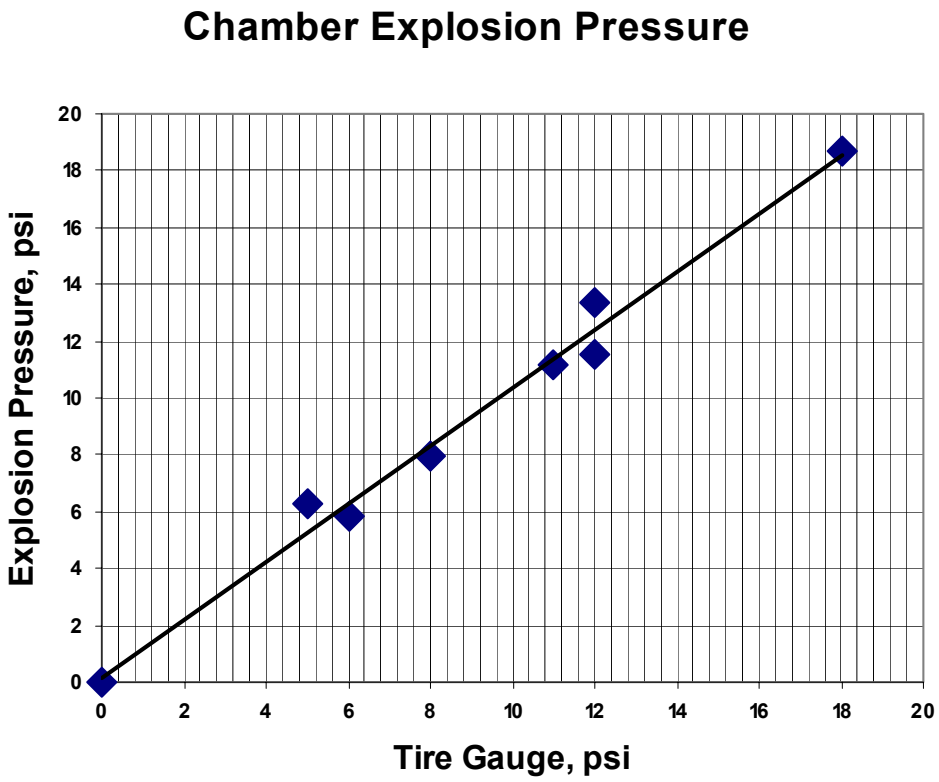

Figure 2.–Comparison of chamber explosion pressure with tire gauge response.