Phosphate Recovery from Slime Sized Ore

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Abstract
Phosphate ores containing clayey and cherty minerals are conventionally de-slimed for concentrating phosphate minerals or for further processing (generally) by flotation. Substantial amounts of phosphate values are misplaced into the slime product which is discarded as tailing. Eshidiya beneficiation plant generates 400,986 tons/annum of slimes contains around 18% P₂O₅, equivalent to about 72,177 tons/annum of P₂O₅. Attempts were made to recover phosphate mineral from the discarded slimes of Eshidiya (Jordan) ore by flotation process. It is noted that reasonable up gradation is possible say from +18% P₂O₅ to H” 28% P₂O₅ at P₂O₅ recovery from 66% to 77%, though at prohibitively high doses of collector and 30% higher impeller RPM.

Keywords: Slimes; flotation; fatty acid; phosphate mineral.

1. Introduction
Eshidiya phosphate beneficiation plant generates three types of wastes (1) The coarse (-12 mm to +1.40 mm) rejects (2) slimes (d80 H” 25im) from overflow of desliming hydrocyclones and (3) flotation circuit tailings. In the present work, the possibility of recovering phosphate values from the slimes is studied. Eshidiya beneficiation plant is operating in two streams to treat two different types of ores marked A-1 and A-3.
A-1 ore is medium hard to friable fragments, rich in phosphate and detrital quartz particles, microcrystalline calcite, silica associated with clays analyzing 18.31 to 27.86% P₂O₅. A-3 ore is friable and composed of a physical mixture of phosphate particles and detrital quartz in various proportions associated with minor clayey minerals analyzing 18.31 to 22.88% P₂O₅. A-1 ore beneficiation involves scrubbing, oversize (-12 mm to +1.40 mm) rejection by screening and desliming by hydrocyclones. A-3 ore is scrubbed, oversize (-12 mm to +1.25 mm) rejecting by screening, desliming by hydrocyclones and fed to flotation circuits to separate phosphate values mainly detrital quartz particles.
The clayey content in the phosphate ore confirmed the presence of palygorskite, kaolinite and mixed illite/smectite in the Eshidiya area.
The slimes generated in the plant represent about 18.40% and 11.10% of the feed by weight.
in case of A-1 and A-3 ore respectively. The annual generation of slimes from A-1 and A-3 streams is about 4,00,986 tons/annum of slimes contains around 18% $P_2O_5$ and equivalent to about 72,177 tons/annum of $P_2O_5$. Attempts were made to recover $P_2O_5$ values from the discarded clayey slimes of Eshidiya ore by flotation process.

2. Experimental

2.1 Materials

A representative slime feed sample of combined A-1 and A-3 collected from tailing disposal area. The sample analyzed 19.29% $P_2O_5$ in the particle size of d80 at 24.82 µm. The distribution of size fractions and $P_2O_5$ of slime feed sample and concentrate are shown in Table 1a and 1b.

### Table 1a: Distribution of feed size fractions and $P_2O_5$

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Weight retained.</th>
<th>% $P_2O_5$</th>
<th>% $P_2O_5$ distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ 53 µm</td>
<td>8.40</td>
<td>25.56</td>
<td>11.13</td>
</tr>
<tr>
<td>+ 45 µm</td>
<td>2.50</td>
<td>22.65</td>
<td>2.94</td>
</tr>
<tr>
<td>+ 38 µm</td>
<td>2.80</td>
<td>21.59</td>
<td>3.13</td>
</tr>
<tr>
<td>- 38 µm</td>
<td>86.3</td>
<td>18.51</td>
<td>82.80</td>
</tr>
<tr>
<td>Calculated feed</td>
<td>100.00</td>
<td>19.29</td>
<td>100.00</td>
</tr>
</tbody>
</table>

### Table 1b: Distribution of concentrate size fraction and $P_2O_5$

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Weight retained.</th>
<th>% $P_2O_5$</th>
<th>% $P_2O_5$ distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ 53 µm</td>
<td>11.6</td>
<td>31.66</td>
<td>12.25</td>
</tr>
<tr>
<td>+ 45 µm</td>
<td>2.73</td>
<td>30.03</td>
<td>2.84</td>
</tr>
<tr>
<td>+ 38 µm</td>
<td>3.33</td>
<td>29.67</td>
<td>3.43</td>
</tr>
<tr>
<td>- 38 µm</td>
<td>82.78</td>
<td>28.39</td>
<td>81.48</td>
</tr>
<tr>
<td>Calculated concentrate</td>
<td>100.00</td>
<td>28.48</td>
<td>100.00</td>
</tr>
</tbody>
</table>

2.2 Reagents

All the reagents used in the tests are of commercial grade which are being used in the plant. The fatty acid extracted from the tall oil (955 fatty acid and Iodine No. 131, titer 8°C) is supplied by M/s. Arizona Chemical Company, USA, Light Diesel Oil (LDO) by Jordan oil corporation, sodium silicate is of 38% concentration and Alfa olefin sulphonate (AOS) (38% active matter, 0.2% free alkali, 2% sodium sulphate, 2% sodium chloride, 4% free oil (100% basis) and pH of 5% A/M solution is 9±1) is supplied by M/s. Godrej Industries, Mumbai, India.

2.3 Methods

Flotation experiments were conducted in two liter Denver sub-aeration type flotation cell and 200 grams of phosphate slime sample taken for each test. The ore pulp was conditioned at 2200 RPM for one minute by adding sodium silicate at 18.82 % solids. The fatty acid/tall oil, LDO and AOS added after conditioning the pulp with sodium silicate and pulp was further conditioned for another 9 minutes. After conditioning the pulp was diluted to 9.41 % solids by weight before starting the flotation tests at 1500 RPM. The rougher concentrate was cleaned twice to get final concentrate in one or two liter capacity cells as required.

The impeller RPM in normal flotation tests is maintained at 1100 RPM. However we had increased the impeller speed to 1500 RPM as the results at normal RPM were poor. The products i.e froth and tailings were filtered, dried, weighed and analyzed. The results of some tests were shown in the flow charts as figure 1 to 3.

3. Results and discussion

The results of the experiment were given in flow charts as figures 1 to 3. The results indicate that H++ 18 to 19 % of $P_2O_5$ in the slime rejects can be recovered at a concentrate grade of 28 % $P_2O_5$ with about 66 to 77 % weight recovery.
The recovery of P₂O₅ slightly lower side to 61%, when tall oil was used as collector is shown in figure 3.

4. Conclusion

To ensure proper mixing of reagents and pulp RPM of the impeller of flotation cell was set high. The bench scale experiments show the technical feasibility to produce concentrate grade of 28% P₂O₅ at 66 to 77% weight recovery from the slimes. However the reagent consumption is prohibitively high.

An important observation in this study is that flotation performance of slime sized feed improved at increased RPM of the impeller from 1100 to 1500.

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References