Debtech's RhoVol: real-time sample density measurement

With metallurgical operations constantly looking to improve recoveries, the RhoVol densimetric measurement system from De Beers Technologies SA (DebTech) now makes it possible to determine material density on-site quickly and easily – allowing process plants to be quickly optimised for best results.

According to Grant High, research and development manager at DebTech, density is a key element in a range of mineral separation processes, and knowing the density profile of material entering a metallurgical process is critical in determining the way that process is set up to give best results.

"Traditionally, this is done by taking a sample and putting it through a sink-float process where heavy liquids are prepared at different densities and the sample is moved between these liquids to establish a density profile of that sample," says High.

This absorbs time, effort and cost, and turnaround times are anything from a number of days to even weeks. Most mines or plants will not have these facilities on-site so will have to send samples away for testing. He adds that there are also health, safety and environmental issues associated with these liquids, as they can be toxic and carcinogenic.

The manual nature of the testing process also makes it susceptible to human error, often introducing levels of variability that undermine the effectiveness of fine-tuning back at the process plant.

"By the time the results of the sample tests are returned to the customer, it is often too late to adjust the set-up process with sufficient effect," he says, "especially as the density profile of the material passing through the plant may have changed since the last sample was taken."

He notes that it has been something of a 'holy grail' for the metallurgical industry to be able to measure the density of incoming material in real time, so that the plant's settings can be optimised in time to make a difference. In search of solutions, some years ago DebTech developed the vision size frequency distribution (VSFD) technique. This is a camera-based system for measuring the size of particles. In this system, specially situated cameras take a number of silhouette photographs of a particle, each photograph contributing to the reconstruction of a 3D model of each particle. On this basis, the volume of the particles is used to generate a size distribution.

An accurate density histogram of a sample can be determined within hours of passing the sample through RhoVol.

At the starting point of determining a density profile, RhoVol measures and records the mass of each particle in the sample.

In the RhoVol, the VSFD breakthrough is combined with a rapid weight measurement device, so that both the mass and the volume can be determined with great accuracy and speed, and can then provide the density of every particle. The weight of the particle can be measured within 700 milliseconds to a very high accuracy level – with an error margin of just 0.5 %.

An added advantage of this technology's accuracy is that large samples are no longer required. Instead, very precise and accurate results can be achieved with much smaller samples than are commonly used in traditional sink-float methods – where 25-30 kg samples are often required. In the testing of kimberlites, for example, the sample size when properly riffled could be as small as 400 g depending on the size fraction.

"The RhoVol's high process rate of 1 000 particles per hour makes it possible for users to rely on getting useful results in just one hour, as we have found that 1 000 particles is a good benchmark for a sample's representivity," he says. "When that number of particles is exceeded, the results tend not to vary much as a result."

Once the particles' volume data has been captured, a range of other measurements and information can be derived about the shape of the particle – such as elongation, flatness and compactness. "While size counts, so does shape," says High.

For the first time, RhoVol gives metallurgists the ability to analyse not just the density and size of particles but their shape. This knowledge can play a key role in troubleshooting the performance of dense medium separators. Where separators also act as shape classifiers, they cause flat particles, for instance, to report to the 'wrong' side of the separation process. This kind of problem can now be identified through the RhoVol data – and this information would not have been available from a normal sink-float analysis.

"The 3D model allows any physical dimensions or ratios to be derived," he adds. "All this information is very valuable in understanding the particular metallurgical process in question."

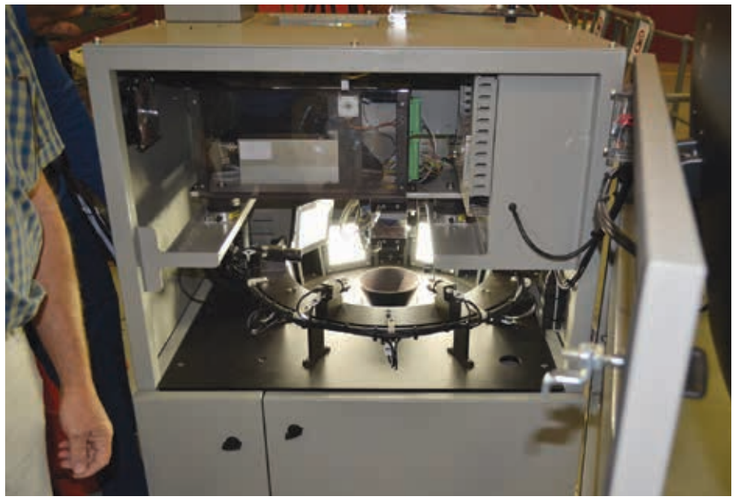
While earlier devices were developed to measure only diamonds – which had a constant density – the RhoVol's measurement of both weight and volume allows the density profile of any ore sample to be generated.

"The simplicity of the RhoVol means that a plant does not require any specialised laboratories on site, and a relatively unskilled operator can conduct the measurements," High says. "And because the results of the tests will be available within hours, rather than days or weeks, the plant operators can now have a clear picture of the density profile of the material coming in to the plant, and make the necessary changes upfront."

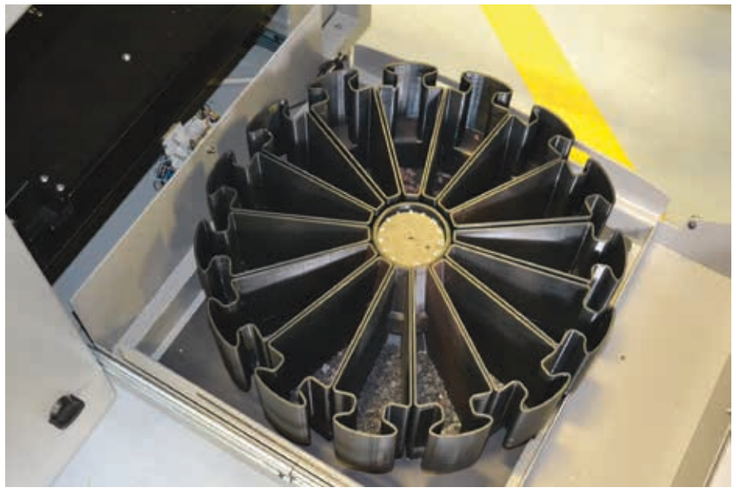
He emphasises that plants want to audit not only the density profile of the run-of-mine material entering the plant, but they also want to audit the material on the output side, to check that the plant is performing to expectations in terms of separating valuable from non-valuable components.

The RhoVol machine also has an optional sorting functionality, accommodated by ten bins at the base of the unit into which particles are sorted according to density or shape, making them conveniently available for chemical or other analysis.

There is even scope to raise the resolution of the 3D models that RhoVol creates. While seven cameras capture the image of each particle when the particle passes through the machine, there is a multi-pass 'match and merge' facility for cases where a particularly high quality result is required. This gives even more accuracy about the particle's characteristics. For this higher fidelity result, material can be recycled and re-photographed to gain greater resolution. The machine recognises and 'matches' the particle, and then 'merges' the new information with the existing dataset – essentially creating another seven views each time the particle is re-cycled. This can be done up to five times, delivering a very high accuracy volume measurement.



Following mass measurement, each particle is dropped into space where seven cameras capture silhouettes, which are processed to accurately determine volume and shape.



Depending on the real time measurements of each particle, particles are sorted into bins of similar densities.

"The first pass therefore gives a seven-view, the second pass a 14-view, the third pass a 21-view, and so on – with each view adding to the resolution of the 3D model," says High. "While multiple passes can be conducted, the real benefit is obtained by the end of the third pass, after which the law of diminishing returns applies," he concludes. ❑

Cutting edge R&D, studies and consulting

DebTech develops value-adding technology to the De Beers family of companies in the areas of diamond exploration, mining and ore treatment, taking innovations from concept stage through to commercialisation, supply and customer support. It also makes selected technology available to broader markets.

It also offers ore dressing studies (ODS) and technical consulting through its Metallurgical Services division; while ODS provides input to capital projects – delivering optimal conceptual flow sheets prior to engineering – the consulting services include metallurgical plant assessments, operational troubleshooting and equipment evaluation. ❑