Density Tracers for Coal
(low RD range) applications

COAL Non-RFID Density Tracers

To monitor the performances of DMCs and other density separators

Compliant with
Australian Standard AS5213: 2019
ISO Standard ISO5146:2022

- Added to and retrieved from the circuit manually
- Bright pink to assist retrieval
- 51 densities at 32mm and 64mm

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RDs	Tolerance
1.26, 1.28	100% ±0.006
1.30, 1.31, 1.32 … 1.59, 1.60	100% ±0.006
1.62, 1.64, 1.66, 1.68, 1.70	100% ±0.011
1.72, 1.74, 1.76, 1.78, 1.80	100% ±0.011
1.82, 1.84, 1.86, 1.88, 1.90	100% ±0.011
1.95, 2.00, 2.10	100% ±0.011

Density tracers with densities spanning the range of interest are added to the circuit feed and are manually retrieved from the product and rejects streams. They are bright pink to facilitate retrieval. For statistical confidence, at least 30 tracers are used for each selected density.

After retrieval they are sorted into their various densities, and the resulting data are used to plot a partition curve (AS5213:2019 and ISO5146:2022). The form of the curve can indicate whether the metallurgist should take actions such as adjust medium density, replace a worn circuit component, or correct an overload or medium instability situation.

Procedure

The following procedures focus on Dense Medium Cyclone circuits but are adaptable to other units.
For a DMC circuit which has not previously been tested in this way:

1. Select appropriate sizes of density tracers, ensuring they can be retrieved
2. Determine appropriate tracer densities to be employed
3. Determine the number of tracers to be used at each density interval
4. Assemble the required personnel and conduct the test
5. Interpret the partition curves and assess the data

Select appropriate sizes of density tracers

To ensure relevance of the data to be generated, it is strongly recommended that tests be conducted with feed on. Retrieval rates commonly approach 100%, but reliable partition curves can be generated with retrieval rates as low as 70% (Wood, 2004).
It is usually feasible to employ only one size of tracer, which must be large enough to be reliably seen in the load on drain-and-rinse screens. For installations with a feed topsize in the 20-70mm range, 32mm tracers are most often used. For circuits with smaller feed, it is sometimes possible to use 16mm tracers. At least one person must be positioned to retrieve tracers from each drain-and-rinse screen in the circuit, for the duration of the test.

Determine appropriate tracer densities to be employed

Density tracers in the RD range 1.30 to 1.60 are available at density intervals of 0.01 g/cc (1.30, 1.31, 1.32 etc.). For densities below 1.30 or above 1.80, larger intervals are used. Under common operating conditions, the separation density for a coal-washing dense medium cyclone is typically around 0.1 RD units higher than the feed medium density. In cases where the expected cutpoint is in a region of low “near-gravity” material; for example, greater than 1.60 g/cc, adequate definition of the partition curve can be obtained using the larger 0.02 RD intervals.
One may conduct a "sighting" test with small numbers of tracers at densities from say 0.1 RD units below the feed medium density to 0.3 RD units above the feed medium density. For example, if the feed medium density were 1.40, three tracers at each of the densities 1.30, 1.32, 1.34, ...1.68, 1.70 may be used - a total of 63 tracers. The results of this test provide an improved estimate of separation density or definition of a density range of particle retention (refer following notes on interpretation of partition curves).
If tracers larger than the feed topsize are employed, this test will also show whether they will pass freely through any unusual sieve-bend feed chute and skirt arrangements. If there is little or no retention, the full test should use tracers spanning a density range of approximately 0.3 RD units, centred on the estimated separation density. For example, if the separation density estimate from the "sighting" test is 1.52 RD units, tracers of densities 1.37, 1.38, 1.39 ..... 1.66, 1.67 may be used.
After further experience with the circuit, it may be possible to reduce the range to less than 0.2 RD units, but still have confidence that the entire partition curve (partition numbers from 0 to 100) will be defined. For circuits with separation densities higher than 1.40, if there is any evidence of a low-density "tail" (Figure 3 in the "Interpretation Section" which follows) to the partition curve, it is desirable to include tracers of a density close to that of clean coal - say 1.30.

Determine the number of tracers to be used at each density interval

In coal operations it is common to use 30 tracers at each selected density. Thus, for a test using 20 densities, the total number of tracers inserted would be 600. To allow manual retrieval, the tracers should be mixed, to allow insertion in random density order, over a period of about 20 minutes. The test would provide no direct information about behavior of smaller particles.

In coal operations with unstable medium, it is not uncommon for large tracers of densities close to the cutpoint to be retained in a dense medium cyclone for periods of an hour or more (see below). If prior experience of a circuit suggests that more than 50% of tracers in some densities may be retained, one may consider using only about 3 tracers at each density. This is sufficient to define a range of retention, and little information of value would be generated by using more tracers.
If separation is efficient, partitioning of particles sized 16mm and larger is very efficient and the curves will likely be indistinguishable. If 16mm tracers are used, there is little point in testing with larger tracers unless the ore contains particles substantially larger than 16mm and small numbers of larger tracers are used to check for retention.

Conduct of the Test

After conducting any preliminary observations such as determinations of the densities of feed, overflow and underflow media, drop the selected tracers into the circuit feed, typically into a deslime screen oversize launder. They should be added at a rate suitable for manual retrieval, around one tracer every two-three seconds.
Five minutes after addition of the last tracer, appearances of tracers on the drain-and-rinse screens will be few and far between, and collection may be terminated. Any tracers not retrieved are considered as lost or retained in the separator. The collected tracers may be rinsed, then sorted by density for counting.
In cases where products from individual cyclones in a module are drained on separate screens, it can be helpful to separately record the tracers which report to those screens. Enter the numbers in the floats and sinks columns of appropriate test sheets.

Interpretation of DMC Partition Curves

These figures illustrate the common forms of density tracer partition curves for dense medium cyclones treating coal. A module of one or more well-operated and well maintained dense medium cyclones should show an efficient separation (Figure 1). By contrast with conventional float/sink techniques, density tracers provide the resolution which shows that large particles can be partitioned with an Ep of less than 0.01 RD units.

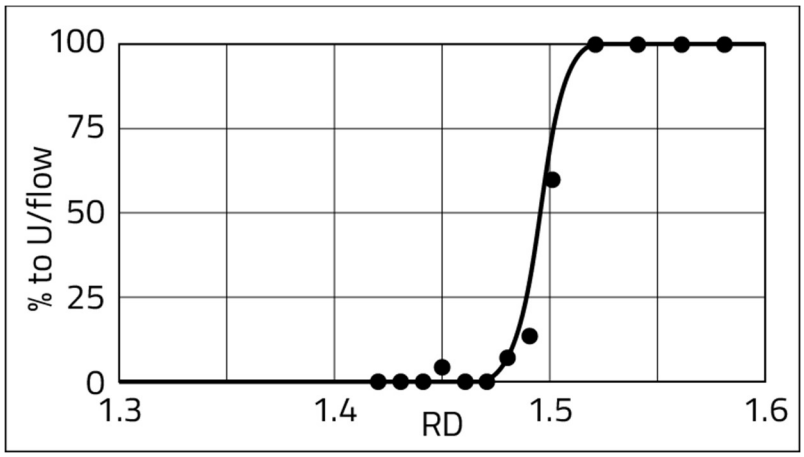

Fig. 1 Normal (efficient) Partition Curve

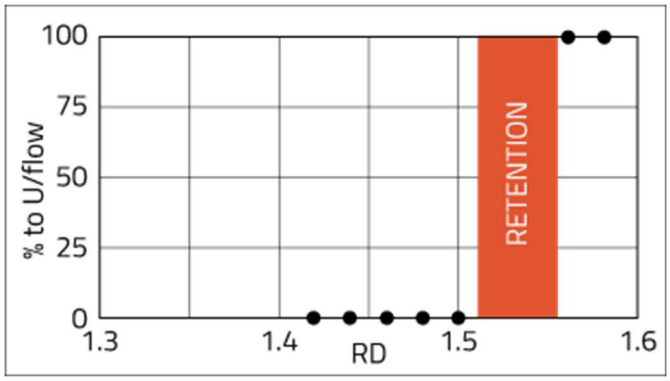

Fig. 2 Particle Retention

A small-to-moderate range of retention shows efficient partitioning, but there is a danger that a small change in operating conditions may increase the density range of retention. The cyclones then may rapidly become choked with "near-density" material and frequently clear themselves by ejecting surges of slurry, including low-density coal, to underflow (Fig. 3). Retention is rare for particles (coal or tracers) smaller than about 20mm.

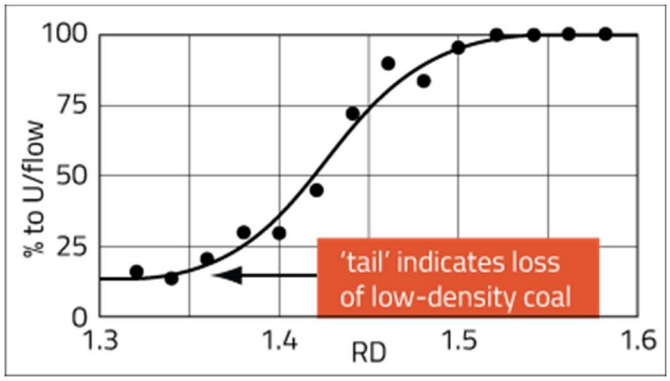

Fig. 3 Surging or Vortex Finder Overload

A large Ep, a low-density 'tail' and a low (sometimes negative) offset between feed medium density and cutpoint may arise from surging (see above) or from vortex finder overload when the medium flow from the vortex finder is insufficient to carry out all the particles which should report to the low-density product. As with surging, the yield loss can be very significant.

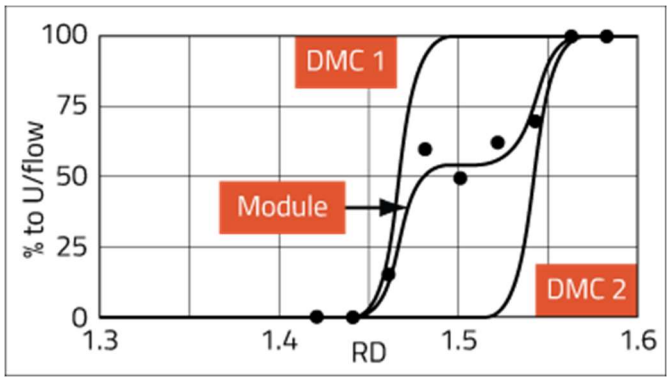

Fig. 4 Separators with Differing Cut Points

A partition curve with a plateau is indicative of differing cutpoints between separators operating in parallel. Examination of the data for individual product screens may suggest which units are separating at high, and which at low cut point.

Means for the correction of these separating inefficiencies may be found in the references listed or by contacting Partition Enterprises Pty Ltd.

References

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