

SURVEY OF GLAZE PREPARATION IN DISCONTINUOUS BALL MILLS AND MEASUREMENT OF GRINDING MEDIA CHARGING BY COMPUTER SOFTWARES

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1. INTRODUCTION

The purpose of this paper is to describe how the characteristics have evolved of glaze preparation in discontinuous ball mills.

When you are using discontinuous ball mills, you must add grinding media to the batch regularly, because the grinding phenomenon during glaze preparation has a valid proportion of grinding media to raw materials in its cycle to optimize the grinding time and size distribution.

As is well known, in the first step the characteristics of the ball mills must be measured.

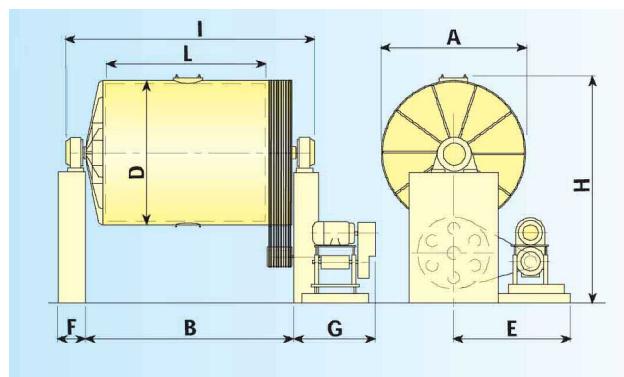


Figure 1. Schematic illustration of a ball mill.

D_B = Internal diameter of ball mill with the liner, L_B = Length of the ball mill, A = External diameter of ball mill, B = External length of ball mill, D_L = Liner diameter.

To calculate the real volume of the ball mill the liner diameter must be subtracted from the ball mill diameter.

$$V_B = \pi (D_B - D_L) \times L_B \quad \text{where } V_B \text{ is ball mill volume.}$$

2. GRINDING MEDIA PERCENTAGE IN THE BALL MILL

For continuous ball mills, it is recommended to use grinding media making up about 40 to 45% of ball mill volume; these data being 50 to 55% for discontinuous ball mills (55% in this study). There is approximately 35 to 40% vacancy in the charged grinding media (40% in this study). Therefore, the real volume quantity of grinding media in a ball mill can be calculated by subtracting the vacancy of the space between grinding media from total volume occupied by the grinding media. The real volume of grinding media in a ball mill is $60 \times 55\% = 33\%$ and is $40 \times 55\% = 22\%$ of the total volume of the ball mill. This value shows that if we have charged materials less than 22% of the total volume of the ball mill, friction will occur between the grinding media. In the other way, the grinding media were put in the glass with 200 ml volume. By considering the density of the water equal to 1 and

adding water to the glass to fit the container, the density of the grinding media is equal to the weight of water. Grinding media were used in 5 sizes: 2, $\frac{3}{14}$, $1\frac{1}{2}$ and $1\frac{1}{4}$ inch.

By calculating the density, having the volume of the grinding media, the weight of the ball mill can be calculated: $W = V \times D$.

In this formula, W is grinding media weight, V is grinding media volume, and D is grinding media density. The weight of the slip can be calculated by this formula:

Dry weight = $(0.45 \times V \times D_p) / 100$, Water weight = $(0.45 \times V \times W_p) / 100$ where V is real volume of the ball mill, D_p is the dry percentage of materials in a slip (approximately 68~69%) and W_p is water percentage in a slip (31~32%).

Slip weight is the sum of the dry weight and water weight.

The ball mill cross section can be calculated from:

$$a = 2 A \cos \left(1 - \left(\frac{h}{R}\right)\right), A' = 0.5 R^2 \left[(0.01745 \times a) - \sin a \right], V = [(\pi R^2) - A'] \times L$$

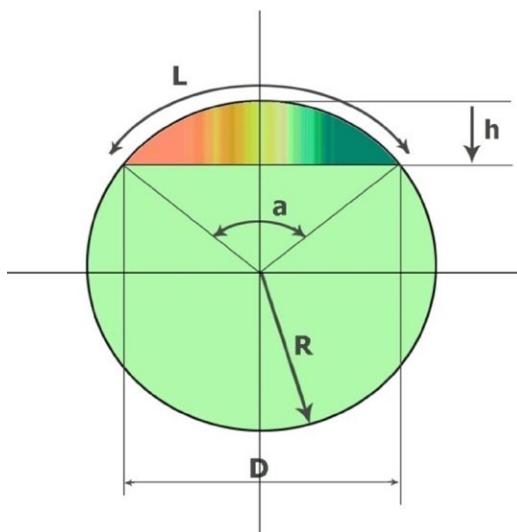


Figure 2. Ball mill cross section.

where R is the ball mill radius, h is the height of the empty space in the ball mill and L is the ball mill length. The desired height of the grinding media in the ball mill can be calculated by Microsoft excel software to obtain 55% of total ball mill volume. In this study, the parameters in table 2 are calculated to obtain the suitable grinding media height.

3. SIZE DISTRIBUTION OF GRINDING MEDIA WITH IMAGE ANALYSIS

To obtain the size distribution of the grinding media in a ball mill some images were prepared from ball mill grinding media by high resolution digital camera and

the images was estimated by Adobe Photoshop software to real size distribution approximately. In this method, the total surface and the percentage of each grinding media size was calculated to obtain the weight of the grinding media charge in the ball mill. For ensuring the grinding media size, the size of some used grinding media was measured. Figures 4 to 8 shows measurements for 2 to 1 inch grinding media.

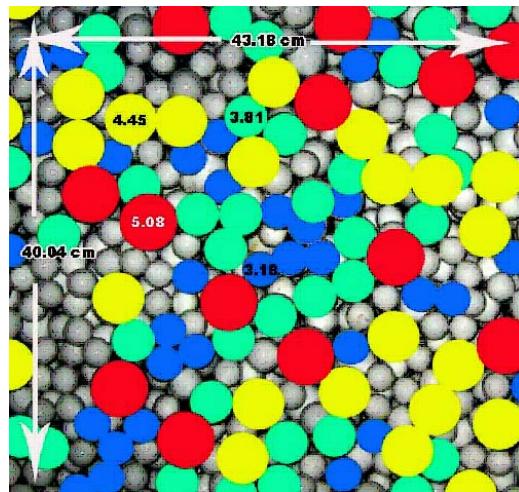


Figura 3.

4. SUMMARY

By comparing table 2 and 3 and manually measuring the height of grinding media in a ball mill, the difference between the practically used ball mill and its theory can be calculated. By measuring the shortage of the grinding media height, the charging content can be estimated.

The size distribution of the grinding media can be measured by image analysis to calculate the percentage of each grinding media size.