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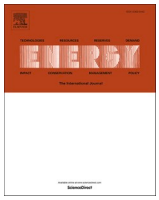

# The role of different explosives in reducing energy and emissions in mining comminution for sustainable improvement

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ABSTRACT

In the mining industry, comminution represents one of the most energy-intensive activities that generate large amounts of $CO_2$, making it a great challenge to the industry. Using high explosives in the blasting operation can cover this comminution-related challenge. In this study, the effect of blasting on the comminution was investigated considering the mentioned challenge by blasting samples of granite rock mass using three types of common explosive materials, namely ANFO, emulite, and pentolite, at different powder factors, contrasting with other studies that focus primarily on increasing the powder factor of a specific type of explosive. Based on the results of this study, it was observed that compared to ANFO, other explosives tested in this work increased the energy consumption per ton of rock mass in the blasting stage by 1.1–1.8 times, with $CO_2$ emission for the ANFO, emulite, and pentolite measured at $0.78 \times 10^{-3}$ kg, $3.10 \times 10^{-3}$ kg, and $5.14 \times 10^{-3}$ kg, respectively. Also, Using ANFO, emulite, and pentolite led to 4.47 %, 6.45 %, and 7.07 % relative advantages in terms of saving total mining energy in the comminution stage. Finally, $CO_2$ emissions for the comminution stage were estimated using Bond's indices and regional electricity data.

## 1. Introduction

Mining is an energy-intensive industrial activity. This is the second energy-consuming industry in the three top countries by energy consumption: China, the US, and India. As of present, this industry is exposed to high risks. Because, on the one hand, according to a report by the International Energy Agency (IEA), fuel prices fluctuate but generally follow an increasing trend, thereby challenging the mining industry due to its large reliance the energy resources. On the other hand, trying to control, the emission of greenhouse gases (GHG), governments around the world are increasingly adopting strategies that affect the mining industry as a leading source of the GHGs [1,2]. Accordingly, energy conservation and efficiency have become attractive topics in the mining industry thanks to the need for energy-saving and keeping satisfied environment-friendly communities in terms of reduced carbon footprint [3–5]. The importance of these two subjects has prompted the introduction of new equipment and methodologies in the mining industry. For instance, drones (Unmanned Aerial Vehicles or UAVs) have gained considerable popularity as new equipment in recent years. They can be used in wireless communication coverage, particularly during emergency situations, to the exchange of information such as images and videos without reliance on infrastructure communication systems. This property is referred to as UAV communications [6]. This aspect seamlessly interacts with operators, providing sensing, navigation, real-time control, data collection, data processing, transmission, and situational awareness [7]. These communications are classified into UAV-to-UAV, UAV-to-Ground Base Station, UAV-to-Ground Wireless Node, and UAV-to-Satellite systems [6]. UAV Communications are extensively utilized across civil, commercial, and military sectors for various purposes including public safety, search and rescue operations, managing unexpected events, transportation oversight, and scientific data gathering, due to their high mobility and flexible deployment [6,8]. This feature can be used in mining areas lacking wireless communication infrastructure. For instance, the UAV can be utilized as an aerial relay communication node between the exploration team and the ground control station. This facilitates intelligent mapping and exploration endeavors, especially in areas with complex topologies [9]. It can also be used in drilling and blasting for pre- and post-site monitoring and assessment of the damage caused by blasting, in managing the fleet and haul roads, in mining safety including dust and emission monitoring of $CO_2$, and in monitoring the progress of mining [10]. While this study does not focus on UAV communications, it specifically addresses the

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