Nitro Sibir Australia – Polar SX Emulsion

Case Study

The Product:

Nitro Sibir Australia (NSA) commenced manufacture of bulk emulsion explosives in Australia during 2014. NSA's key focus was to produce a quality, higher energy bulk emulsion that provided explosive energy at a lower cost per unit to its customers.

The bulk delivery system, or mobile processing unit (MPU) was available to be used by clients who wanted to use their own equipment to deliver the product into the blast hole. NSA also offers a loading service to sites that do not own their own MPU's.

NSA began manufacturing a robust, low water content, emulsion that provided higher energy than other offerings in the market. This product was named Polar SX emulsion. The Polar SX series of products can be delivered at densities of 0.85gcm^{-3} to 1.25 gcm^{-3}, enabling the product to be matched to all types of rock mass.

Figure 1 Polar SX 70% ANE / 30% ANFO Blend

The Challenge:

Ammonium Nitrate Emulsion (ANE) is manufactured by melting high purity ammonium nitrate and emulsifying it with a fuel. By keeping the water used in melting the AN as low as possible, a more energetic ANE is produced when compared to those with higher water volumes.

Increased water content will result in a lower energy product – water is an energy sink. These emulsions, in medium to soft ground conditions, undergo sub optimal detonation, resulting in lower energy output and a potentially higher fume output.

Table 1.0 displays the effects of water content on the energy rating of the ANE solution.

Scenario	1	2	3
%Wt Fuel / Emulsifier	5.20	4.96	4.71
%Wt AN	78.8	75.04	71.29
% Wt H_2O	16.0	20.0	24.0
Energy Q# (MJ/Kg)	2.83	2.59	2.31
% Reduction From 1		8%	18%

Heat of Detonation (MJ/Kg)

Table 1 Evaluation of the Effect of water on Q (MJ/Kg)

Emulsion based bulk explosives are typically loaded into the hole with densities from 1.15 gcm^{-3} to 1.25 gcm$^{-3,}$ based on the convention that the higher the powder factor the better the blast result. As the powder factor does not define the contained energy (Mj/Kg), (it defines the explosive mass at an unknown energy rating), it cannot be used as an indicator to select explosives density.

In a similar manner, it is believed that ANE bulk explosives final density must be denser than water (1.0 gcm^{-3} to 1.05 gcm^{-3}) to ensure that it does not float. This is not the case. Bulk ANE explosives are pumped into blast holes at densities greater than 1.2 gcm^{-3}, i.e. denser than water. By using the correct loading techniques, bulk ANE explosives loaded into the hole from the bottom of the blast hole in a continuous column displaces the water by forcing the water towards the collar of the blast hole. Once the column of bulk explosives starts to gas (expand and sensitise) the water is pushed further up by the column of explosives. The bulk explosive will only float if the product is loaded incorrectly or the water content of the emulsion is too high thus reducing the adhesiveness of the product and therefore its ability to stick to the wall of the blast hole.

Bulk explosives performance must be based on more than powder factor. Performance of bulk explosives will be influenced by:

- Ground conditions (confinement);
- Bulk explosives sensitivity (density);
- Heat of detonation (water content, confinement and sensitivity);
- Contained energy (water content);
- Loading techniques.

So often bulk emulsion explosives are delivered at the same density in all blast hole diameters and in all ground conditions. Given the list of factors affecting blast outcomes, this is unlikely to result in optimal outcomes every time.

The Solution:

NSA manufactures an emulsion with low water content that delivers high levels of explosive energy in all ground conditions.

NSA, by engaging an explosive application specialist, worked on lowering the in hole bulk density of the explosives without compromising the energy delivered when the explosive is initiated when compared to the product loaded by the previous supplier. This enabled the client to achieve the same fragmentation and blasted muck pile movement using a lower powder factor. This change resulted in a significant cost saving for the client.

NSA has conducted multiple trials at current customers and competitor supplier's sites, with similar beneficial blasting results at lower powder factors. This is achieved through energy matching the lower water content bulk explosives to the ground conditions.

Dependant on the ground conditions and required blast outcomes, NSA can deliver a bulk explosive, Polar SX, at densities from 1.25 gcm^{-3} to 0.85 gcm^{-3}. Soft geology that contains water, like clay, does not require a high density bulk explosive e.g. 1.2 gcm^{-3}, as the ground conditions are not conducive to obtaining optimal detonation of a bulk emulsion.

Where ground conditions do not provide high confinement during detonation the sensitivity of the bulk explosives must be increased to promote an improved detonation, e.g. more air voids to promote an effective detonation. This practice is known as impedance matching. The explosive energy and sensitivity is matched to the geological properties of the rock mass that is being blasted. This is based on chemistry principals where an ideal detonation requires constant temperature, pressure and volume. If the ground conditions cannot maintain one or more of these requirements then the only option is to increase the bulk explosives sensitivity to improve the detonation outcomes.

Figure 2 Delivery of Polar SX at customer site

The Benefit:

Sites that are using NSA Polar SX emulsion have the option of using their own Mobile Processing Units (MPU) or having an NSA operated MPU load the product for them. The following benefits are realised through the use of the Polar SX series of products:

- Lower water content enables increased fragmentation at the same density when compared to most competitors' products at similar price;
- Lower water content enables same explosives energy to be delivered at a lower density compared to most competitors' products at similar price;
- Lower in hole densities available than competitor's products;
- Lower $/MJ cost than competitor emulsion products;
- Increased stability of product due to higher emulsifier content;

Shown above in table 1.0 is a theoretical evaluation of bulk ANE energy with varying water content. High water content ANE can significantly affect your blast outcome. Ask your explosive supplier today: "What is the water content of the ANE we purchase"?

Disclaimer: This case study is based on factual evidence, Nitro Sibir Australia (NSA) provides no implied warranty or guarantee of performance