

A Novel Collector for Flotation of Phosphate Minerals

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ABSTRACT: Flotation of fine phosphate particles is one of the most difficult parts of fine particle processing in preparation plants. One of the main difficulties is due to the fact that the recycled water is used in the flotation circuit, which has high dosages of suspended particles and harmful ions. For this reason, currently used flotation reagents (i.e., fatty acid and diesel) cannot produce desired grade and recoveries on fine phosphate particles. In the present investigation, a novel collector was developed and used for the purpose of improving the grade and recovery of phosphate particles. The test results showed that at least 10% recovery with higher grade could be achieved on phosphate samples. As a result, it is concluded that in the presence of the new collector phosphate companies could have higher benefits from the ore.

1 INTRODUCTION

Phosphate is mainly used as a fertilizer in agricultural industries. It is reported that more than 95% of phosphate rock produced in the world is utilized for the phosphoric acid production. With one-third of the world phosphate production, the USA (Florida, North Carolina and Idaho) is the largest producer of the world, and more than 80% of the US production comes from Florida itself. When the phosphate is mined, it does not meet requirements for the phosphate industry due to the higher gangue mineral contents (i.e., dolomite, silica sand, clay, clay-sized minerals, etc.), and necessary to improve the content of phosphate (P₂O₅) in the final product. Flotation that has been applied for the separation of phosphate fines since late 1920s seems to be the best separation method (Miller *et al.*, 2000 and 2001).

Nowadays, double flotation process is mostly preferred one for the separation of a phosphate from the gangue minerals. This process includes an anionic flotation (fatty acid + fuel oil) of the phosphate minerals at alkaline pH, and then cationic flotation (amine) of fine silica minerals (presented during the anionic flotation) at neutral or acidic pH. The second step is conducted after the concentrate is de-oiled with diluted sulfuric acid. This double flotation process is extensively applied to sedimentary phosphate minerals in the USA (Miller *et al.*, 2000 and 2001; and El Shall *et al.*, 1999).

Recently, plant-recycling water is used to float the phosphate lines in several flotation circuits due to the environmental concerns in the world. However,

it is found that the plant water contains several nanosize suspended particles and different harmful ions including Ca, Mg, Al, Fe, Na, K, Cl, F, Si, S₂O₃, and P, which increase the plant water hardness and decrease flotation recovery and phosphate grade (Weiss, 1985; and Summers *et al.*, 2002). Among these ions, the phosphorus ion seems to be one of the worst ions affecting the flotation process in the plant. Thus, to eliminate these effects the reagent consumption is increased to receive the higher recovery and grade but this also increases overall flotation costs. For a while, a number of research programs have been performed on the phosphate flotation using plant water, and it was seen that recovery results were still far from the expected one (approximately 10% lower than tap water) (Miller *et al.*, 2000 and 2001; and El Shall *et al.*, 1999). In order to solve the problem associated with the phosphate flotation using the plant water, a novel flotation reagent (dissolved in appropriate carrier solvent before use) has been developed and successfully conducted on phosphate samples. The chemical seems to be the most promising option for the phosphate industry to recover fine phosphate in the flotation circuits.

2 EXPERIMENTAL

The deslimed phosphate samples from the USA were screened in two sizes (-2+0.075 mm and -1+0.075 mm), and then representative samples were poured into a conventional 4-liter stainless steel Denver

flotation cell. It is known that the desliming improves the flotation recovery and grade due to the removal of ultrafine dolomite and clay-sized particles, which can also eliminate the cationic flotation step [Miller *et al.*, 2000; and Weiss, 1985]. A hydrophobic surfactant - called Reagent P123 and saponified fatty acid (crude tall oil) were employed for the flotation tests at 1600 rpm and 17% solid content. Before the tests, the phosphate samples were conditioned with fuel oil and the chemicals at 70% solid content for two minutes, and then flotation tests were performed for two minutes at pH 7.4-8.1 using plant recycling water. The ratio of fuel oil to fatty acid (or new flotation reagent) was 0.6. The purpose of these tests is to compare the efficiency of the new collector with fatty acid under plant water conditions.

3 RESULTS AND DISCUSSION

Figures 1 and 2 show the results obtained on the phosphate sample (-1 mm + 0.075 mm) using plant-recycling water. The test results with a single stage flotation step showed that a 1000 g/ton of Fatty acid and Reagent P123 gave 27.30% P₂O₅ and 27.81% P₂O₅ grades and 89.68% and 97.89% recoveries, respectively. This indicated that the hydrophobizing agent could improve the force of attachment between bubbles and hydrophobized particles (selectivity), which in turn affected the recovery and grade of the phosphate fines. However, the traditional fatty acid/fuel oil combination did not provide such a high selectivity in the harsh water conditions. In addition, it was also observed that in the presence of the new reagent flotation kinetic was also improved at least 50%, which might be due to the same reason.

In order to compare the efficiency of the new collector on coarse particles (-2+0.075 mm), a series of flotation tests were also conducted using the same plant water. The flotation recovery/collector dosages and recovery/grade curves of the tests are shown in Figures 3 and 4, respectively. Based on the flotation test results, it is seen that using a 1000 g/ton of the new collector a single stage flotation recovery of 86.76% is possible on the coarse phosphate particles with a concentrate grade of 24.64% P₂O₅. The higher recovery (i.e., more than 11%) as compared to the conventional reagent could be attributed to the fact that the new reagent specifically adsorbed on the phosphate particles, and made those particles hydrophobic enough for better flotation in the plant conditions. Additionally, the improvement of the flotation kinetics was also seen in all the tests.

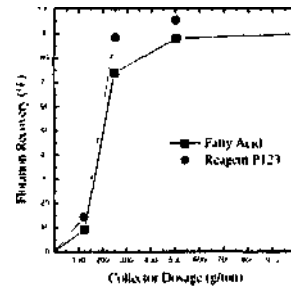


Figure 1 Flotation recovery of phosphate sample (-1+0.075 mm) as a function of fatty Acid and Reagent P123 with plant water

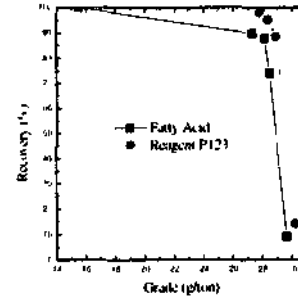


Figure 2 Comparison of recovery/grade curves obtained using Fatty Acid and Reagent P123 for the phosphate sample (-1+0.075 mm) with plant water

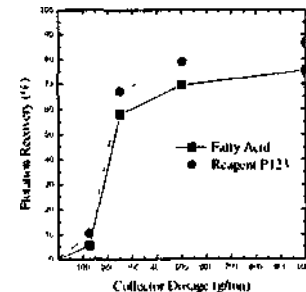


Figure 3 Flotation recovery of phosphate sample (-2+0.075 mm) as a function of Fatty Acid and Reagent P123 with plant water.

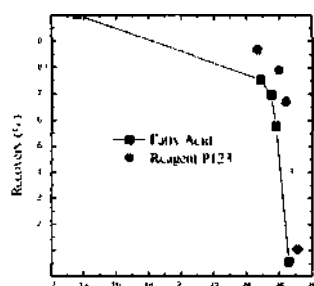


Figure 4 Comparison of recovery/grade curves obtained using Fatty Acid and Reagent P121 for the phosphate sample (-2+0.075 mm) with plant water

4 CONCLUSIONS

A newly developed hydrophobic reagent was tested on flotation of a phosphate sample at neutral pH to be able to improve recovery and grade of the phosphate samples. All the tests were conducted in the laboratory condition using plant water supplied from a phosphate company. The test results showed that flotation performances of fine phosphate samples, including recovery, grade and flotation kinetics

could be significantly enhanced. This can be attributed to the fact that the novel reagent improved the hydrophobicity of the fine particles to be efficiently floated in the flotation circuit.

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