

Comments on Rock Blasting

Explosive Selection in Rock Blasting (3 of 4)

By Bruno Pimentel.



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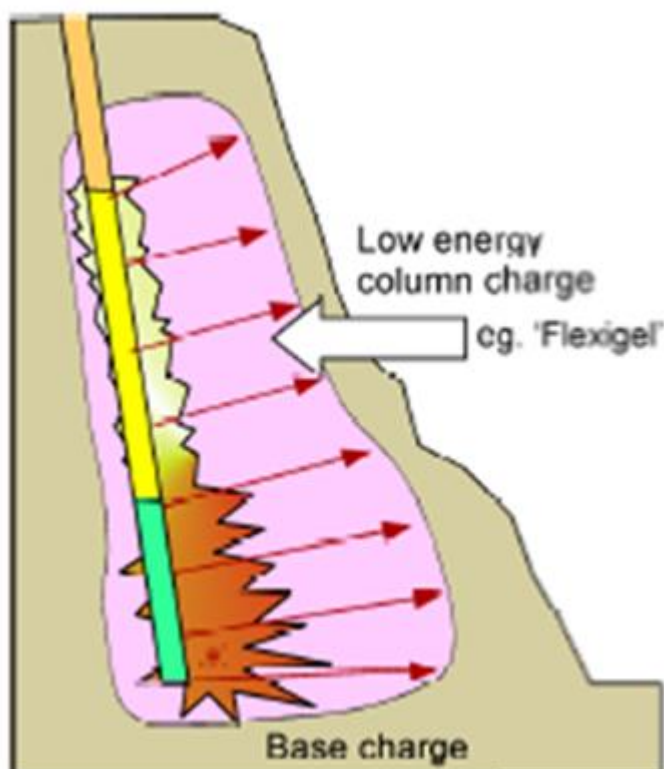
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In our previous article, we examined a series of criteria that we need to analyze, whether when choosing an explosive for a new operation or considering the replacement of the current explosive. Therefore, in today's article, we will continue our list of points of attention, where we will address the following points:

- **Energy:** The energy released by the explosive affects its fragmentation capacity.
- **Presence of Water:** Waterproof explosives may be necessary if there is water on-site.
- **Hole Characteristics:** The diameter, depth, and configuration of the holes influence the choice.
- **Operational Considerations:** Practical aspects related to application and logistics play a relevant role.
- **Team Experience:** The team's experience in dealing with a particular explosive is important.

- **Environmental Conditions:** Environmental factors should be taken into consideration.
- **Product Compatibility:** Compatibility between explosives and accessories is essential.
- **Performance in Similar Situations:** Assess how the explosive performed in similar operations.

9 Energy



The energy of explosives is a challenging criterion to accurately compare between different explosives. This occurs for several reasons: first, the exact amount of energy required to fragment the rock according to the desired specifications cannot be reliably determined; second, manufacturers use various methods to calculate the energy of their explosives, making the comparison between distinct explosives less straightforward. Additionally, it is complicated to assess how much of the energy available in an explosive will be truly useful during the fragmentation process, as well as whether we can harness the same amount of energy from different explosives.

The energy of explosives is generally divided into two categories: shock energy and gas energy. However, it is difficult to precisely determine the quantity of each of these energies and the necessary proportion to achieve an ideal detonation performance.

Despite uncertainties and the lack of practical information to guide choices, the energy of explosives is more relevant than the charge ratio in detonations, especially in hard rocks. Therefore, in theory, energy should be the primary factor for comparison between explosives. However, in practice, this comparison is not straightforward and can be complex due to the lack of availability and standardization of energy information across different suppliers.

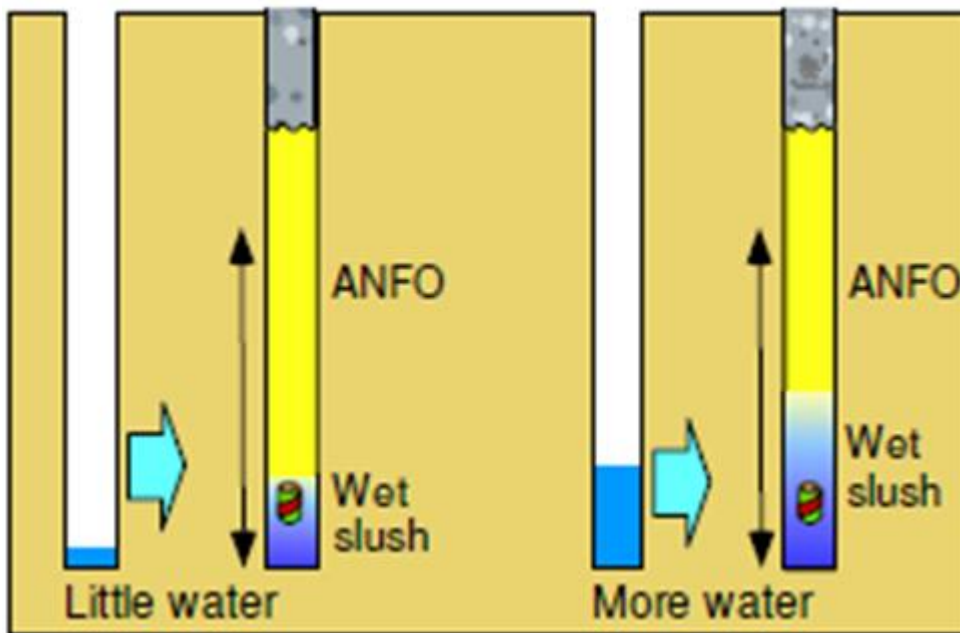
Practical experience and conducting tests play a crucial role in comparing and selecting explosives. Performing tests that simulate real detonation conditions and evaluating the results obtained can offer valuable insights for choosing the most suitable explosive. Thus, although comparing energy between explosives is challenging, conducting specific tests can provide a solid basis for making informed decisions in explosive selection.

In practice, comparing energy between explosives is more frequently done among products from the same manufacturer. This is because it's understood that the manufacturer will adopt similar criteria for all their explosives. However, when analyzing explosives from different suppliers, the energy reported by them is used as a reference. In these situations, the comparison tends to focus on other characteristics, such as Detonation Velocity (VOD), density, and other properties. This is often done through testing and comparing the results obtained.

In operations involving variations in conditions and types of rock, it may be necessary to adjust the energy factor for each specific detonation configuration. However, in practice, we do not always have a wide variety of explosives available for this adaptation. In this context, the flexibility of the explosive's characteristics becomes crucial. Blended explosives, which offer variations in density and composition, can be a significant advantage to consider. They allow for greater flexibility in detonation settings, enabling adaptation to different operational scenarios.

When the flexibility of explosives is not feasible, it is fundamental to choose an explosive that meets the most challenging conditions or has a greater impact on the overall operation's results. This approach aims to ensure the best possible overall performance, even in the most adverse situations. Therefore, when dealing with the complexity of comparing energy between explosives, it is important to consider strategies that allow for more accurate and informed assessments for each specific operational scenario.

10 Presence of Water



A practical aspect that deserves attention is the presence of water during detonation, especially when considering the use of explosives with low resistance or no water resistance, such as ANFO and its derivatives. It is essential to recognize that the presence of water is not a constant in most operations, occurring only in certain periods of the year or in specific areas. The focus should be on how to deal with this situation when water is present.

This analysis gains relevance because, although ANFO and its derivatives are low-cost alternatives that can yield good results, especially in softer and fractured rocks, they tend to be completely desensitized in the presence of water. Therefore, it is crucial to assess the likelihood of water presence, the impact it may have, and the available alternatives to address this situation. This may involve considering water-resistant explosives or implementing techniques that allow the use of non-water-resistant explosives when necessary.

When water is a predominant factor, it may be more advantageous to opt for explosives that are intrinsically water-resistant since limited use of an explosive may not justify its presence. The situation becomes more complex when water is in motion, which is common in underground operations. Besides the impact of the water itself, its movement and force can create additional challenges. This is particularly evident in highly fractured rocks, where water can transport explosives through the fractures. In underground detonations with up-hole drilling, the presence of water hinders the retention of explosives in the holes.

In this context, besides selecting the appropriate explosives, it is necessary to consider the application techniques that will be used. There are effective approaches, such as dewatering or lining the holes internally with plastic casings. These techniques can be especially effective in simpler scenarios, allowing in some cases the use of non-water-resistant explosives. Therefore, when facing the presence of water during detonation, it is essential to adopt a holistic approach that considers both the choice of explosives and the application strategies that best suit the specific conditions of each operation.

11 Hole Characteristics

Another crucial aspect in the selection of explosives is considering the standard characteristics of the boreholes that will be used in the detonation, with a special focus on diameters and maximum depths.

- **Borehole Diameter:**

It's essential to be attentive to the critical diameter of each explosive. In operations where multiple diameters are used, it's highly recommended that all explosives meet the smallest possible diameter. This prevents the possibility of mistakenly using the inappropriate explosive in a specific diameter.

The implications of diameter are varied and affect detonation velocity. Larger diameters result in higher detonation velocities, while smaller diameters require more sensitive explosives. Additionally, application characteristics also play a role. For instance, when pneumatically applying ANFO, smaller diameters are viable due to greater confinement. Conversely, poured ANFO exhibits lower confinement, necessitating a larger critical diameter.

- **Borehole Depth:**

Borehole depth also influences the choice of explosives. Very deep boreholes may require special explosives. It's recommended to pay attention to initiation practices, suggesting one primer every 10 meters of explosive charge. The deeper the borehole, the more advisable it is to use more powerful primers to maintain the maximum VOD (Velocity of Detonation) of the explosive throughout the explosive column.

It's important to consider chemically gassed explosives, especially in deep boreholes. Density variation along the borehole can result in high density at the bottom, decreasing the explosive's sensitivity to initiation.

Therefore, a meticulous analysis of borehole diameter and depth is essential to choose explosives that ensure an effective and safe detonation. Understanding the complex interactions between diameter, confinement, detonation velocity, and sensitivity is vital for making informed decisions and optimizing detonation performance.

12 Operational Considerations



It is crucial to emphasize that the planning and execution of detonation have a significant impact on the final outcome. Therefore, we should not overlook operational issues when choosing the explosives to be used.

- Selection Based on Application Techniques:

The need to apply explosives through manual or mechanized techniques already indicates the category of explosive to be used. The choice should take into account the characteristics of these techniques to ensure effective and safe application.

- Impact of Operational Quality:

The quality of the loading operation and detonation preparation directly influences the performance of the explosives. Any attempt to achieve better results should begin by ensuring that operational practices are enhanced and that explosive application is of high quality. It's important to note that transitioning from ready-made products like cartridges to pumped explosives can present challenges. The quality of application becomes even more crucial in this scenario.

- Evolution of Operational Quality:

Before considering a change of explosives, it is imperative to ensure that operational quality is sufficient to maximize the current and potential explosive's performance. Improving operational quality is a prerequisite for achieving superior results when making changes in the type of explosive used.

- Prioritization of Operational Safety:

Safety in operations is another determining factor in the choice of explosives. Evaluating the existing safety level in the operation and selecting the most suitable explosive to prevent unwanted events are of utmost importance. The safety of workers and the entire operation must be a primary consideration.

Therefore, when selecting explosives, it is fundamental to evaluate the suitability of application techniques, enhance operational quality, ensure operational safety, and ensure that the transition to new explosives is carried out efficiently and safely. Only with a comprehensive approach that takes into account all these operational issues is it possible to optimize detonation outcomes.

13 Team Experience



An often underestimated yet crucial aspect is the quality and skill of the available workforce in the operation. This consideration should be evaluated in conjunction with operational issues since the competence of the team involved in the application of explosives plays a crucial role in the success of the detonation.

- Availability of Skilled Labor:

In various operations, especially in remote locations, the availability of skilled labor for the application of explosives might be scarce. Some types of explosives require specific criteria and assessments during application, making it essential to have qualified personnel to ensure adequate performance. Without a trained team, the explosive results can be compromised.

- Need for Adequate Training:

The quality of the workforce is particularly important for explosives that require detailed application procedures. An example is the use of pumped emulsion. The successful application of this type of explosive requires rigorous quality controls, both regarding the product itself and the application conditions. Adjustments are often necessary to optimize performance. In this context, it is fundamental for operators applying the explosive to have proper training to make these adjustments accurately and efficiently.

- Ensuring Performance:

To ensure the effectiveness of explosives, it's essential to have a team that understands application procedures and can make necessary adjustments. Otherwise, even the best explosives may not reach their maximum potential due to the lack of team competence. Therefore, investing in workforce training is a smart strategy to ensure the success of detonations.

- Continuous Training:

In addition to initial training, providing ongoing training to the explosives application team is important. This allows them to stay updated with best practices and handle potential challenges that may arise during operations.

In summary, the quality and skill of the available workforce play a crucial role in the selection and application of explosives. Ensuring that the team is trained and competent to handle the specific application procedures of different types of explosives is essential to achieve consistent and successful results in detonations.

14 Product Compatibility



In addition to operational considerations and workforce quality, compatibility between products and techniques used is a crucial factor to be evaluated when selecting explosives for a detonation. The evolution of energetic explosives and accessories, such as wireless detonators, offers interesting opportunities, but it's essential to understand the need and assess the feasibility and compatibility of these products with the operation.

- Assessment of Need and Feasibility:

The choice of more energetic explosives or innovative accessories should be based on a careful assessment of the actual need and potential benefits. Compatibility between these products and other detonation elements should be considered, ensuring that the extra investment in more advanced products translates into better results.

- Proper Utilization of Products:

Using more energetic explosives may be advantageous, but it's fundamental to ensure that all necessary conditions are in place to maximize their utilization. This includes assessing whether the operation provides suitable conditions for the effective use of these explosives, including the necessary accessories for initiation and detonation.

- Compatibility with Accessories and Techniques:

It's important to assess the compatibility between explosives and accessories used in detonation. For example, if an operation uses detonating cord or electronic detonators, it's necessary to ensure that these accessories are suitable for initiating the chosen explosive and that their performance is not compromised.

- Overall Operation Context:

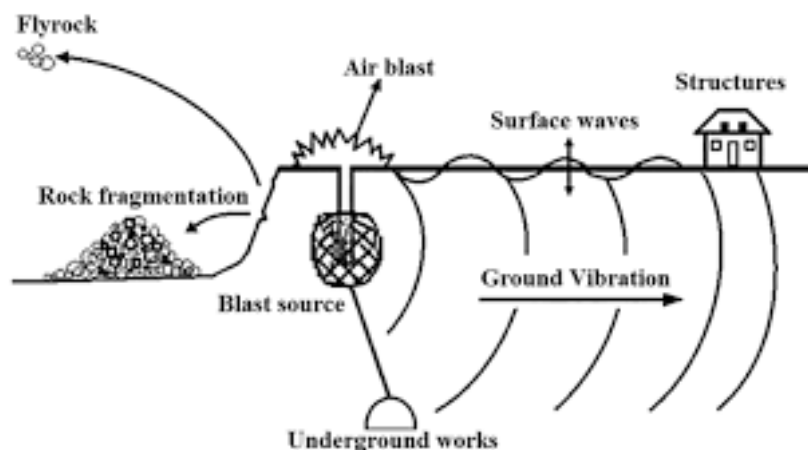
The compatibility assessment should consider the overall context of the operation. For instance, switching to more energetic explosives may not make sense if the initiation accessories used are not compatible with these explosives. It's necessary to ensure that all parts of the system are aligned and complement each other.

- Comprehensive Evaluation for Better Results:

Compatibility between products and techniques is a critical factor for successful detonations. Evaluating compatibility isn't limited just to the products themselves but also involves a comprehensive analysis of initiation techniques, accessories, and operational conditions. This holistic approach is fundamental to ensuring that the selected explosives can be fully utilized and contribute to optimized outcomes.

In summary, the choice of explosives should consider not only their individual characteristics but also compatibility with techniques, accessories, and operational conditions. A thorough assessment will help determine whether using more advanced products is advantageous for the operation and if they can be effectively incorporated to achieve the best possible results

15 Environmental Conditions



In addition to operational and technical considerations, environmental conditions play a crucial role in choosing appropriate explosives for a safe and effective detonation. Environmental characteristics, including potential risks, influence the selection of explosives aiming to minimize impacts on safety, control, and damage prevention.

- Impact Control and Risks:

In areas close to urban or sensitive zones, the need for control over detonations is higher. The selection of explosives should consider their ability to minimize impacts such as flyrocks, vibrations, air blasts, dust, and unwanted gases. Explosives offering greater control over these aspects are preferable in such situations.

- Explosive Characteristics and Environmental Impacts:

Explosive characteristics, such as shock energy and gas energy, have a direct impact on environmental effects. Explosives with higher shock energy may generate more intense vibrations and air blasts. Greater gas energy is associated with increased dust lifting, gas generation, and potential flyrock risks. These considerations are essential to minimize impacts on the surrounding environment.

- Factory-Manufactured Explosives vs. On-Site Produced:

Factory-produced explosives tend to have more predictable characteristics. On the other hand, explosives produced on-site may require stricter monitoring, especially concerning factors like oxygen balance, which can influence the generation of toxic gases. Operational practices also affect performance and detonation effects.

- Delayed Charge Control:

The need for delayed charge control can impact the amount of explosives to be applied. This affects the effectiveness of manual or mechanized approaches. The selection of explosives should consider this limitation and the ability to maintain desired performance, even with delay restrictions.

- Holistic Considerations:

Explosive selection under environmental conditions should involve a comprehensive analysis considering both explosive characteristics and the specifics of the detonation environment. This includes assessing potential risks, environmental effects, and detonation control capabilities.

- Impact Prevention and Mitigation:

The choice of explosives should prioritize the prevention and mitigation of negative impacts on the environment and safety. The careful selection of appropriate explosives, aligned with the surrounding environment and operational practices, will ensure that detonations are conducted responsibly, minimizing associated damage and risks.

16 Performance in Similar Situations



When selecting the ideal explosives for a detonation, considering the performance achieved in operations under similar conditions is valuable. While not a decisive factor, analyzing experiences from other operations can serve as a reference and provide useful insights in the selection process.

- Practical References:

By analyzing operations that share similar characteristics with ours, such as rock type or application conditions, we can obtain practical and contextualized information about the choice of explosives. While variables may vary, observing the type of explosive used, the application approach, and the results obtained can provide valuable information.

- Collaboration and Information Exchange:

Companies often have partner operations or networks that facilitate information exchange. Additionally, explosives suppliers play an important role in connecting

different operations and providing support. These collaborations can offer valuable insights into explosive selection.

- Historical Records and Learning:

Historical records of operations, including explosives used and results obtained, are valuable resources. Unfortunately, not all operations maintain detailed records. Lack of records can result in repeated testing and choices based on outdated information as professionals change over time.

- Continuous Learning:

Analyzing performance under similar conditions encourages continuous learning in explosive selection. Based on experiences from other operations and historical records, it's possible to adjust approaches, avoiding past mistakes, and enhancing detonation results.

- Caution in Extrapolations:

It's important to highlight that each operation is unique, with specific variables and different contexts. Analyzing similar experiences should be done carefully, considering the nuances and particularities of each situation.

- Final Considerations:

Analyzing explosive performance in similar operations complements the decision-making process in choosing appropriate explosives. Shared learning and analyzing results from other operations can enrich the selection process, contributing to safer and more effective detonations.

That's it, everyone. Let's stop here for today. In the next article, we will continue discussing the selection of priming for initiating our main explosive and the initiation system that will govern the pace of our detonation.

As always, please comment and share so that we can have safer and higher-quality blasting!

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