EFFECTIVE, EMULSION-BASED BLASTING

Baron Fidler, Dyno Nobel, the Americas, discusses how implementing emulsion technology helped improve a drill and blast operation.

In opencast coal mining, solutions to a problem can sometimes cause new problems. These unexpected issues can create challenges to the mine's bottom line or to the safe removal of material. The drill and blast tasks in an opencast coal mine can have a significant impact on the removal of materials, such as overburden and coal, as well as on costs and productivity of related downstream tasks.

One example of a solution leading to another problem is the creation of an active mining area dewatering programme. The mine in this study uses a crack line system ahead of the working panel or cut to allow dewater pumps to be inserted into the coal cut. Dyno Nobel used a blast optimisation team (BOT) to discuss possible solutions for a large coal crack that had opened along the coal seam dewatering structure. The structure consisted of 11 in. dia. holes drilled over 100 ft deep along a 5000 ft panel length of mine.

The challenge

During the dewatering process, a crack opened in the coal seam just in front of the dewatering line, ranging in width from 2 - 7 ft. It was decided that trying to fill the crack in order to tram a blast hole drill across was not a safe option, so the BOT started to discuss possible solutions.

One proposed solution was to talk with a contract drill company who had a smaller track drill that could reach over the crack to drill holes from the surface into the standing production coal. This would allow the drill to remain on stable ground and the drill operator to drill at different angles with varied hole lengths to best match the burdens. This is similar to a fan pattern using three or four holes.

The mine has a great safety performance record – it works hard to review projects and tasks to minimise risks and ensure the safety of miners and contractors. The mine led the

Figure 1. Drilled and install dewatering fracture line.

Figure 2. Resulting ground instability between fracture line and face crest.

Figure 3. Drilled stations.

Figure 4. Blast loading and tie-off point.

management of change process, which consisted of maintaining demarcation of unstable ground and tie-off when working outside of the crack, as well as crossing the crack with portable plank-type bridges, continual crack monitoring, and doubling the blast event clearance distance. The main goals of the project were:

- Ensuring the safety of the surveyor, drill crew and blast crew.
- Recovering the coal.
- Minimising wear on the equipment.
- Effectively managing costs.

To help ensure the safest project execution, many project meetings were held to discuss plan improvement and maintain team communication. The final coal blast pattern had 107 holes with 5 in. dia. in three rows along 505 ft, consisting of 43 drill locations/stations. Drill hole angles ranged from 7 - 58˚ off vertical in a fan shape, and hole depths ranged from 25 - 48 ft with hand stemming of 12 - 35 ft.

The process

At first, a spherical button bit was used, but it was slow and eventually progressed to a ballistic bit. In support of the mine's safety culture, Dyno Nobel engaged a contracted driller, as it was critical for them to understand not to place themself or the drill in a dangerous situation (i.e. too close to the open crack). The drill operator had the ability to stop work should an unsafe situation arise.

There were three blast crew members working the hole loading process: one member to load the holes with tie-off on the outside of the crack, another member with tie-off on the inside of the crack, and the bulk truck operator. The primers were NONEL MS (millisecond) down-the-hole delays and Trojan cast boosters.

TITAN XL1000 emulsion was loaded into the holes with a 1.10 g/cm^3 cup density using a 1 in. flexible hose. Stemming collars ranged from 10 - 15 ft. The holes had to be hand stemmed and, at times, a stem material push pole was used to assist the material in sliding down the 58˚ angled holes, especially when water was present or when the collar zone was a little ratty.

The TITAN DIFFERENTIAL ENERGY (ΔE) calculator, which is available to both Dyno Nobel experts and customers, was used in the design of the blasthole loading options. The calculator considers up to four emulsion segments based on emulsion final cup density, hole angle, hole depth, wet or dry hole, designed stem height, and the length of the loaded emulsion segment. A print function is available to assist bulk truck operators in loading the holes where a paper loading sheet document adds value.

The TITAN emulsion uses only a single density emulsion segment per hole, but the calculator is able to calculate various column load comparisons – it uses up to four segments to allow targeted placement of energy in the blast hole.

TITAN bulk emulsion technology offers TITAN XL1000 and TITAN ΔE delivered into the hole at a loading rate of up to 1800 lb/min., but in this project, a 1 in. dia. loading hole was used at a rate of 125 lb/min. Many times, wet holes are dewatered prior to loading either blasting agent, but in the case of this project, the hose was pushed into the holes and the water was displaced as the emulsion was loaded.

The company's technology provided the customer with flexibility to pump a variable density product into a variety of angled blast holes. The detonation velocity is typically greater than 20 000 ft/sec. compared to solid, sensitised repump emulsions, which increases the detonation pressure on hard material. The emulsion is shipped and stored as a 5.1 oxidiser and loaded into the blasthole as a 1.5 blasting agent – this is beneficial to the mine, as it has greater restrictions with storing blasting agent volumes. The emulsion technology was applied during the emulsion loading process to consistently load the designed density of 1.10 g/cm^3 within each blasthole segment. Average loaded density within the blasthole was 1.16 g/cm^3 or 9.8 lb/ft loaded (32.15 kg/m).

The benefits of using the emulsion technology include:

- Reduction or elimination of post-blast NO_X fumes.
- Increases in water resistance, actual energy yield vs theoretical value, and product sensitivity.
- The ability to control density, redistribute energy, increase detonation pressure, maintain cost per loaded foot and observe trends toward fragmentation and displacement.

The company believed the lower density at the collar would minimise potential highwall crest damage that could create a future safety challenge. The ability to homogenise the emulsion as it is loaded into the hole helps reduce the loss of emulsion into cracks.

Conclusion

Optimising material fragmentation and removal usually creates unique challenges for each stratum within the mine. The main goal of this project was to safely blast the coal section. By using a BOT approach, an additional result was that the blasted coal provided good fragmentation and good displacement, very similar to regular standing coal blasts – this helped ensure coal volume recovery. A drone was used to capture blast videos, blast data and blast event cost comparisons to help document and ensure project success.

General comments included that the material was dug without complaints from wheel loader operators and that there was no change in production. The continuous evaluation of the emulsion product density and placement within the hole, along with stemming height, helped the blast crew make small field adjustments. Providing various levers to pull for fine tuning blast results is one advantage of the emulsion technology.

In conclusion, new challenges should be handled with a team willing to discuss options openly and honestly. It is crucial to include the right people in the discussion and ensure they are willing to actively participate so that the project solution can be safely executed. New technologies can provide viable options to solve problems and challenges. In this study, new drilling technology and TITAN bulk truck technology were both considered as viable options to safely blast down 24 000 t of sellable coal at a powder factor of 0.58 t/lb. WC