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EXPERIMENTAL STUDY FOR OBTAINING BRICKS FROM THE USE OF MINING TAILINGS CYANIDE PROCESS

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ABSTRACT
An experimental prototype that uses tailings miners of cyanide process has been designed and built to the manufacture of building bricks. This prototype is composed of three units. The first unit, includes a thickener and a neutralizer tank. The second unit, a filter, a mixer and a molder. The third unit comprising a dryer - oven. The develop process allows the entered tailings to be separated into liquid and solid, to be neutralized later caro acid. Then, the resulting mixture will be filtered and will be added the necessary additives (clay or green clay) for the constitution of the brick. Finally, this mixture will pass through a drying stage, where the furnace oven temperature reached one thousand degrees centigrade.

INTRODUCTION
So practices for tailings disposal that reduce the negative effect on the environment has been developed. One of the most applied is the accumulation of mine tailings in tailings storage areas or tailings dams. This reduces in small amount the environmental impact, but it causes erosion and toxicity to soils, groundwater contamination, damage to health among other diseases [1].
Peru is no stranger to the problem of accumulation of tailings. Against to this accept of laws and decrees has been established. These laws and decrees established parameters and environmental management which focus
it to develop techniques for tailings accumulation such as underground fill, which is a method of discharging and thickened tailings disposal dehydrated [2].
Although, the use of accumulated tailings has not been promoted by these laws and decrees [3 - 5].
Moreover, in recent years, several studies have been developed the USA, India and Mexico. These studies demostrated the potential of using tailings as raw material for the production of building materials [6]. Due to the fact that tailings contain silica and alumina compounds which allows the use that under high temperature and pressure controlled allow the use of tailings as raw material for the formation of ceramic [7].
There is a lot of research in this field, out of the references mentioned in the previous paragraph. This research aims to design and develop a process for the production to bricks from mining tailings for the cyanide process.
This work has been carried out in a concentration plant whose production is less than 25t/day in Arequipa (Peru). This process is a mixture of tailings and certain additives. An analysis have been made on the properties of the bricks for different ratios at them first additives.
The account for constitution the percentage of compounds for the manufacture of bricks, the amount of cyanide reduce from the tailings and resistance achieved in the final product how product quality standards.

EXPERIMENTAL MODEL AND PROCEDURE
The experimental model (Figure 1), consists of three units. Unit 1(thickener and neutralizer) which is responsible for separating and neutralizing this cyanide in the mixture. Unit 2 (filter, mixer and molder) additives such as clay are added given the final product, and unit 3 (dryer and sintering) cooking occurs at high temperatures (about 1000 ° C) to obtain the final product.
Among the instrument for measuring and monitoring employees have a meter cyanide (colorimeter) located between unit 1 for measuring cyanide neutralized with a measure range between 0.0000 to 0.2000 mg/L, a Mini pH controller that controls the present pH in the neutralizer with a measure range between 0.00 to 14.00 pH and a pyrometer - thermocouple that controls the injection of heat in unit 3 (drying and sintering) with a measure range between 0°C a 1000°C .All of the equipment are brand HANNA.

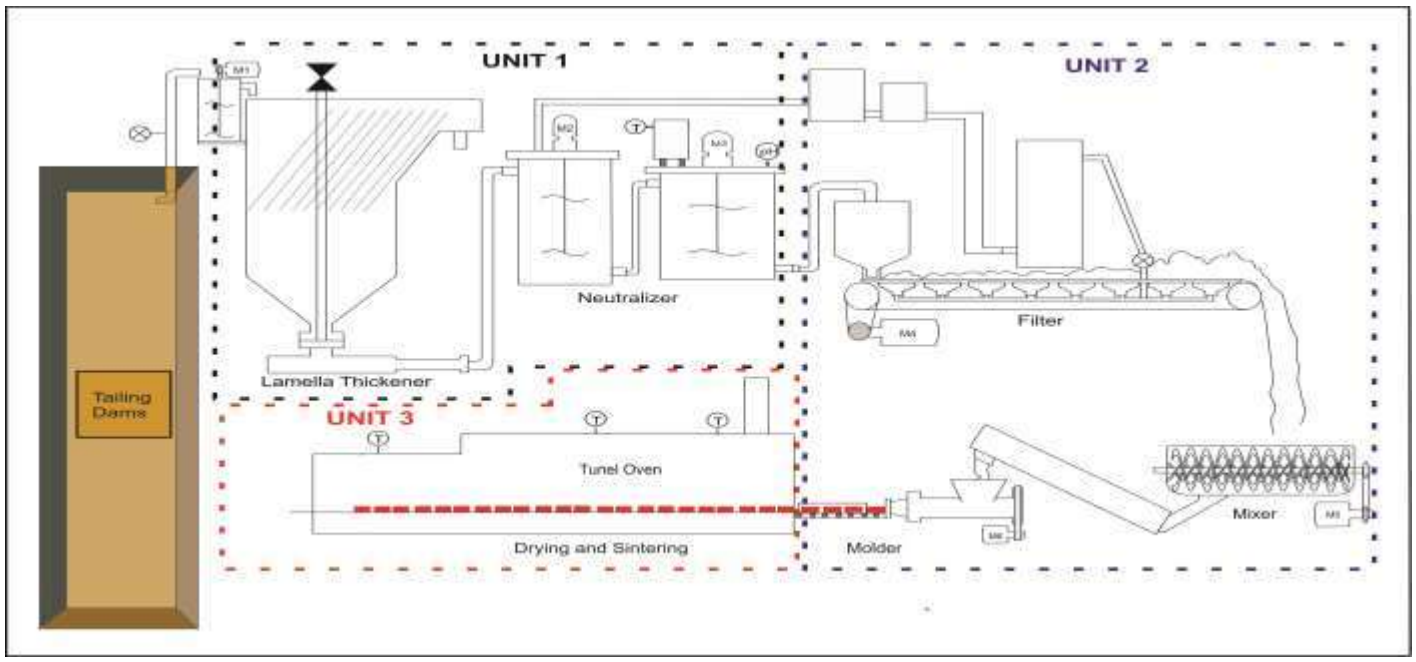

Figure 1. Scheme of Experimental Apparatus

The process begins with the sludge sucking from dams to unit 1, then the tailings are directed to feeder where they are stirred with flocculant Magnafloc. To later be deposited into the grooves of plates of the lamellar thickener. Here, the solid part of the mixture slips over the lamellar plates sedimenting and accumulating in the bottom of the machine. The clarified liquid portion, which consisting of a solution with a high content of free cyanide, overflows off the plates sets and leaves sits to be reused again in the cyanide process (returns to the leaching plant). The accumulated solid part in the thickener should contain between 60% and 70% solids to be unloaded and driven to the conditioner tank. In the conditioning tank (unit 2), water is added without the presence of cyanide to lower the solids percent from 60% to 30%. Once ready, the mixture is discharged to the neutralization tank, where the remaining cyanide is removed through an oxidation process by using caro acid.

This caro acid is synthesise by mixing 98% purity solution of H_2SO_4 and 50% purity solution of H_2O_2 [8].

The temperature of this stage is 120°C which is suitable for the neutralized of the cyanide. pH should be control between 9.0 and 9.5. Then cal is added to avoid the formation of HCN in order to make the same the pH between 9.0 and 9.5.The cyanide level in the exit o th neutralizer should be maintain to 0.001%.

The resulting mixture enters the unit 2, the filter strip for the separation of solids and liquids. The liquid is absorbed by small suction trays, which are positioned along the carrier band. The resulting dough sees a moisture between 15% to 20%.The percent of solids increases from 75% to 80%. The liquid part, sucked from the top of the trays will be carried to a conditioner tank to pre-treatment and recover metal residues. Precipitated the solids are sent to the mixer, where green clay is added to provide the tailing compressive strength of the final product.

The mixture should have between 80% and 85% solids when driven to the extruder. The molds must contain approximately 20% moisture.

The molds with the mixture then enter the oven at 1000 ° C when the totally dry cooked and sintered. The removal of the 100% of water presents to proceed with the cooling of the bricks.

EXPERIMENTS AND RESULTS

A series of tests were conducted to determine the necessary parameters to achieve desire brick properties. Two tests were conducted in unit 1, one test in unit 2 and one in unit 3.

A sedimentation test was done to obtain the percentage of solids needed for the neutralization step. Subsequently, the neutralization test was developed to determine the percentage of neutralizer to reduce to the cyanide present in the tailings. Mixturement are done in unit 2 to obtain the percentage of additives to be added to the mixture. In the Unit 3 the optimal cooking temperature is identified, and the mechanical are performed. Each one of these tests is detailed here:

- **Sedimentation Test:** The graduated cylinder method was applied, taking into account the concentration of cal (1 kg / TM), and flocculant Magnafloc (from 0.25 to 1 g / TM). These tests are necessary to determine the rate and settling time in the thickener, obtaining the required percentage of solids in the sample for the neutralization step.

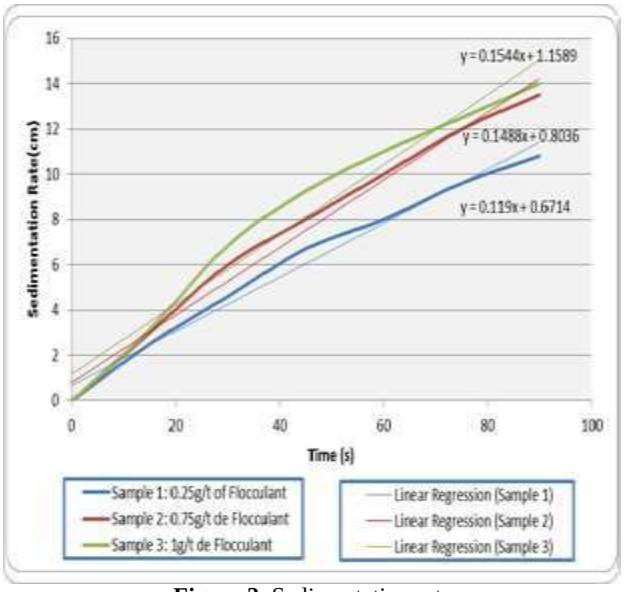

Figure 2 Sedimentation rate

Neutralization Test: Neutralization was applied with different acids: Caro acid with an initial sample of 30% solids, 9.5 pH; and a mixture to H_2SO_4 and hydrogen peroxide at 120 ° C. With the mixture of these neutralizers the cyanide became to reduce from 0.065% to 0.001%.

Preliminary Tests of Bricks: This test includes 5 stages: Selection of raw material, mixing, molding, drying, cooking and cooling. In stage 1, the percentage of tailings is determined to be ranging from 60 to 90%, according to parameters in [6].

The volcanic ash or pozzuolana will be selected in relation to the highest level of compressive strength obtained. Parameters to the clay during a period of time rending to obtain to 15 minutes.

The tests in the steps 3, 4 and 5 are performed in the Muffle oven with a preheating temperature of 200 °C. According to [6] the optimal temperature for the cooking frousen varies between 800° and 1000°C. For this work the temperature will be set 1000°C.

Figure 3. Baking step of the sample

Mechanical tests: The methods of sampling and testing were applied to determine the compressive strength of 25 MPa according to standard NTP 399.613, with sets the level of strength established by current legislation [9].

Figure 4. Compression tests

For the realization of evidence, 8 samples were taken to analyze the impact of the variation in the percentage of tailings and clay percentage in compressive strength. Likewise, the variation of the percentage of pH and the relationship between the H2SO4 and H2O2 have been analyzed to determine the variation in the percentage of cyanide.

The percentage of solids, the relationship between H2SO4 and H2O2 and the time were constants in all the samples in which the test was performed. The percentage of solids was 30%, the relationship between H_2SO_4 and H_2O_2 was 1/1 and the test was realized in 15 minutes.

Two Mechanical tests were realized, one of these on samples with presence of Volcanic ash and the other on samples with presence pozzolan.

MECHANICAL TEST									NEUTRALIZATION ESSAYS		
	Volcanic ash				Pozzolan						
Sample	Tailing (%)	Clay (%)	Volcanic ash (%)	Compressive Strength MPa	Tailing (%)	Clay (%)	Pozzolan (%)	Compressive Strength MPa	pH	H_2SO_5 /CN	CN (%)
1	90%	10%	0%	6.42	70%	5%	25%	5.02	9.32	3/1	0.0005
2	90%	5%	5%	6.36	70%	10%	20%	6.84	9.32	2.5/1	0.0007
3	85%	12%	3%	23.07	70%	15%	15%	17.14	9.40	1.5/1	0.0125
4	87%	10%	3%	12.17	80%	5%	15%	6.98	9.32	1/1	0.0250
5	85%	10%	5%	10.54	80%	15%	5%	13.26	9.32	1.5/1	0.0125
6	85%	10%	5%	9.86	80%	10%	10%	7.24	9.40	2/1	0.0007
7	82%	15%	3%	23.86	90%	5%	5%	5.00	9.16	2.5/1	0.0010
8	80%	15%	5%	25.45	90%	10%	0%	6.00	9.16	2/1	0.0010
9									9.30	2/1	0.0010

Table 2. Mechanical and neutralization tests

Results and Discussions

The most important parameter influence the properties of the bricks was the additives tailing reaction.

Percent of solids from sedimentation the percentage on the remove cyanide had also the major influence in those properties.

In the sedimentation tests (Figure 4), the sample 3 had the highest rate of sedimentation which ensured obtaining 60% solids necessary for the increased removal of cyanide in the final product.

By performing neutralization tests (Table 2), in the sample 6, the amount of cyanide was reduced to 0.0007% due to the high presence of H_2SO_4 and hydrogen peroxide. These neutralizers were used in different concentrations in sample 2 obtaining the same results. However, the sample 6 has a lower proportion of H_2SO_4 per gram of present cyanide. Since H_2SO_4 is more expensive than hydrogen peroxide, this option is to be more interesting at first approach. In addition it present a use research and the reduce corrosivity; and a pH of 9.40, which is not relevant for the results since it is located between the levels of 9 to 9.5 where the formation of HCN is not faivored.

Regarding to the brick preliminary test evidence to mechanical testing. Ashen was used as additive for the sample 8 (Table 2). It reached a higher resistance to compression at a temperature of 950 ° C using 80% of tailings and 15% of clay. These conditions were the same for sample 5, which was added pozzolan (Table 2). This resulted in to less resistance to compression due to the lower amount of silica present in comparison to the volcanic ash.

The sedimentation rate, the resulting cyanide, the percentage of the additive and the compressive strength were different for samples taken from different dams, due to differences on site conditions and minerals present in the place of sample collection and differences in additives is used in process.

Further research is recommended to carry out tests using diatomite as additive for the manufacture of bricks, because this material gives lightness to the final product.

CONCLUSIONS

An experimental building tricks by the using of tailing of cyanide was designed and developed.

The sedimentation rate, the amount of eliminated cyanide, the percentage of constituents, the cooking temperature and the final strength of the products were identified and studied as the parameters.

It was determined that using a minimum of 1 gram of flocculant per ton of tailings used by the rate of sedimentation face to that. It was from that the ratio between H_2O_2 and H_2SO_4, had to be these with 9.4 pH in order to obtain an elimination of cyanide of that.

It has been found that this 80%of tailing, 15% of clay and 5% of volcanic ash at 950° C matches the requirement of correct mezclation [10].

Finally the most important parameter influence the properties of the bricks was the additives tailing reaction.

Percent of solids from sedimentation the percentage on the remove cyanide had also the major influence in those properties.

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