

TABLING

Ayushi Srivastava(2019UGMM009)

Utkarsh Deep(2019UGMM060)

Shrishti Mourya(2019UGMM093)

One of the functions of minerals processing, is concentration. Concentration may be simply defined as the upgrading of a mineral. That is, to increase the fraction of the valuable material versus the discard material. This may be achieved with a host of different processes. What these methods have in common is that they take into consideration the physical properties of the material(s) of interest. Of course, unlike processes in pyro-metallurgy and hydro-metallurgy, which take into account the chemical properties of ore material. In this investigation, the primary physical property considered relates closely with gravity; density. Second to that, is the texture (and size) of the material - which also affects the efficiency of the separation mechanism, specifically, on a shaking table.

Three 100g samples with a composition of 25% ilmenite (FeTiO_3) and 75% silica (SiO_2) are separated on a shaking table. To simplify the experiment, certain operating conditions are kept constant. The feed rate is kept at 22.17 g/minute, the slope of the deck is maintained at 19° , and the water flow rate is kept in the vicinity of 0.21 litres/second. The only variable is the frequency of the table's vibrations.

Ilmenite is heavier than silica. The expectation is that the ilmenite particles will settle at the bottom of ridges in-between riffles. The silica particles, as they are closer to the top of the ridges, should be carried by the flowing water towards the tailings launder. On the other hand, the ilmenite particles will travel across the table (in-between the riffles), forming a curved profile as they migrate onto the riffle-less region of the table. Most of the ilmenite is expected to collect in the concentrate launder. The rest of the ilmenite will report in the middlings and in the tailings. It would seem that separation would be best at 30 Hz because ample time would be allowed for ilmenite and silica to separate extensively.

SHAKING TABLE

Shaking tables are one of the most environmentally friendly methods of mineral

processing as the only reagent used is water.

They utilize both particle density and to a lesser extent particle size to fractionate fine ore samples (<1mm) into products, middlings and waste fractions . That is, if a milled ore is introduced into this system, it can be expected to undergo natural sorting wherein high-density particles sink to the bottom and lighter ones float to some extent. The Wilfley shaking table which consists of a transversely sloping rectangular deck A, onto which feed of about 25% wt solids is introduced from the feed box and distributed along C, wash water is dispersed along the balance of the feed side from launder D. The table is vibrated longitudinally by mechanism B using a slow forward stroke and a rapid return. This makes the movement towards the discharge end slow and return fast. An adjustable splitter at the end is often used to separate this product into two fractions – a high grade concentrate and a middlings fraction.

Separation of the 3 fractions is mainly affected by a number of operating variables like wash water flow rate, feed pulp density, deck slope, amplitude of vibration and feed rate. Particle shape and size distribution also play important roles as well.

Some of the parameters that can influence the grade of the concentrates are briefly explained below:

- An increase in the wash water flow rate, increases the grade of the concentration fraction at both lower and higher feed flow rates. As wash water flow rate increases, the transport of gangue minerals to the tailings fraction increases which in turn improves the grade of the concentration fraction .
- Higher grade of the concentrate fraction is obtained at higher level of both deck tilt angle and feed flow rate. With a lower level of deck tilt angle, an increase in the feed rate decreases the quality of the concentrate fraction .

Advantages of the shaking table

- Highly selective, with high upgrading ratio if used correctly.
- Able to see separation and make adjustments. (Falconer, A., 2003)

Disadvantages of the shaking table

- Low capacity, large floor area requirements.
- Require frequent operator attention, checking and adjustments.
- Feed should be sized. Shaking tables are relatively old equipment but still have a very

important place in the mineral processing industry. They typically treat finer material than jigs but at a lower capacity. Shaking tables are still used for coal cleaning of 0-6 mm and also for concentrating heavy non sulfide minerals e.g. cassiterite, scheelite and gold .

RECOVERY

Theoretical Grade-Recovery

It is defined as the maximum predicted recovery by flotation of a mineral at a specific grade. This grade value is determined by the liberation of surface area of the valuable

minerals. This grade value is determined by the liberation of surface area of the valuable minerals. As a result of previous process, it is directly related to utilization of the grind size in the process. The theoretical grade-recovery can be normally utilized to identify potential recovery quickly and it can help to optimize the flotation process which can be more efficient.

EXPERIMENT

The material and equipment provided:

- A shaking table and water
- Three 100 g samples (25% ilmenite and 75%silica)
- Magnetic separator

The following procedure was followed:

1. Measure the slope of the deck. (19°) This angle is kept constant.
2. Start running the water and measure/adjust its flow rate.
3. Place containers under the holes to collect the tailings, middlings and the concentrate.
4. Place sample in the continuous feeder and calculate the feed rate. Keep this rate constant throughout all experiments.
5. The experiment was done three times at 30 Hz, 37 Hz and 40 Hz.
6. Once the concentrates, middlings and the tailings have been collected for all three frequencies, the samples are to be dried in an oven.
7. They are then fed into the magnetic separator separately.
8. If there is still some mixing of silica and ilmenite, re-feed the contaminated container into the magnetic separator to completely separate.
9. Once again weigh the respective samples, these weights will be used to calculate the grades and recoveries of the three experiments.

10. During the experiments photographs are taken to show the difference in splitting at the various frequencies.

Three samples of 75 g Silica and 25 g ilmenite were separated on a shaking table. Each sample was separated at a different frequency. The results of each separation process are summarised below. On all the images, the dark particles are ilmenite and the light particles are silica.

Sample 1 - 30 Hertz

Shaking table operating conditions:

Water flow rate: 0.20 dm³/s

Feed rate : 20.62 g/s

Deck slope : 19°

Table of results of experiment 1

RESULTS AND DISCUSSION

The above three images were captured at random times, each representing the separation process for 30 Hz. In figure 4.1, it can be seen that the majority of the silica is reporting to the tailings. As the separation process continues, the ilmenite reports to the middlings and most of it to the concentrate. With recovery as low as 58%, the grade is expected to be high; grade and recovery are generally inversely proportional. However, operating at this frequency was time-consuming.

Sample 2 - 37 Hertz

Shaking table operating conditions:

Water flow rate: 0.21 dm³/s

Feed rate : 20.62g/s

Deck Slope : 19°

Table of results of experiment 2.

First separation profile. First separation profile.

As with the previous experiment, the above images were captured at random times for the separation at 37 Hz. The separation of ilmenite and the silica was quicker than in the previous experiment - the separation profile stays elongated for a shorter period. However, this wasn't without sacrifice. More ilmenite is lost in the middlings and tailings launders than when the frequency was set lower. Recovery is relatively high, therefore it is expected that the grade be

lower compared to when the frequency was set at 30 Hz. However, the grades are about the same i.e 28%.

Sample 3 - 40 Hertz

Shaking table operating conditions:

Water flow rate: 0.20 dm³/s

Feed rate : 20.62g/s

Deck Slope : 19°

Table of results of experiment 3

Operating at a frequency as high as 40Hz, the sample was expected to be poorly separated considering the amount of time it takes for the process to finish. The profile of the separation was random - not as close to uniform as the profile at frequency of 30 Hz. This particular frequency results in a high recovery of approximately 78%. It is lower than the 40 Hz recovery therefore, it makes sense that its grade is higher; the grade of ilmenite is 30.65%. It is however, still unapparent why the grade at the frequency of 30 Hz is lower than 30.65%.

Separation profile 1 Separation profile 2 Separation profile 3

Based on the results obtained for the various separation processes, one can conclude, that working at a frequency of 40Hz is most effective - the process spans the least period and produces the highest grade. From what was observed and from the pictures taken, it appears that the heavier mineral separates the slowest. That is, even though there is more silica in the sample, for most of the separation process, there is more ilmenite than silica remaining on the table. Also, separation will always occur diagonally regardless of the frequency. Frequency has minimal effect on the material distribution. Material distribution is largely dependent on the deck slope and water flow rate. Steeper decks and fast flowing water concentrate less weight.

Upon performing the experiment, one can deduce that the shaking table has several advantages as well as several disadvantages. The major advantage of shaking tables is the fact that separation can be observed in real-time. This enables changes and allows adjustments to be made, hence improving the next separation process. The disadvantage of using a shaking table is the water consumption. Water is increasingly becoming a rare and expensive commodity. Considering that the 30 Hz experiment lasted for 2 hours and 15 minutes, yet produced a lower grade ilmenite than the 40 Hz experiment - which lasted

only 13 minutes.

In conclusion, it was found that the frequency of vibrations of the shaking table plays a major role in the concentrating of minerals. The experiment carried out at the 40 Hz frequency was the most effective as it produced a higher grade separation in a relatively short amount of time. The 30 Hz frequency was found to be inadvisable for a concentrating plant as the process is time-consuming. In addition, it used up a lot of water yet produced a lower grade concentrate.

From observations, it appeared that the minerals that were the heaviest (and roughest), separated slower than the lighter and finer particles, which were carried by the water easier and rolled on the surface of the table instead of sliding. The mineral with the highest density (ilmenite) sunk while the mineral with the lowest density (silica) floated to some extent. They separated partially due to the slope of the deck and water flow rate. However, the main reason for their separation was their natural differences in density.