

## Comments on Rock Blasting

# Explosive Selection in Rock Blasting (2 of 4)

By Bruno Pimentel.



Hello, my friends. I hope you are all well, and that our articles are somehow contributing to making your detonations more efficient and safe. As always, we provide the links below for you to check our previous articles and to register to receive automatic notifications for each new article we publish monthly:

Português

<https://www.linkedin.com/newsletters/desmonte-de-rocha-c-explosivo-6941709482355748864/>

English

<https://www.linkedin.com/newsletters/rock-blasting-6959820770344595456/>

As we mentioned in our last article, we have a series of 4 articles discussing the selection of explosives and accessories for rock blasting. Our aim isn't to present theoretical formulas or create a step-by-step guide on making this choice, as there are various scenarios, each potentially requiring a different approach. Instead, we aim to provide insights on the key considerations needed when determining which products to use.

We concluded our previous article with a list of the main criteria to analyze, whether selecting an explosive for a new operation or considering replacing the current one. Therefore, in today's article, we will analyze the first points on this list and continue with the others in the next article.

These are the points we will discuss today:

- **Special Conditions:** Unique situations like the presence of explosive atmospheres or reactive rocks might require specific explosives.
- **Availability and Flexibility:** The availability of explosives in the market and their capacity to adapt to operational variations are crucial points.
- **Desired results:** It is important to evaluate the desired results to buy with the properties of the explosive to be chosen.
- **Costs:** Considering the financial impact of the explosive choice in relation to the benefits is vital.
- **Blasting Type:** The type of blasting to be carried out influences the choice of explosive.
- **Blast Size:** The scale of the blast and the quantity of rock to be fragmented are relevant factors.

- **sleep time:** The time necessary for the explosive to remain in the borehole before detonation.
- **Rock Properties:** The composition and characteristics of the rock affect the effectiveness of the explosive.

So without much delay, so as not to make our article too long, let's address each of these points!!!

## 1 Special Conditions



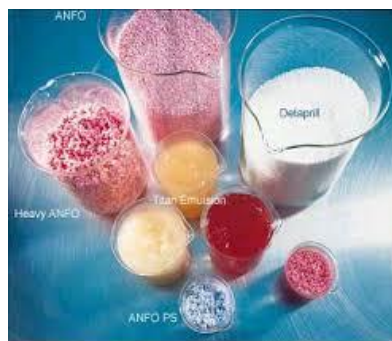
In the context of explosive selection, certain special conditions play a decisive role in choosing the most suitable explosive. This is the initial point to consider when analyzing the available explosive options. These special conditions can encompass various aspects, including technical, operational, and safety considerations. They may arise as constraints or limitations that influence our choice. For instance, there are conditions requiring explosives with specific characteristics, with prime examples being the need for explosives in explosive atmosphere environments, reactive rocks, hot terrains, or deep boreholes. In addition to these scenarios, there are other more common conditions that also shape our explosive choice.

Consider the scenario of highly fractured rock. In this setting, the use of packaged or less fluid explosives might be necessary to reduce explosive migration through rock fractures. This illustrates how the rock composition can impose specific restrictions on the most appropriate explosive.

Another situation involves urban areas near the operation. In this context, there may be limitations on the quantity of explosives that can be used, which, in turn, might restrict borehole diameters. Consequently, selecting an explosive effective in smaller diameters becomes relevant.

In summary, the crucial first step in explosive selection is identifying the presence of special conditions or limiting factors. From this identification, we can then proceed to analyze the other criteria influencing the choice of the ideal explosive. Recognizing and understanding these special conditions is essential for making informed and strategic decisions, ensuring the efficiency and safety of detonations.

## 2 Availability and Flexibility



After analyzing the limitations that impact explosive selection, the next crucial step is to assess the availability of explosives and their applicational flexibility. This aspect can hold different significance depending on the operational circumstances.

For some well-located operations with reliable suppliers, the availability of explosives might not pose a problem. However, in more complex scenarios such as remote operations or areas with a limited number of suppliers, the choice of available explosives can become more restricted.

A specific consideration involves mechanically applied explosives, such as blended explosives. The application of these explosives might not be economically viable for smaller operations or in conditions that do not allow for the efficient use of specific equipment. For instance, challenging terrains or narrow tunnels might create limitations for the application of blended explosives.

The availability of explosives is a crucial consideration since considering explosives that are not readily accessible for the specific operation is futile. Additionally, flexibility plays an essential role. Operations often encounter diverse scenarios and conditions that might require different explosives. Having the capacity for flexible choice is a constant need for many operations.

While some operations might demand only one type of explosive, others might need two or even three distinct types, depending on the particularities of the detonations. Blended products offer a highly flexible approach, allowing the combination of different explosives in specific proportions to meet varying needs.

Currently, advanced application equipment is available for producing various types of explosives and blends. These devices feature not only emulsion and ammonium nitrate tanks but also separate compartments for components such as aluminum, low-density products, and special additives. This allows for a more precise adaptation to the characteristics of each detonation.

In summary, analyzing the availability and flexibility of explosives is fundamental to ensure that choices align with specific operational conditions and the diverse needs of detonations.

### 3 Desired results



After analyzing the special conditions, restrictions, and availability of explosives, attention turns to a crucial point in determining the appropriate explosive: the needs and goals to be achieved. This involves the desired results, whether related to fragmentation or other specific needs.

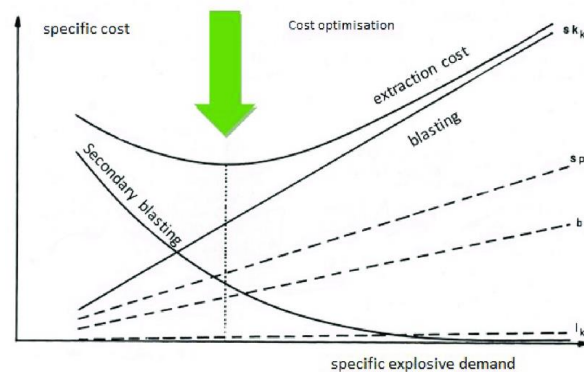
As mentioned earlier, objectives and needs serve as a starting point to define parameters in any detonation, especially when there are no restrictive limitations. Beyond influencing the choice of explosive, objectives also shape detonation planning, operational practices, and employed techniques.

The pursuit of specific results or maximizing performance in determined areas not only guides the selection of explosives but also the entire detonation planning process. For instance, the need for more efficient fragmentation might require the use of higher-energy explosives. Achieving greater throw might demand more gaseous explosives. When precise wall control is essential, special or lower-density explosives might prove ideal. In each case, specific needs dictate the most appropriate type of explosive to achieve the desired results.

However, it's important to acknowledge that objectives aren't always compatible. In situations where multiple needs coexist, more detailed analyses might be necessary to select balanced explosives. The flexibility of available explosives for use is also essential, particularly in large-scale and complex operations where operational variables are constantly changing, or rock characteristics vary significantly.

In summary, considering the desired results is a pivotal step in selecting explosives. These results shape the selection of the explosive and influence the entire detonation planning, ensuring that objectives are achieved effectively and efficiently within the complex operational realities.

#### 4 Costs



Another highly relevant aspect that deserves attention is evaluating the costs associated with selecting explosives, a crucial point that must be carefully weighed with the specific characteristics and demands of each operation. In this context, it's crucial to adopt a comprehensive approach in assessing costs, considering both unit aspects and the total cost, conducting detailed comparisons of the results obtained with each option.

It's essential to emphasize that when analyzing costs, it's imperative to go beyond merely assessing the unit price. A more comprehensive approach requires understanding the total costs involved, alongside comparative analysis of the results achieved in each scenario. This more comprehensive approach allows for a more precise view of the financial impacts related to the choice of explosive.

When evaluating costs, it's essential to adopt two main perspectives. First, costs should be considered in relation to the energy provided by each explosive. It's a common observation that more economical explosives tend to provide less energy or may have limitations, such as ANFO, which, despite being a low-cost option, isn't viable in aquatic environments and has comparatively lower shock energy.

In addition to cost evaluation, examining the results each explosive can deliver is crucial. As widely recognized, detonation results directly influence subsequent activities. For instance, choosing a low-performing explosive might lead to higher costs in drilling, loading, transportation, and subsequent processing. Conversely, explosives that, despite having a higher initial cost, offer superior results, can lead to significantly lower overall costs.

It's evident, therefore, that the cost factor cannot be underestimated. However, the approach to cost analysis must be holistic and consider various criteria. The analysis should be comprehensive, allowing costs not to become a limiting factor in selecting explosives but rather be seen as an investment opportunity to achieve more significant and efficient results.

In many instances, it's of utmost importance to conduct practical comparisons when assessing costs, opting to analyze the cost per unit of energy rather than the cost per kilogram of explosive. Additionally, whenever feasible, conducting comparative tests or seeking references in other

operations can be valuable strategies to evaluate the results delivered by each of the explosive options under scrutiny.

As addressed on multiple occasions, the impact of the detonation on subsequent activities is undeniable, whether in mining operations or civil construction projects. It has been demonstrated that superior results in detonation lead to much more significant cost reductions in subsequent stages. This realization makes the cost analysis of detonation a more intricate task than simply evaluating the unit cost of explosives.

It's crucial to remember that the performance of the detonation isn't solely based on the explosive's performance itself but on all the factors comprising the detonation plan. Therefore, employing a high-quality explosive improperly would be tantamount to wasting its potential energy. Apart from evaluating the cost-effectiveness of the explosive, it's imperative to consider other technical and operational conditions to fully harness the characteristics of the chosen explosive.

## 5 Blasting Type



It's an intuitive conclusion and, in certain contexts, could even be classified as a special condition. However, it's essential to meticulously evaluate the type of detonation we plan to perform. This is because certain specific types of detonation may require the use of equally special explosives.

A tangible example is the distinct nature of detonations in open-pit and underground operations. These two categories often present significantly different scenarios and conditions, justifying the existence of explosives specifically developed to meet the demands of each. For instance, an exclusive emulsion could be designed for underground detonations in production operations, optimized for application in reduced diameters, in deep boreholes, and with outstanding adhesion. Although theoretically usable in open-pit detonations, its primary characteristics wouldn't be fully utilized in that context.

Therefore, each detonation variant may prompt the need for a specific explosive or one that exhibits attributes providing superior performance within that scenario. At times, explosives formulated exclusively for a particular type of detonation may showcase better performance compared to more generic alternatives. However, it's important to note that, in general, these targeted products tend to incur higher costs. An example is the class of explosives developed for presplit or artistic purposes, where the higher cost is justified by the excellence of results achieved in that specific blast type.

## 6 Blast Size





An operational parameter significantly influencing the choice of explosive to be used is the size or volume of the detonation to be carried out. This consideration is closely linked to available resources and the time allocated for the preparation and execution of the detonation process.

In general, for smaller detonations, it is appropriate to employ explosives that can be applied manually or through pneumatic application devices. These explosives are suitable to cater to a diverse range of smaller-scale operations. On the other hand, for larger-scale detonations, the use of equipment designed for the application of pumped or poured explosives proves more ideal. These devices offer a higher production rate and, due to the larger quantity of explosive to be used, tend to be more cost-effective.

Therefore, the size of the detonation is a crucial criterion in selecting the type of explosive to be employed. The choice between manually applied explosives, especially in smaller operations, and explosives applied by high-capacity equipment tailored for large-scale operations, is decisive in achieving operational objectives efficiently and effectively.

### 7 sleep time



Another crucial operational characteristic is the duration during which the explosives remain in the boreholes before detonation. It's essential to remember that, to ensure optimal performance during detonation, explosives must be maintained under ideal conditions. It's worth noting that explosives can degrade over time or due to variations in the conditions to which they are exposed.

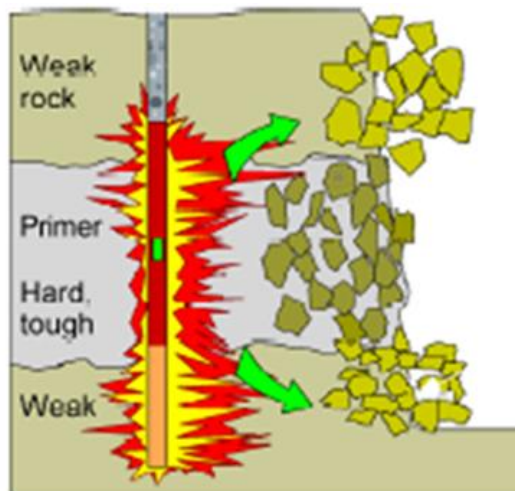
As widely known, all explosives have an expiration date, determining the period they can be utilized when stored under appropriate conditions. However, beyond this expiration, after the application of explosives, evaluating the time until detonation, known as "sleep time," is crucial. This period is directly influenced by the environmental conditions to which the explosive is exposed.

An apt comparison can be drawn to perishable products or preserves which, when unopened and kept in their original packaging, can last for months or years. However, upon opening and exposure to environmental conditions, their validity diminishes to a few days.

Typically, information about the duration of explosives is provided in the products' technical data sheets. Additionally, this information can be obtained directly from manufacturers. These durations can vary significantly, ranging from immediate detonation recommendations, such as in the case of ANFO, which is sensitive to moisture and temperature, to explosives that can be used after several months, as seen with packaged explosives.

Maintaining vigilance over the duration conditions is fundamental as they can change under adverse circumstances. In critical situations, it's essential to consult the manufacturers or consider using products specially developed to withstand various conditions and extended durations.

## 8 Rock Properties



After evaluating the limiting factors, technical and operational conditions, it becomes necessary to focus on more specific characteristics of the detonation to be carried out, and one of the most significant is undoubtedly the properties of the rock in question.

Each type of explosive can yield different results in different rock types, especially considering the geomechanical properties of the rock mass. Attention to rock characteristics and structures is crucial, as these factors have a direct impact on all parameters of the blasting plan, including the type and quantity of explosives to be employed.

Hence, possessing substantial knowledge about the rock mass is paramount. This knowledge is not only essential for selecting the appropriate explosives but also for achieving satisfactory results. This aspect becomes even more crucial in large-scale operations, especially in mining involving rock processing. In these cases, the detonation results influence an even greater number of subsequent stages.

In practice, in small detonations where the primary goal is material removal, a reasonable visual assessment of rock characteristics might be sufficient to select the appropriate explosive. However, in more complex operations, a profound understanding of rock properties, especially regarding

harder rocks, is imperative. These rocks often demand more powerful explosives capable of ensuring optimized performance.

To broadly understand the general scenarios, we can categorize rocks into four main groups:

- **Solid and Resilient Rocks:** This group encompasses hard and compact rocks. For these, explosives with high density and detonation velocity (VOD) are recommended. The higher detonation pressure generated by these explosives results in more extensive fractures during the fragmentation process.
- **Highly Fractured Rocks:** In this case, rocks have significant fractures causing energy loss and gas migration. Explosives that generate a high volume of gases are preferable, as these gases fill the fractures and expand them before being released into the atmosphere. Due to the dispersion of shockwaves through existing fractures, the gases maintain their efficacy, allowing more effective work before dispersing.
- **Porous Rocks:** This group includes elastic rocks that absorb shock energy. In this context, explosives with low density and detonation velocity are preferred. They enable prolonged gas expansion, allowing greater dilation and material release. This approach is necessary to overcome the characteristic damping of these rocks.
- **Rock with Blocks or Layer Variations:** In situations of rocks with block or pre-existing layered structures, the choice of explosive has less impact on the final result. In these cases, geometric parameters of the blasting plan, such as the distribution of explosives along the rock, have a more significant influence. The choice of the explosive is based on the rock's hardness characteristics, focusing more on the blasting plan details.

Therefore, the choice of explosive depends on a deep understanding of the properties of the rock involved in the detonation. This understanding guides the selection of the most appropriate explosives to optimize fragmentation and desired outcomes, taking into account the specific characteristics of the geological scenario.

That's it. We'll stop here for today. In the next article, we'll continue discussing the other points we need to evaluate::

- Energy
- Presence of water
- Borehole characteristics
- Operational issues
- Available labor force
- Environmental conditions
- Product compatibility
- Performance in similar conditions

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