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Use of belt air in underground coal mines — with special emphasis on TSP recommendations

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ABSTRACT: The use of belt air in underground coal mines has been a continuous discussion since it was first introduced in the Federal Coal Mine Health and Safety Act (Coal Act) of 1969. Although the Coal Act prohibits the use of belt air to ventilate active workings, there were two exceptions prior to the 2004 Final Rule. There have been several major studies/rule-proposals by MSHA since 1985 and the most recent of which is the Technical Study Panel (TSP) established by the Mine Improvement and New Emergency Response (MINER) Act of 2006 to study the use of belt air and related issues. This paper reviews the history of belt air use, its associated controversies, and more specifically, the 20 recommendations unanimously approved by the TSP.

1 Introduction

Belt air refers to the airflow in a belt entry (Figure 1), separated from intake and return airways, flowing directly to ventilate working sections in underground coal mines. To separate airflow in haulage entries from ordinary intake airways was first introduced in the Federal Coal Mine Health and Safety Act of 1969. Based on information and technology available at the time, the Act requires the quantity be limited to the amount necessary to provide an adequate supply of oxygen and keep the methane below 1.0 percent. This was further expanded in the Federal Mine Safety and Health Act of 1977 (the Mine Act) where, in addition to the separation, it also limits the velocity of air coursed through the belt haulage entries, and methane content in such airways shall be less than 1 percent (Sec. 301(y)(1)). Although mine operators were allowed to seek approval through a petition (for modification, or PFM) process to utilize the belt air at working sections, added monitoring and other safety measures discouraged such uses and there were only around 123 petitions granted between 1975 and 2003.

Figure 1. A typical belt entry in underground coal mines

Although years of field practice have proven the use of belt air, if done properly, can be safe and provides significant benefits, many still think belt air might contain airborne coal dusts and methane emitted from the transported coal in the belt entry, and they believe using it for ventilation exposes miners to excessive amounts of coal dust. This is contrary to experience obtained from the field which show that the use of belt air in working sections, although slightly increase airborne dust and methane concentration, it can be safe with benefits disadvantages.

2 History of Belt Air Utilization and The Miner Act of 2006

Separating belt entry from the intake and return was first stipulated in the Pennsylvania Bituminous Coal Mine Act of 1961 (52 P.S.§701-242(c)), but it did not require the air to be diverted directly to the return. Recognized the potential safety hazards, the 1969 Coal Act requires that belt and haulage entries be separated from intake and return airways, prohibited the use of air in these entries and limited air velocities to the minimal amount necessary to provide an adequate supply of oxygen and keep the methane below 1.0%. The belt air be diverted directly to the return; mines opened prior to the effective date of the Act were exempted through a petition for modification (PFM) process.

The first successful PFM permitting belt air usage at the face was granted in 1975 to Island Creek Coal Company in its Virginia Pocahontas No. 4 mine, contingent on the installation of a carbon monoxide monitoring system. This opened the door to increased use of belt air in the working section and between 1975 and 2003, a total of 172 petitions for modifications were granted allowing the use of belt in working sections. (Anon., 2007).

On January 27, 1988, MSHA proposed revised safety standards for ventilation for underground coal mines and the following year called for a thorough review of safety factors associated with the use of belt air. A committee, consisting of MSHA employees, was formed and the ensuing report, “Belt Entry Ventilation Review” (BEVR, 54 FR 35356), finds that directing belt entry air to the face can at least be as safe as other ventilation methods if certain conditions are met that would significantly reduce hazards. Three significant safety requirements had emerged: (1) a more stringent CO monitoring system that called for a sensor every 1,000 feet rather the previous 2,000 feet. (2) The elimination of 300 fpm upper air velocity in belt entry from the Coal Act as long as it does not become the primary intake airway, and (3) further development of ongoing conveyor belt flammability tests. The committee also provide additional recommendations ensuring the safe use of belt air in working sections. (Anon., 1989)

A second committee, the Belt Air Advisory Committee (BAAC), was appointed by the Secretary of Labor in 1992 to make “recommendations concerning the conditions under which air in the belt entry could be safely used in the face area of underground mines.” This was an independent committee consisting of government, academic, and industry personnel. The subsequent BAAC report, submitted to the Secretary in November 1992, contained 12 recommendations in support of the conclusion that belt haulage entries can be safely used as intake air courses provided that an early warning fire system is in place and the miners are properly trained. The committee also outlines additional practices to ensure safe use of belt entry air. Despite the additional support of the BAAC report, the issue remained controversial. (Anon., 1992).

In 2003, MSHA proposed a rule to eliminate the PFM process for the use of belt entry air in longwall mines with three or more entries and in most other mines; in 2003, MSHA published a Notice of Proposed Rulemaking on underground coal ventilation that allowed the use of belt air once certain controls were implanted in mines with three or more entries; after five public hearings, the rule was finalized on April 2, 2004.

Congress passes the MINER Act of 2006 which requires the establishment of a Technical Study Panel to examine the utilization of belt air and the composition and fire retardant properties of belt materials in underground coal mines.

3 Use of Belt in A Working Section

In U.S. underground coal mines, coal is mostly transported via conveyor belts installed and operated in separate and isolated entries by stoppings, doors and overcasts today. Depending on the particular ventilation system, airflow in these entries are either flowing towards the face or away from the face (Figures 2 and 3); in either case, air in belt entries is diverted directly into the return airways just prior to reaching working sections as this air is not supposed to be used to ventilate working sections by law, except when the belt entry is equipped with necessary safeguards specified by 30 CFR§75.350(b).

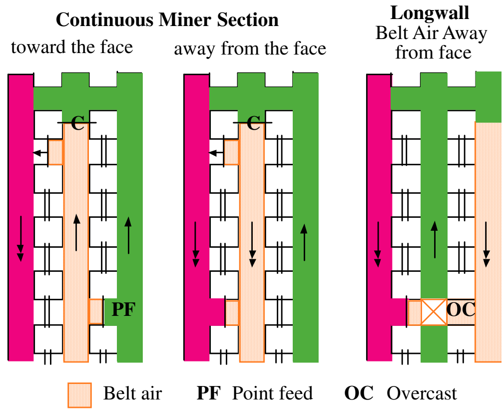

Figure 2. A typical panel ventilation system layout with belt air on return for both continuous miner and longwall sections. (After Kohler and Timko, 2007)

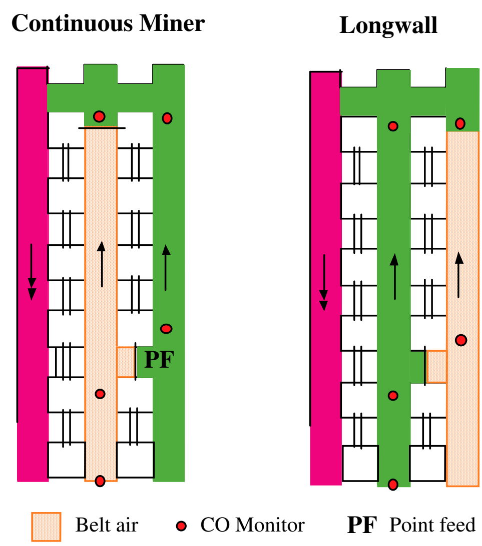

Figure 3. A typical panel ventilation system layout with belt air on intake for both continuous miner and longwall sections. (After Kohler and Timko, 2007)

Belt air can and has been used in working faces in cases where there is an urgent need for additional fresh but cannot be provided readily through existing airways, due either to exceedingly long air traveling distance and/or practical limitations on available fan power; or in some cases, it is not possible to add additional entries due to safety concerns because of excessive ground pressure, provided air is carefully monitored by CO sensors spaced every 1,000 feet; this spacing is reduced to 350 feet if air velocity in the belt entries is less than 50 fpm. In addition, mine operators are also required to monitor the air quality in escapeways.

Several reasons have been used to justify the use of belt air: (1) it provides additional air quantity to working sections that would otherwise not possible without such a system; additional air quantity can reduce the chance of air reversal in certain sections of the belt entry due to leakage. (2) In many situations the existing ventilation system may not be able to deliver the required air quantity even with the highest fan settings and motor capacity due to excessive air-traveling distance. (3) In bump-prone regions where the geological conditions make it necessary to limit the number of entries in certain areas. This condition and the amount of methane generated in the working section make mining more dangerous without using the belt air. (Calizaya and Tien, 2007)

Another added benefit is that the use of belt entry for ventilation reduces the effective section resistance because of added airways, resulting in an increased air quantity at a decreased fan pressure. The real advantage would be the additional air quantity at the working sections with the same number of airways.

There have been several major concerns over the use of air that has been coursed over the belt entry to ventilate working sections: (1) conveyor belt system is subject to problems that can ignite fires (e.g., idler bearing failures, belt tracking, belt slippage); (2) coal spillage and accumulations in belt entries can become airborne; (3) conveyor belt flammability that is a fire source; (4) possible dust entrainment due to improper air velocity in belt entries; and (5) possible methane emitted from shipped coal on conveyor belt. (Kohler and Timko, 2007) Again, all these concerns can be satisfactorily addressed through proper system design, vigorous monitoring and inspection, and diligent monitoring system operator training.

One critical element for the safe use of belt air is the comprehensive use of a monitoring system. A 2003 survey by MSHA indicated that the number of mines using Atmospheric Monitoring System (AMS) increased from 115 mines in 1992 to 146 in 2003, representing 20.6% of active mines that year. Sensors with the ability to discriminate between CO from a fire from CO produced by diesel engines enable mine operators to reduce alarm levels and increase fire detection capabilities. Recent development of a hydrogen-insensitive sensor provides a method to monitor battery charging stations without being interfered by hydrogen. (Francart, 2005)

4 Technical Study Panel Recommendations

There were two primary charges to be addressed, the first is "whether belt entry ventilation air should be permitted to be coursed to the working section to supplement the primary intake ventilation air," and the second question is "what requirements should be enforced on belt flammability and use of the AMS to reduce the hazards of carrying combustion products to the working face in mines using belt air at the face." (Anon., 2007) There were also many auxiliary questions to be considered to ensure that the belt air utilization was carried out without endangering the miners.

The Panel members attended 12 days of public meetings in five different locations over a nine-month period, each with an emphasis area, all coordinated by MSHA personnel. Three of these meetings were scheduled for Panel to hear from technical experts and people or organizations interested in providing inputs. The meetings were held in Coraopolis, Pennsylvania with emphasis on belt fires, belt maintenance, belt flammability and toxicity, ventilation, and escape issues; in Salt Lake City, the emphasis was on ground control and convergence issues; and in Birmingham with emphasis on fire detection, sensors and AMS. National Institute for Occupational Safety and Health (NIOSH) and MSHA were present at all meetings. Panel members also visited underground coal mines in Utah and Alabama to see first-hand the mining conditions under which belt air was being properly utilized as additional source of intake air. (Anon., 2007)

Analysis of study results were conducted by the Panel working in three-member subcommittees, with each assigned a block of topics and charged with proposing recommendations to be considered by the entire Panel. The final public meeting was held on September 17-19, 2007 in Reston, Virginia to evaluate and vote on the recommendations. Each and every one of the draft recommendations were thoroughly discussed, changes in wording negotiated, with some draft recommendations emphasized or combined after active discussions, and then voted on each of the redrafted recommendations. At the end, all 20 redrafted recommendations were passed by unanimous (6-0) votes of the Panel.

The 20 recommendations can be loosely summarized into the following two broad categories. (Anon., 2007)

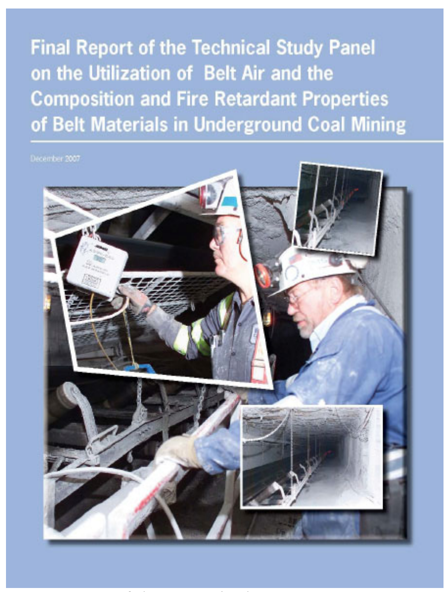

Figure 4. Cover of the TSP Final Report

1) Mines using belt air to ventilate workings sections must be held to a higher standard of safety that involves the use of (a) an atmospheric system (AMS) and/or other suitable monitoring instruments to provide early and reliable detection of smoke, CO and other signs of a belt fire; (b) belt materials must meet the flame resistance requirements specified in the NIOSH/MSHA-developed Belt Evaluation Laboratory Test (BELT) and other test standards recommended by the Panel; and (c) more rigorous inspection procedures by MSHA inspectors.
2) MSHA evaluate the use of belt entry air coursed to the working sections as part of the mine ventilation plan approval process and the District Manager specifically evaluate whether the belt air can be safely used in working sections.

Of all the safety recommendations by the Panel, perhaps the most important one was the one on applying improved flammability standards in U.S. underground coal mines, i.e., the BELT standards as it more closely resembles real in-mine conditions. U.S. is the second largest coal producers in the world with nearly 40% of coal being mined underground. Panel found that the belt fires continue to occur on MSHA-accepted belts, and Thus the Panel recommends that the more rigorous BELT standards be applied to belt materials in U.S. underground coal mines.

Since frictional heating is a common cause of belt fires, the panel recommends that MSHA evaluate a drum friction test for a period of two years to determine the suitability of the BELT to U.S. coal mining industry, incorporate it as part of the flame test requirements if the evaluation proves to be positive. The Panel also recommends that BELT, once proven suitable, be applied to all underground coal mines, not just the ones using belt air in working sections. (Anon., 2007)

The Panel found that the underground mining conveyor belt flammability standards world-wide are more stringent than the standards applied in the U.S., and recommended that MSHA staff involved in belt fire resistance testing "establishing contacts and maintain dialogue with their counterparts in other key mining countries with the goal of working toward more universal standards." (Anon., 2007)

In addition to spending considerable amount of time examining the efficacy of AMS, including the level of training AMS operator receives and the specific tasks assigned to the operator, and the type of electronic sensors used in the AMS, the Panel also considered a significant number of related topics that are peripheral to the use of belt entry air to ventilate working sections: (a) ventilation air velocity be limited between 100 feet per minute (fpm) and 1,000 fpm in the belt entry with certain exceptions; (b) existing lifeline requirements be improved and made uniform throughout the U.S. coal mines to properly indicate presence/availability of doors, SCSR caches, and impediments to travel; (c) existing escapeway design, escapeway planning, and training of miners be improved; (d) dust concentrations be better controlled in working sections; (e) methane concentrations in working sections be not increased by methane concentrations in belt entries being coursed to working sections; and (f) increased MSHA inspection efficiencies. (Anon., 2007)

Among the research areas recommended are to investigate alternate methods of enhancing escape, methods of reducing air leakage through improved ventilation control devices and overall system design, and possible use of booster fans in underground coal mines.

Finally, the Panel suggests that Congress consider increased funding for MSHA and NIOSH to implement these recommendations as many of measures recommended will require additional resources such as inspection personnel, research equipment and personnel, and support services. (Anon., 2007)

5 Summary

Experience shows that the use of belt air in working faces in underground coal mines, implemented properly, can be safe yet provide opportunities to mine in areas where it would not be possible without it, e.g., gassy bump-prone mines with deep covers and deep, large and gassy mines.

One critical element in the safe use of belt air is the implementation of an Atmospheric Monitoring System and strict AMS operators training. It is also important that belt used in underground coal mines pass strict flammability BELT as recommended by the TSP. In addition, proper maintenance of haulage system, a sound ventilation system, ventilation control devices with minimum air leakage, good housekeeping underground, and emergency escape training all play a critical role in reducing and even eliminating underground disasters.

Despite significant improvements in mine safety, recent tragic accidents in Sago, Darby No. 1 Mine, and Aracoma's Alma No. 1 Mine are all reminders of the importance of continuous effort in mine safety. With increasing mining depth, future coal operations in the U.S. will likely be more challenging to operate, there will be an increasing need for more suitable mine ventilation systems, improved ventilation control devices and sound AMS. Since all of them are operated by men, it is critical that personnel with proper skill and regularly trained be part of the overall mine planning.

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