DETERMINING THE EFFECT OF GEOGRAPHIC ALTITUDE ON BUBBLE SIZE

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ABSTRACT

Doña Inés de Collahuasi is a copper mining company located in Chile's First Region, known as Tarapacá. Its operations include a concentration plant with a processing capacity of 135,000 TDP, located at 4,320 meters above sea-level. The flotation stage of the copper and molybdenum concentrator plant consists of a rougher flotation circuit equipped with both conventional self-aerated cells and injected air cells. The cleaning circuit, however, operates in two stages; the first uses conventional self-aerated cells and the second cleaning stage is performed in columns. Extensive biographical information supports the correlation between the bubble size and the recovery of sulphides minerals. Based on this, Doña Inés de Collahuasi Mining Company decided to carry out an evaluation campaign to determine the effect of geographical altitude on the bubble size. In order to perform the experiments, measurements were done using the same laboratory scale flotation cell and the same standard frother. Also, the same technique for bubble size measurement was used in both cases. The flotation cell was set up to measure and control the air flow online, with the option of being operated either with self-aerated or injected air. The flotation cell was installed on a vehicle to allow measurements at different altitudes. The main conclusions from the experiment were the following: 1.- The bubble size generated in self-aerated cells is not affected either by the agitation speed or by the geographical altitude, 2) The air flow measured inside the self-aerated cell is not affected by the geographical altitude, 3) The bubble size is not affected by the way in which the airflow is supplied, whether this be by self-aerated or by injected air, 4) The smallest bubble size measured was using the self-aerated flotation cell.

KEYWORDS: flotation; geographic altitude; bubble size; flotation cell.

1. INTRODUCTION

Doña Inés de Collahuasi Mining Company is a Copper and Molybdenum producer, located at Los Andes Mountains, at 4.322 meters above sea level. Leaching and concentrator Copper processes are performed. During 2011, the average daily throughput was 135.000 tpd in the concentrator plant. For the concentrator process, the ore is mostly primary, with high contain of Chalcopyrite, Pyrite, Bornite and Digenite.

The Flotation circuit has two rougher circuits, each one with 27 cell distributed in three rows 1-2-2-2-2. The first circuit, put on service at 1998 for a throughput of 70.000 tons per day, uses Wemco SmartCell 4500 ft3, self aerated. The second one was put on service at 2004 for an expansion of 110.000 tons per day, uses Outotec TankCell-160 cells with injected air system

Since the plant is located to 4,322 meters, which is defined study the effect of altitude on the geographical size of the bubbles by using laboratory scale flotation cells, meaning that this information will clarify the hydrodynamic performance of the equipment, and serve as a support for future expansion projects.

2. EXPERIMENTAL METHODOLOGY

2.1. Flotation Cell

To carry out the test, we used a laboratory cell, model Wemco under semi batch operation, with capacity to run with self aerated system or forced air system. Agitation levels used in the assays were defined, trying to replicate the linear rotor speed of the tip of the blades in an industrial cell.

Table I. Linear rotor speed in industrial cells installed in Collahuasi.

	Rotor Speed [rpm]	Rotor Diameter [m]	Lineal rotor Speed [m/s]
WEMCO SMartCell 4500	130	1.14	7.8
Outotec TankCell-160	93	1.5	7.3

Since the rotor of the lab cell has a diameter of 5 [cm], the cell should be operated at 2,900 rpm for a speed of 7.6 [m/s]. However, experimentally it was found that the stability and homogeneity of the pulp is maintained until values agitation of 2,300 [rpm]. Based on the above, we defined four levels of work with agitations: 1,300, 1,700, 2,000 and 2,300 [rpm] for testing self-aerated cell. For tests with forced air condition, only was tested to 2,300 [rpm] and considering two air levels, the first one with the same flow obtained in the self-aerated condition and the second flow greater than the previous one.

The cell was operated with water and MIBC as a frother. A dosage of 15 [ppm] of frother was used. MIBC concentration was defined by measuring critical coalescence concentration (CCC) in the concentrator Ujina. The foam height was set at 2 [cm].

Figure 1. Laboratory Cell.

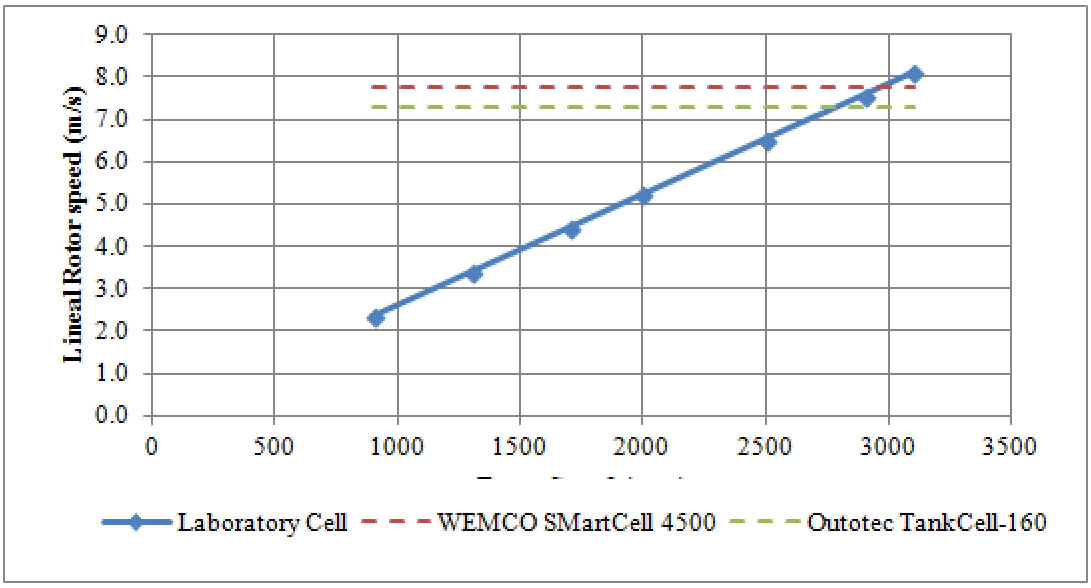

Figure 2. Lineal rotor speed in a laboratory and industrial Cells.

2.2. Bubble size measuring system

The bubble size was measured using the method developed by McGill University (Gomez & Finch, 2002, 2007) which consists of a bubble collector device, where they are photographed, and then processing the images obtained. Since images are obtained at vacuum condition, the bubble size is corrected to the reference plane conditions.

2.3. Measurement on site

Both laboratory cell as bubbles measurement system and the air compressor was installed on a truck. All equipment was powered by a portable generator. The road Iquique - Ujina was used to develop assays. For measurement of air flow, mass flow meter was used, McMillan brand, model 50, fitted to the air inlet of the agitator. The flow values were recorded at standard conditions, ie atmospheric pressure of 1 [atm] and a temperature of 0 [° C], which is why it must be corrected to conditions of the cell. The altitude was measured using a portable altimeter, Suunto, model E203, while the water temperature was measured using a digital thermometer Omega, model 450ATH.

The heights on sea levels were 23, 540, 1041, 1996, 2744, 3405 and 4121 meters. A total of 38 trials were developed.

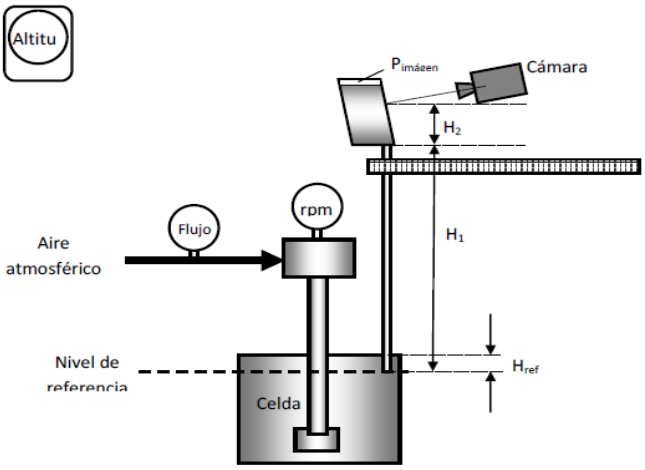

Figure 3. Schematic disposal of measurement system.

Figure 4. Measuring system installed on fiel.

3. RESULTS

3.1. Operation with self-aerated cell

From tests performed in self aerated condition for different levels of agitation and the same geographical altitude, it can be seen that the air flow increases as the level of agitation. However, although the air flow increases, the size of the bubble remains constant. Figure 4 shows the condition at 4,121 meters.

Figure 5 shows the effect of increasing the intake air flow due to increased agitation produces a slight increase in the number of bubbles greater than 0.5 mm

Previous studies in laboratory cells (Young, 2005) and in industrial cells (Oblad, 1998) indicate that the bubble size that produces a flotation cell ought not to be affected by altitude. The effect of the geographical altitude is analyzed from Figure 6. It can be appreciated that the bubble size of self-aerated cell is not dependent on the geographical altitude. The differences observed are kept below the measurement error of the instrument, which is 85 microns.

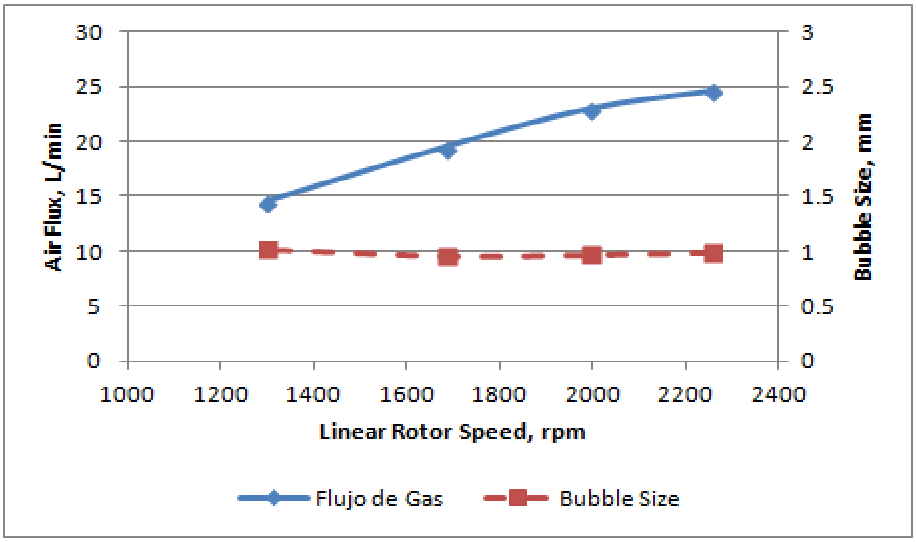

Figure 5. Effect of lineal rotor speed on air flux and bubble size.

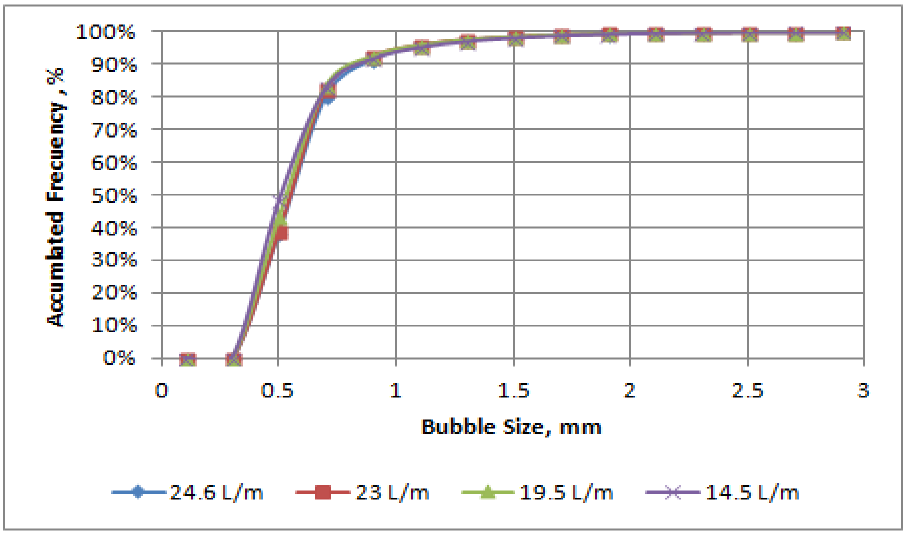

Figure 6. Cumulative distribution of bubble size in self-aerated cell, at different air flux. Assays at 4,121 mosl.

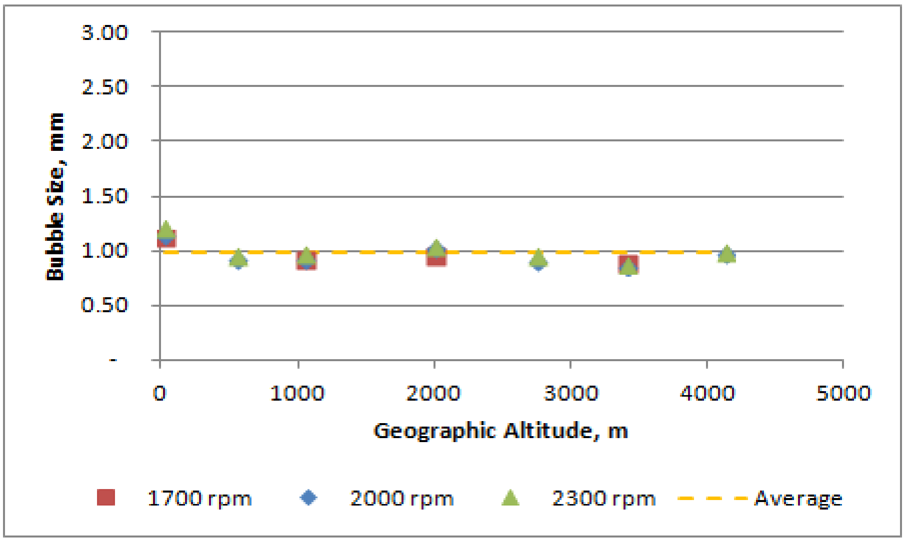

Figura 7. Effect of geographic altitude on bubble size.

In the case of air flow aspirated by the cell, it can be appreciated in Figure 7 that there are a slight increase in air flows at different linear speeds of the rotor. Not a clear trend between the airflow and the geographical altitude was observed. The differences can be associated to impeller speed variations between trials. For the tests performed at 1,996 m, it is presumed that there were problems that were not detected during the measurement.

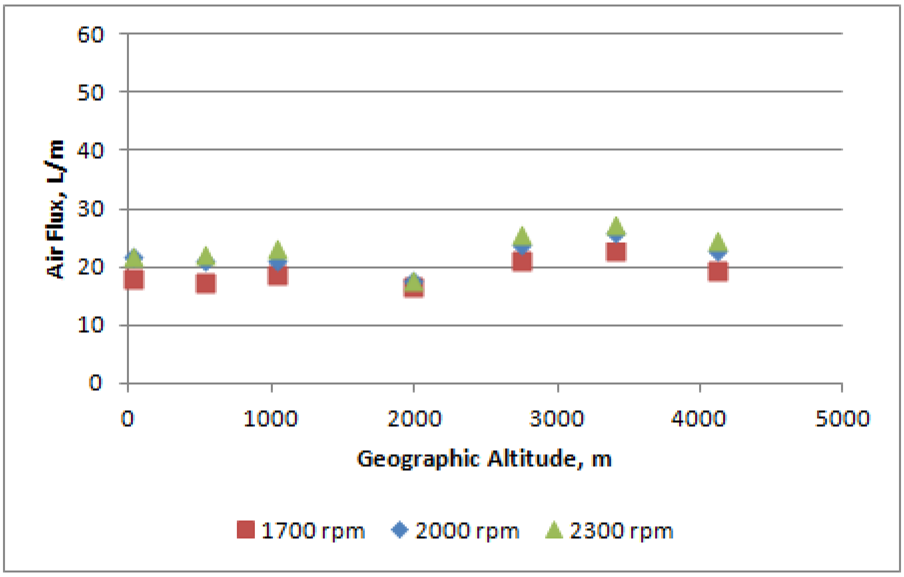

Figura 8. Effect of geographic altitude on aspirated air flux.

3.2. Operation with injected air cell

For tests with injected air cell was used one condition of agitation, 2,300 rpm, under two conditions of airflow. The first one, matching air flow obtained in the self-aerated condition and the second one with flow greater than the previous one. Figure 8 shows how, without difficulty, was reproduced the condition of air flow of a self-aerated cell with injected air condition.

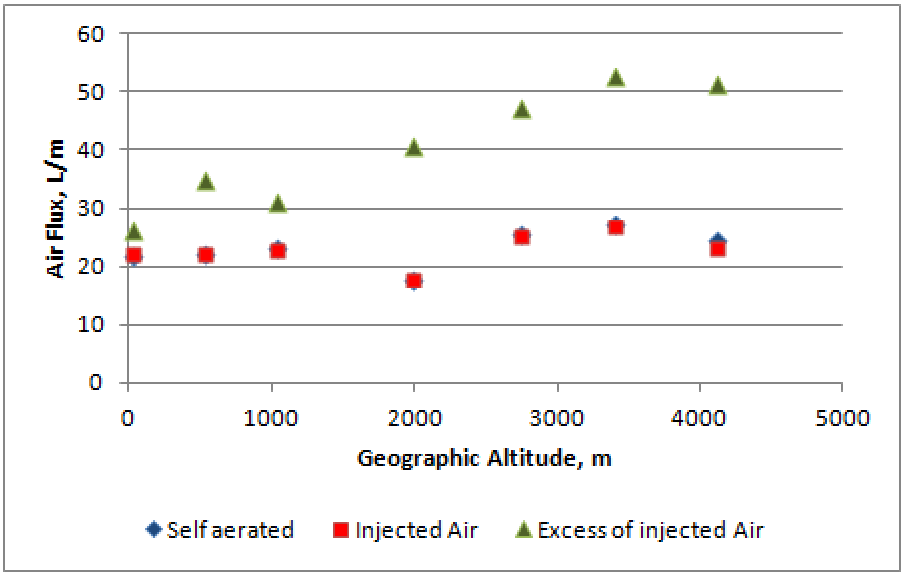

Figure 9. Air flux on self-aerated cell and injected air cell in different geographic altitudes.

Figure 9 shows the effect in the geographic altitude in the bubble size under different scenarios: self-aerated condition, injected-air condition with the same flow of the self-aerated condition, and injected-air condition with an excess o f air flow. As you can see, the way in which air is supplied at the same flow does not affect the bubble size. However, the injection of a higher flow causes an increase in the bubble size. This indicates that the bubble size obtained in self-aerated condition is minimum.

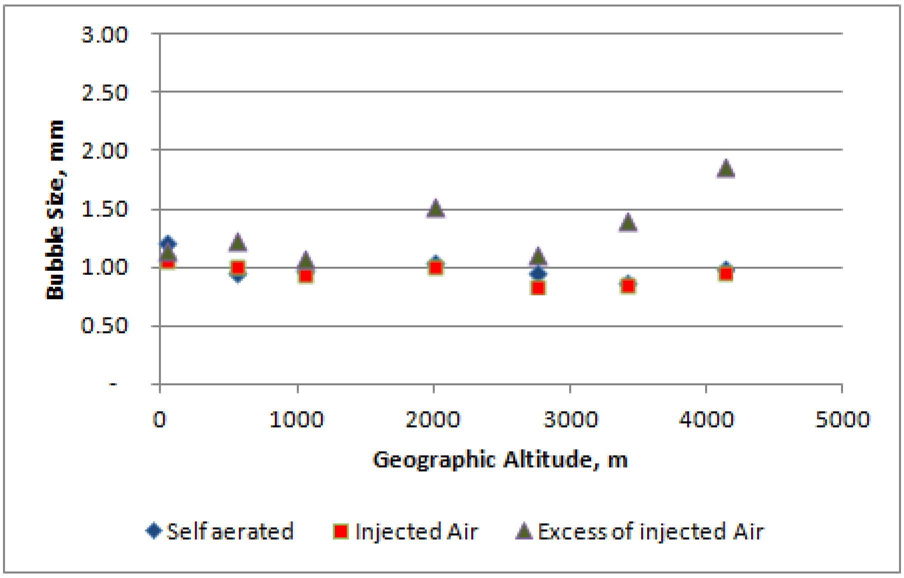

Figure 10. Effect of geographic altitude on bubble size with self-aerated and injected-air cell.

The bubble distribution analysis using different ways to provide air into the cell clearly shows that the injected-air cell, working with the same air flow, gets the same profile of bubbles from a self-aerated cell. However, an increasing in air flux in a injected-air cell generates a diminution in the numbers of bubbles with size smaller than 1 [mm].

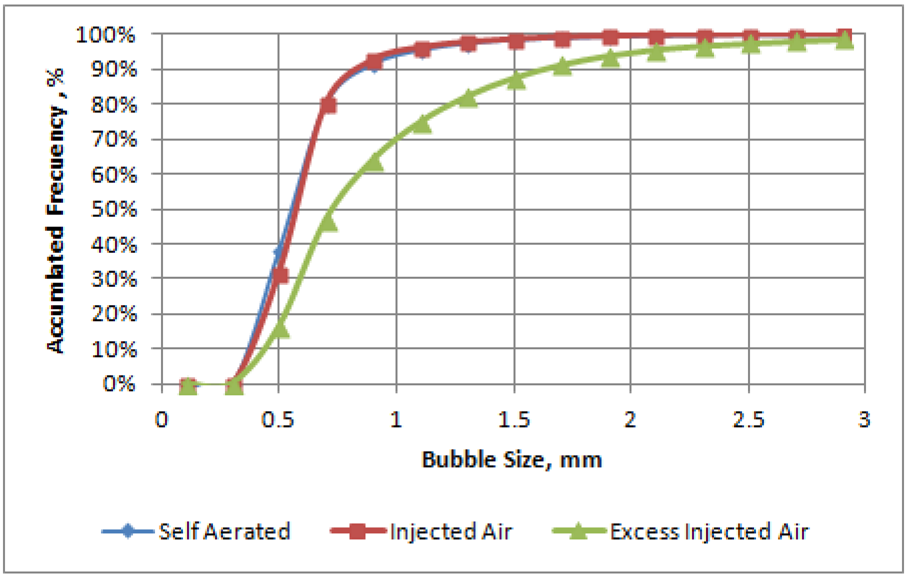

Figure 11. Cumulative distribution of bubble size with with self-aerated and injected-air cell.

4. CONCLUSIONS

A hydrodynamic measurements laboratory cell operating with water and foaming at different heights geographic were performed.
The results of these measurements indicate that a geographical altitude variation does not affect the size of bubbles obtained. Furthermore, increasing the linear speed of the rotor does not affect average bubble size.

The operating results of the cell as a self-aerated and injected-air show that, at the same air flow, there are no differences in the profile of bubble sizes. However, excess air entering the cell, the bubble sizes profile moves, generating larger bubbles. Based on the above it is concluded that the size of bubbles generated by a self-aerated cell is minimum.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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