MacHUNTER R. M. G., The effect of ultra-fine particles on the separation performance of wet gravity processing equipment and flowsheet design implications for their treatment. *Heavy Minerals 2005*, Society for Mining, Metallurgy, and Exploration, 2005

The effect of ultra-fine particles on the separation performance of wet gravity processing equipment and flowsheet design implications for their treatment

R.M.G. M^{ac}HUNTER*
*Roche Mining (MT) Pty. Ltd., Gold Coast, Australia**

The presence of ultra-fine particles affects the separation performance of wet gravity separation equipment. Several studies have been undertaken to establish the maximum level of these particulates that can be tolerated by spiral separators and it has been found that unless the ultra-fine material is effectively processed, relatively low proportions in the ROM material combined with high feed rates can result in degradation in plant performance and/or excessive water consumption.

The maximum level of particulate material in the process water has been determined by examination of separation performance of spiral separators under varying slime loading. This work has been conducted utilizing various feed sources and a robust 'rule-of-thumb' has been derived.

Introduction

The concentration of ultra-fine particles in the transporting medium (water) of a slurry effects the separation performance of heavy mineral particles when being processed on a spiral separator. In certain cases particularly in applications where the heavy mineral is relatively coarse, the separation performance of this fraction is enhanced by low levels of slime material. Beyond this point and with fine heavy minerals the separation performance decreases rapidly with increasing slimes levels.

. Testwork has been conducted comparing the separation performance at different slimes concentrations on two heavy mineral sand feed samples. These materials were chosen as they represent either end of the typical mineral sand feed spectrum.

Definition

For the purposes of this discussion and as usually found in the mineral sands sector ultra-fine particles (slime) are reject material up to 50µm in diameter. They are predominately composed of clay minerals that have no economic value.

For the most part these particles are water born and separate according to the water split within the wet concentrator plant (WCP).

Processing

Depending on the quantity and characteristics of the slime fraction contained in the run of mine (ROM) feed, the WCP has a feed preparation circuit whose primary function is to liberate the valuable heavy minerals prior to being separated in the gravity circuit. In this process the ultra-fine material is dispersed into the process water, which has an effect on the separation performance in the gravity circuit and generally the flowsheet design requires methods to manage the level of slime in the process water.

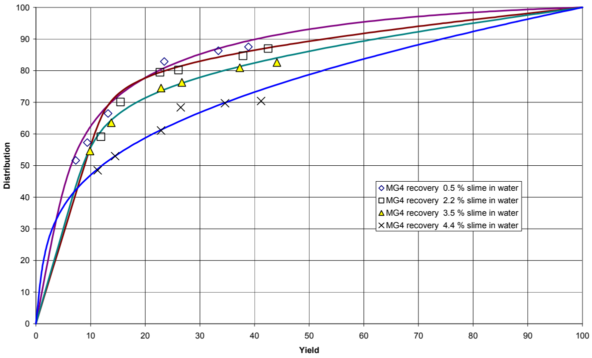
Testwork – fine grained heavy mineral

Testwork was conducted on a sample of fine grained mineral sand (originating in the Murray Basin, Australia) in a closed circuit test rig. The particle size d_{50} of the heavy mineral component was 82µm.

The material was deslimed and the slime fraction reintroduced into the test rig in proportion until the desired slime in water level was achieved. The levels examined were 0.5, 2.2, 3.5 and 4.4% slime with respect to water in slurry.

Data in the form of heavy mineral content and mass and volume flow rates were collected from each of the tests. These data are depicted in Figure 1as heavy mineral versus mass yield to concentrate curves. The data for 0.5 and 2.2% slime cases are essentially grouped in the same distribution curve viz. the spiral performance for these levels of slime concentration are the same. A significant drop in performance of 5 -7% in heavy mineral recovery is noted when the slime content increases to 3.5%. Further dramatic drop in performance is noted when the slime content increases to 4.4%.

Figure 1 - Effect of slime level on spiral separator performance on a fine grained mineral sand



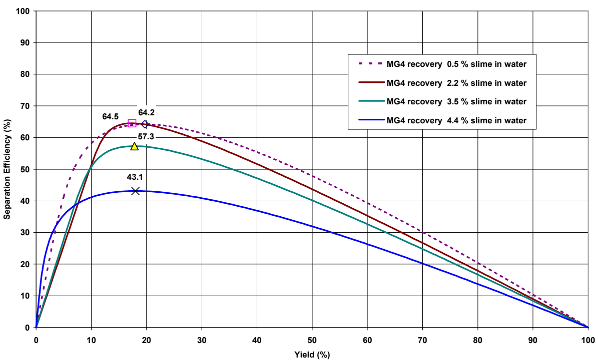
An efficient method for performance comparison of spiral separators was proposed by Holland-Batt[1]. In this work the separation efficiency at mass recoveries to concentrate are determined and the resultant curve plotted. The separation efficiency (E) is determined using the following equation:

$$E = \frac{R - W}{1 - f}$$

Where, R is the recovery, W is the mass yield to concentrate and f is the fractional feed grade.

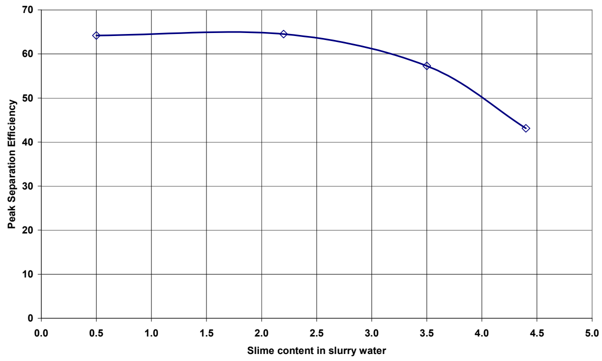
The shape of the curve lends itself to the establishment of a peak efficiency value and therefore a quantitative evaluation of the performance curves. The separation efficiency curves at the different levels of slime contents are depicted in Figure 2.

Figure 2 - Effect on separation efficiency with varying levels of slime concentration in a fine grained mineral sand



Here the peak separation efficiencies for the spiral separator under the varying slime loading indicate that the performance for the 0.5 and 2.2% cases is the same (64.2 and 64.5% respectively). A drop of approximately 7% for the 3.5% slime case is shown with a further drop of 14% to the 4.4% slime case. These data are depicted in Figure 3.

Figure 3 - Peak separation efficiency against slime loading for a fine grained mineral sand

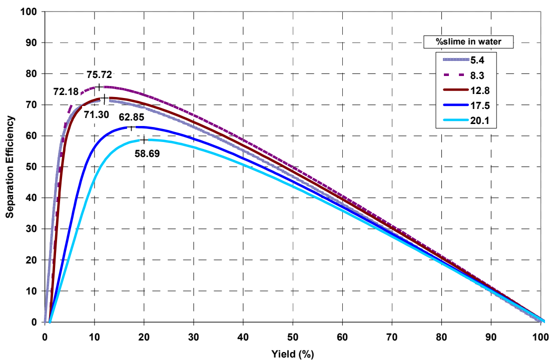


Although somewhat subjective, in this case it was decided that a drop of greater than 5% in peak efficiency would be unacceptable; hence the maximum slime loading was set at 3%.

Testwork – coarse grained heavy mineral

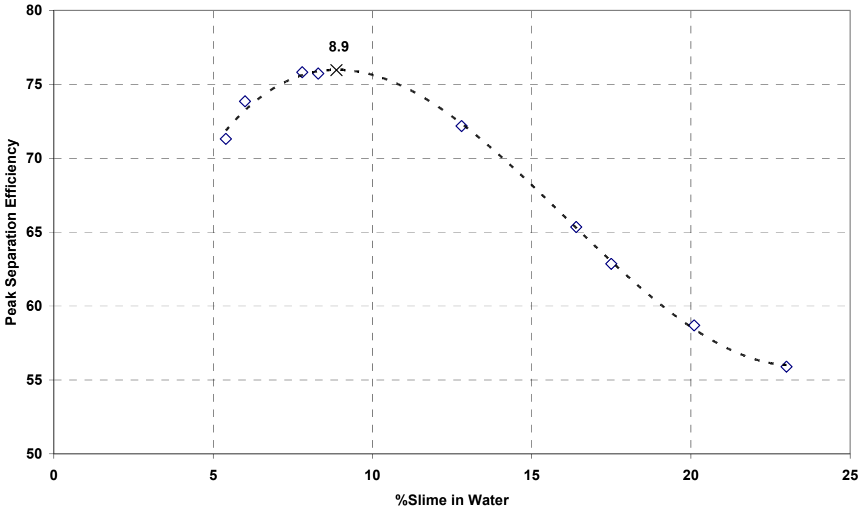
A similar test program was conducted on a Western Australian mineral sand that had a heavy mineral particle d_{50} grain size of 300µm. The resultant separation efficiency versus yield curves are depicted in Figure 4.

Figure 4 - Effect on separation efficiency with varying levels of slime concentration in a coarse grained mineral sand



These data indicate an increase in separation efficiency as the slimes content of the water in the slurry increases up to approximately 9% (peak separation efficiency 76%) and then the performance begins to decline again as found with the fine mineral sand. It is believed that some slime in the water component of the slurry may be beneficial by lubricating the heavy mineral particles in the middling/concentrate band there by assisting in the separation. Once the level of slimes exceeds 9% then the viscosity effects outweigh this benefit and the performance declines. The peak efficiency data are shown in Figure 5 against the % slime in water. A polynomial fit is also included confirming the maximum peak separation efficiency occurs at 9% slime in water.

Figure 5 - Peak Separation Efficiency versus slime content.



Conclusions

Testwork has shown that for coarse grained heavy mineral deposits a low level of slime in the water contained in the slurry is beneficial to the separation performance of material. The work has shown that as a 'rule-of-thumb' the for the maximum slime level in water fraction of a slurry can be determined as 3 times the d50 in micrometers for the heavy mineral divided by 100.

References

1. Holland-Batt, AB (1990), "Interpretation of spiral and sluice tests," Trans. Instn Min. Metall., Janurary-April, 1990, pp. C11-C20.