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Use of Gas Emulsion in Blasting Project for Clearing in a Copper Mine in Southern Peru

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ABSTRACT

The gasifiable emulsion is a technological and productive response to the need to reduce operating costs in the mining project, among the improvements with respect to ANFO are a higher detonation velocity (VOD), better fragmentation and reduction of nitrous fumes. In the test mining operation, a commercial explosive mixture called "Q "73 (70% emulsion and 30% ANFO) is used, where the ANFO is composed of 97% ammonium nitrate and 3% diesel, and the explosive mixture "Q "82 (80% emulsion and 20% ANFO) is also used, 7 blasting processes were carried out with a diameter of 12.25 in. in a waste area, the most characteristic rocks found in the blasting project in the copper mine in southern Peru are Toba Cristal (TC), Andesite Basaltic Propylitic (BA-PRO), Andesite Basaltic Argillic (BA-ARG). The results obtained show a reduction of the Power Factor by 1.32%, with respect to the commercial mixtures "Q "73 and "Q "82 an optimum increase in the detonation velocity of 9.92% and 0.59% was obtained, also the high-resolution images of the fumes after blasting indicate a low presence of orange fumes taking a great relevance in the mining sector on a large scale, achieving better results in the blasting phase.

Keywords-- Gasificable Emulsion, Fragmentation, Detonation Velocity

I. INTRODUCTION

The large mining of metallic elements is in constant optimization of its processes, not being able to control the selling price of its products, it is then opted to reduce operational costs in order to ensure competitive continuity in the face of fluctuating mineral prices (Botín & Vergara, 2015), although the use of explosive mixtures requires techniques that increase the confinement and thus affect the detonation velocities (Jackson, 2017), in order to obtain a fragmentation required by the beneficiation plant, however, as technology and policies around environmental conservation advance, costs in mining operations are increasing, suggesting entrepreneurs to seek new alternatives when fragmenting the rock massif. One option when fragmenting the rock massif is gasifying emulsions, which have been used to a greater extent during the last decades, taking an important relevance in the large-scale mining sector, due to their high physical parameters of detonation and safety in their handling (Xu, Wang, & Fu, 2015).

"This paragraph details the importance of the research" Blasting is the first process of mass fragmentation for rock, obtaining concise and reliable results guarantee a suitable production environment, whether it is ore or waste rock, one should try to achieve optimal fragmentation with the appropriate safety measures

"This paragraph summarizes the objective of the study" Under a "mine to mill" approach, achieving better results in the blasting phase generates lower energy costs at the time of receiving the material in the crushers and then in the grinding mills, transforming these lower costs into higher economic income.

II. METHOD

Pre-cutting, buffer and production drills have been performed, the required personnel are 1 blasting supervisor and two operators, one for the tanker truck and one for the factory truck that use their personal protective equipment (PPE), 7 blasting tests were performed accompanied by a comparative analysis on the parameters of Power Factor, Fragmentation (P80), Velocity of Detonation (VOD), the drills have a diameter of 12. 25 in, a depth of 15 m, a burden of 7m and a spacing of 5m, in addition to geometric, physical and chemical parameters that are detailed in figure # NUMBER".

Projects Name: 3580-0833, 3565-0822_0823, 3355-0705, 3550-0801, 3580-0831, 3565-0827, 3565-0825

Table 1: Geological parameters and key geometric characteristics

Project	Type of borehole	Type of rock	Burden (m)	Spacing (m)
3580-0833	Production	BA-ARG	10.0	11.5
3565-0822_0823	Production	TC	7.0	8.0
3355-0705	Production	BA-ARG	7.8	9.0
3550-0801	Production	TC	7.0	8.0
3550-0801	Production	TC	7.0	5.0
3580-0831	Production	BA-PRO	8.3	9.5
3565-0827	Production	TC	7.0	8.0
3565-0827	Production	TC	7.0	5.0
3565-0825	Production	TC	7.0	8.0
3565-0825	Buffer	TC	7.0	5.0

Note: The abbreviations of the rock type refer to Crystal Tuff (CT), Basaltic Propylitic Andesite (BA-PRO) and Basaltic Argillic Andesite (BA-ARG).

The gasifiable emulsion has an initial density of 1.32 g/cc, which after 20 minutes adopts a value of 1.10 g/cc, it is also highlighted that the Linear Load without Gasification is 100.43 Kg/m, while the Gasified Linear Load is 83.69 Kg/m, so then we show a table with physical characteristics and other geometric parameters.

Table 2: Physical parameters and outstanding geometrical features

Project	Quantity of Explosive (Kg)	Block (m)	Air Chamber (m)	Swelling (m)	Length of Charge without Gasification (m)	Length of Gasified Charge (m)	Rock Density (t/m2)
3580-0833	632.27	6.00	2.70	1.00	6.30	7.30	2.60
3565-0822_0823	913.90	6.00	0.00	0.90	9.10	10.00	2.33
3355-0705	652.80	6.00	2.80	0.70	6.50	7.20	2.60
3550-0801	954.10	5.70	0.00	0.80	9.50	10.30	2.33
3550-0801*	200.90	5.70	6.90	0.40	2.00	2.40	2.33
3580-0831	853.60	6.00	0.80	0.70	8.50	9.20	2.75
3565-0827**	853.60	5.00	1.70	0.80	8.50	9.30	2.33
3565-0827	200.90	5.00	7.60	0.40	2.00	2.40	2.33
3565-0825**	853.60	5.00	1.70	0.80	8.50	9.30	2.33
3565-0825	200.90	5.00	7.60	0.40	2.00	2.40	2.33

Note: (*) Correspond to drillings with an air chamber in the intermediate level, the values of sponging, ungasified charge length and gasified charge length are calculated by the sum of their unit parts. (**) Correspond to buffer type boreholes.

The mesh design for project 3565-0833 considered a total of 160 holes, taking into account the amount of explosive required of 632.27 kg, the blasting would require a total of 101,232 kg of explosive. Project 3355-0705 has 265 drill holes, each hole is designed to contain 652.80 kg, having a total of 172,992 kg for the completion of this project. For the 3550-0801 project the drilling grid considers 486 production drill holes and 56 buffer holes (Fig. 4, Fig. 5), for each production drill hole 954.10 kg of explosive is required, which in total

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gives a result of 463,692. 60 kg of explosive, in the case of the buffer holes, 201.00 kg of explosive is needed, therefore, 11,256 kg of explosive are required for the buffer holes, in general for the project 3550-0881, 474,948.60 kg of explosive are required. Project 3580-0831 considers 80 production drill holes, each with 853.60 kg of explosive, for a total of 68,288 kg of explosive for the designed grid. Project 3565-0827 has 165 production holes and 17 buffer holes, requiring a total of 144,259.30 kg of explosive (Fig. 7, Fig. 8). Project 3565-0825 stipulates in its design a total of 370 production holes and 31 buffer holes, it is estimated that 322,059.90 kg of explosive are required for the project.

Figure 1: Project 3580-0833

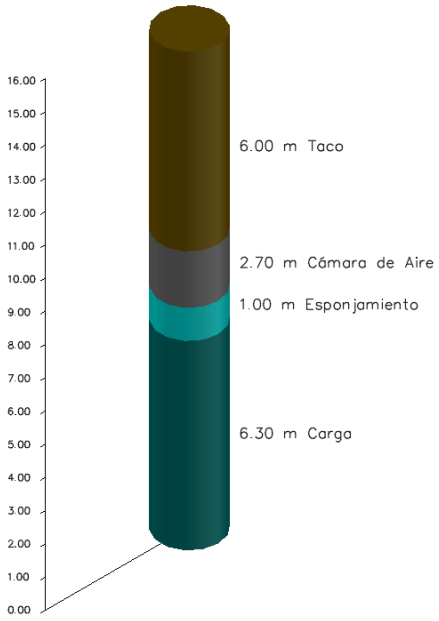

Figure 2: Project 3580-0822_0823 drill production

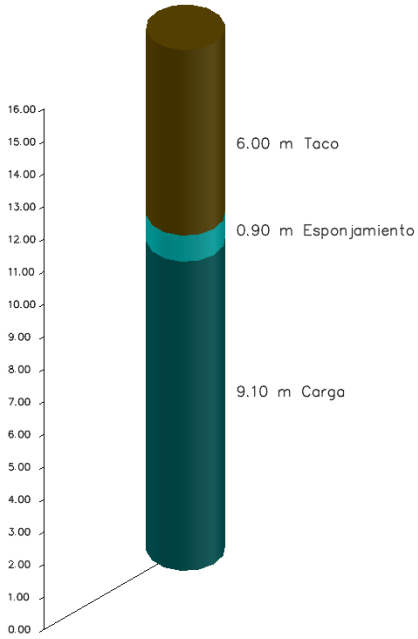

Figure 3: Project 3355-0705 drill production

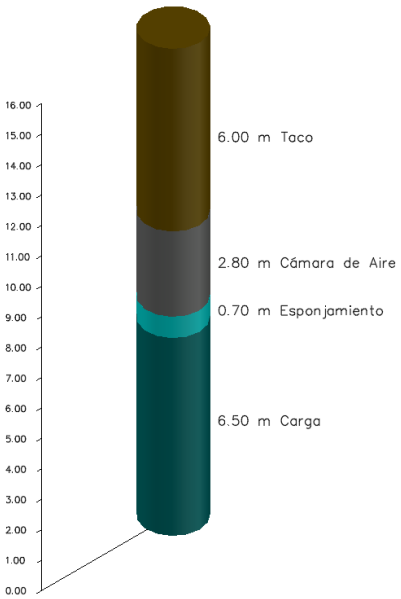

Figure 4: Project 3550-0801 drill production

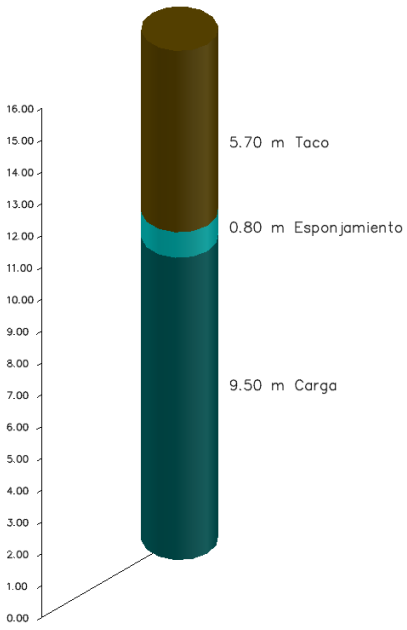

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Figure 5: Project 3550-0801 Buffer Drilling

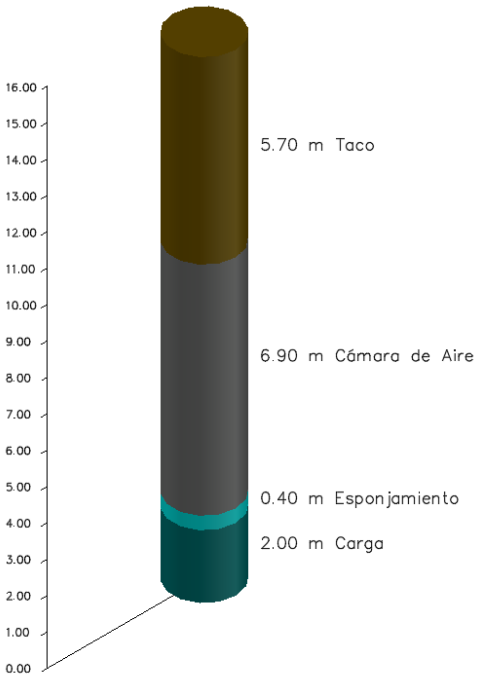

Figure 6: Project 3580-0831 Drill Production

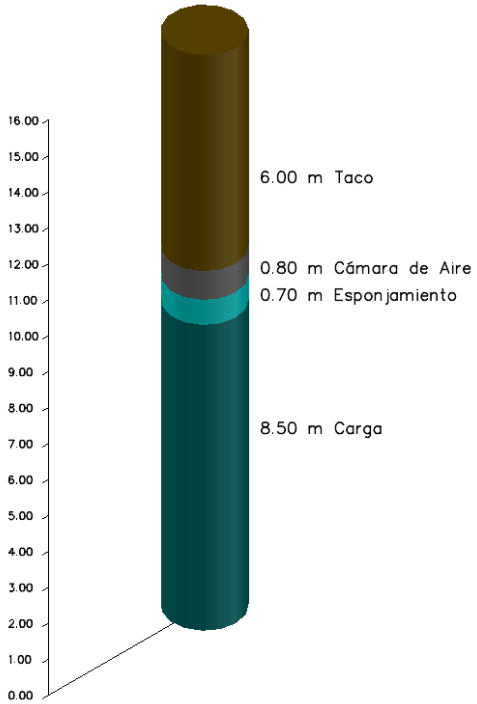

Figure 7: Project 3565-0827 Drill Production

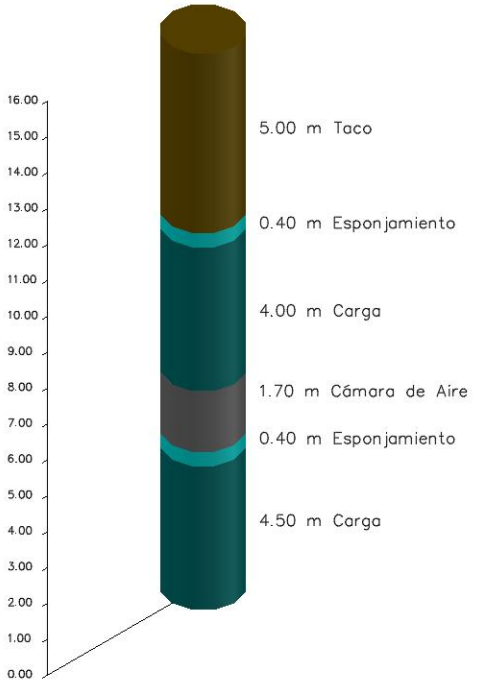

Figure 8: Project 3565-0827 Buffer Drilling

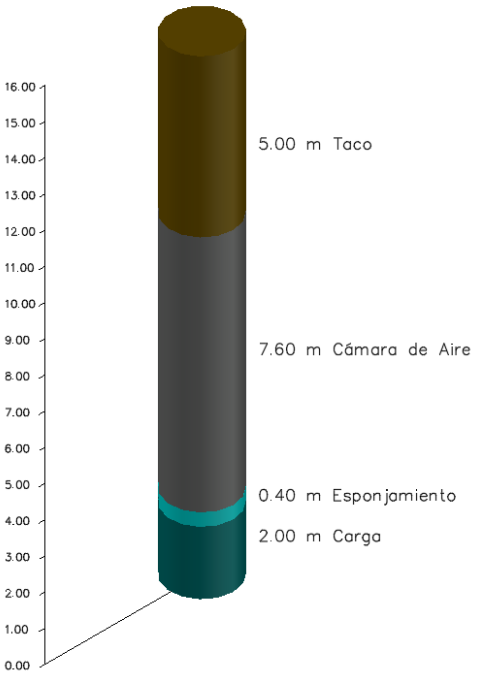

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Figure 9: Project 3565-0825 Drill Production

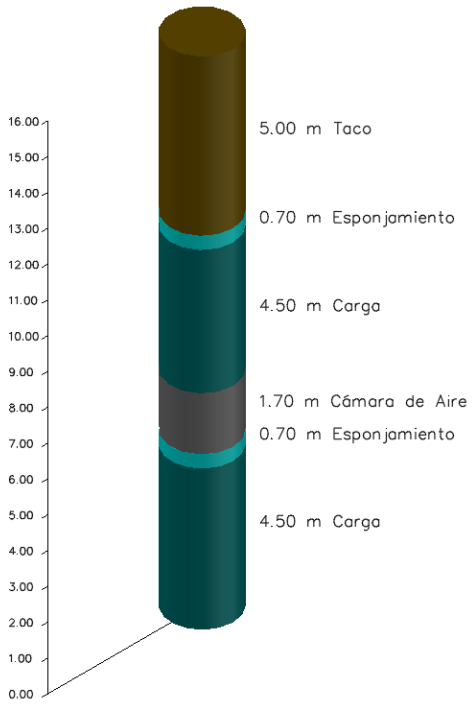

Figure 10: Project 3565-0825 Buffer Drilling

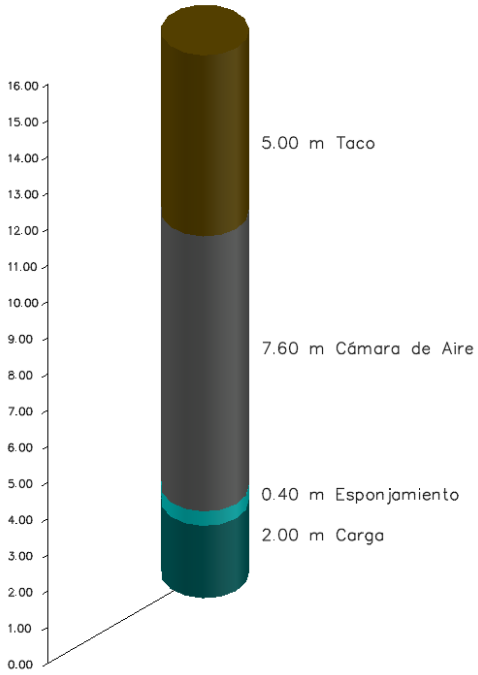

Table 3 shows the different power factors calculated based on the amount of explosive used and the fragmented material, as well as other geometric parameters necessary for the design of the mesh, the P80 obtained in 6 projects is added for further analysis of the results.

Table 3: Summary of P80 by blasting project

Date	Project	B (m)	S (m)	P80 (inch)	Power Factor
06-sep	3565_0822_0823	7.00	8.00	24.92	0.45
07-sep	3565_0822_0823	7.00	8.00	14.84	0.45
08-sep	3565_0822_0823	7.00	8.00	18.07	0.45
09-sep	3565_0822_0823	7.00	8.00	12.48	0.45
10-sep	3565_0822_0823	7.00	8.00	24.80	0.45
11-sep	3580_0833	10.00	11.50	10.12	0.15
12-sep	3355_0705	7.80	9.00	8.11	0.23
13-sep	3580_0833	10.00	11.50	8.46	0.15
14-sep	3355_0705	7.80	9.00	5.28	0.23
20-sep	3580_0831	8.30	9.50	6.73	0.23
21-sep	3580_0831	8.30	9.50	10.55	0.23

III. RESULTS

For the fragmentation analysis it was considered necessary to evaluate 4 projects (3565-0822_0823, 3580-0833, 3355-0705 and 3580-0831) as a representative sample, the three projects not included are of the same type of rock and have the same design parameters as the 3565-0822-0823 project. For the comparison of results, we will take as a baseline the P80 size requested by the mine, which indicates that, for waste rock removal, if we obtain a P80 greater than 12 inches, we have obtained a regular fragmentation, while if the P80 obtained is less than 12 inches, the fragmentation is ideal.

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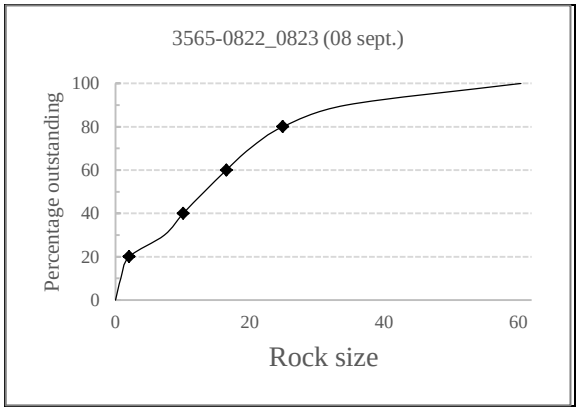

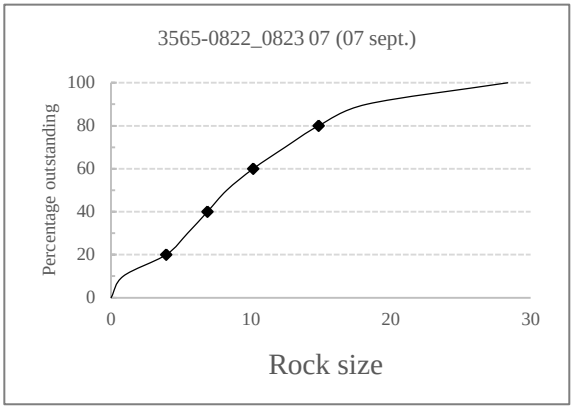

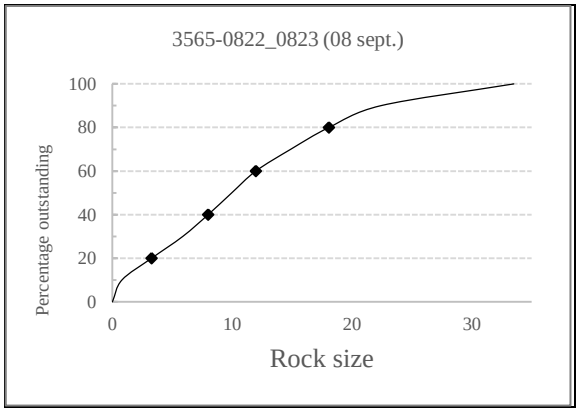

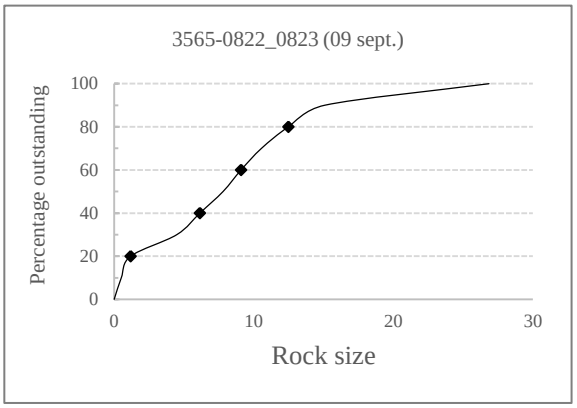

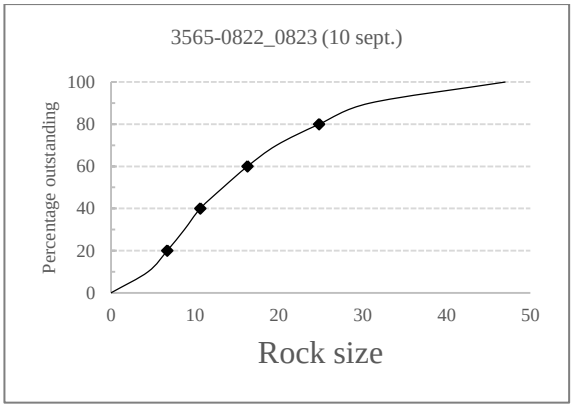

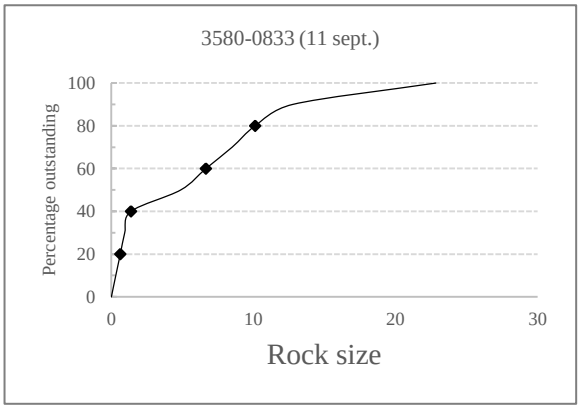

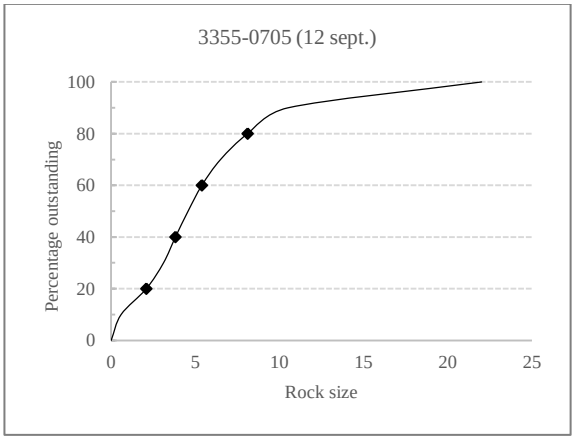

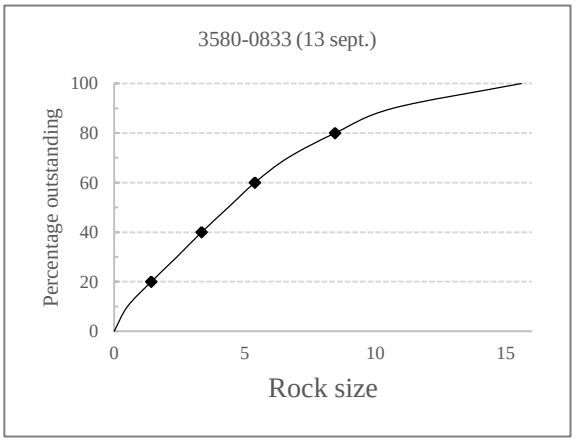

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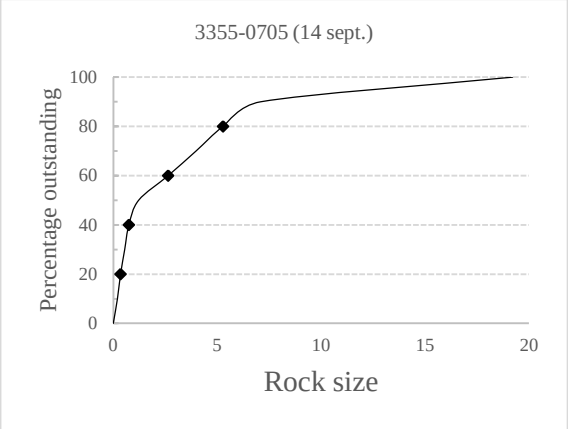

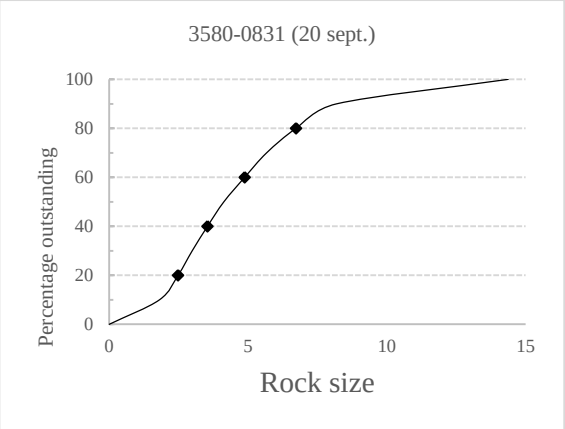

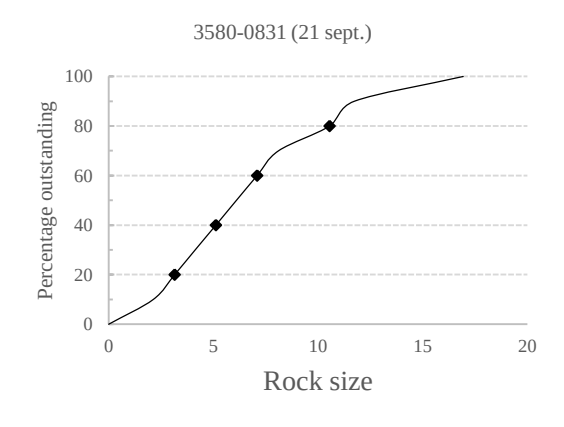

Table 4: shows a summary of the results obtained in the projects fired with the gasified emulsion.

Table 4: Summary of P80 by blasting project

Date	Project	B (m)	S (m)	P80 (inch)	Power Factor
06-sep	3565_0822_0823	7.00	8.00	24.92	0.45
07-sep	3565_0822_0823	7.00	8.00	14.84	0.45
08-sep	3565_0822_0823	7.00	8.00	18.07	0.45
09-sep	3565_0822_0823	7.00	8.00	12.48	0.45
10-sep	3565_0822_0823	7.00	8.00	24.80	0.45
11-sep	3580_0833	10.00	11.50	10.12	0.15
12-sep	3355_0705	7.80	9.00	8.11	0.23
13-sep	3580_0833	10.00	11.50	8.46	0.15
14-sep	3355_0705	7.80	9.00	5.28	0.23
20-sep	3580_0831	8.30	9.50	6.73	0.23
21-sep	3580_0831	8.30	9.50	10.55	0.23

IV. CONCLUSIONES

The following results were obtained from the granulometric analysis carried out on the fired mining faces:

Phase 07 - project 3355-0705 An average P80 of 6.70 inch. was obtained, a value that is below the target 12 inch. which indicates that the result obtained is good.

Phase 08 - project 3565-0822_0823: An average P80 of 19 inch was obtained, value that is above the target 12 inch, which indicates that the results are in the classification of regular, this is due to the fact that at the time of loading the drills there were some areas of caverns and fractures.

Phase 08 - project 3580-0833: An average P80 of 9.3 inches was obtained, value that is below the target of 12 inches, which is an indication that a good fragmentation has been obtained.

Phase 08 - project 3580-0831: An average P80 of 8.6 inch was obtained, which is below the target 12 inch, indicating that good fragmentation has been obtained.

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