

TRACER TECHNOLOGY



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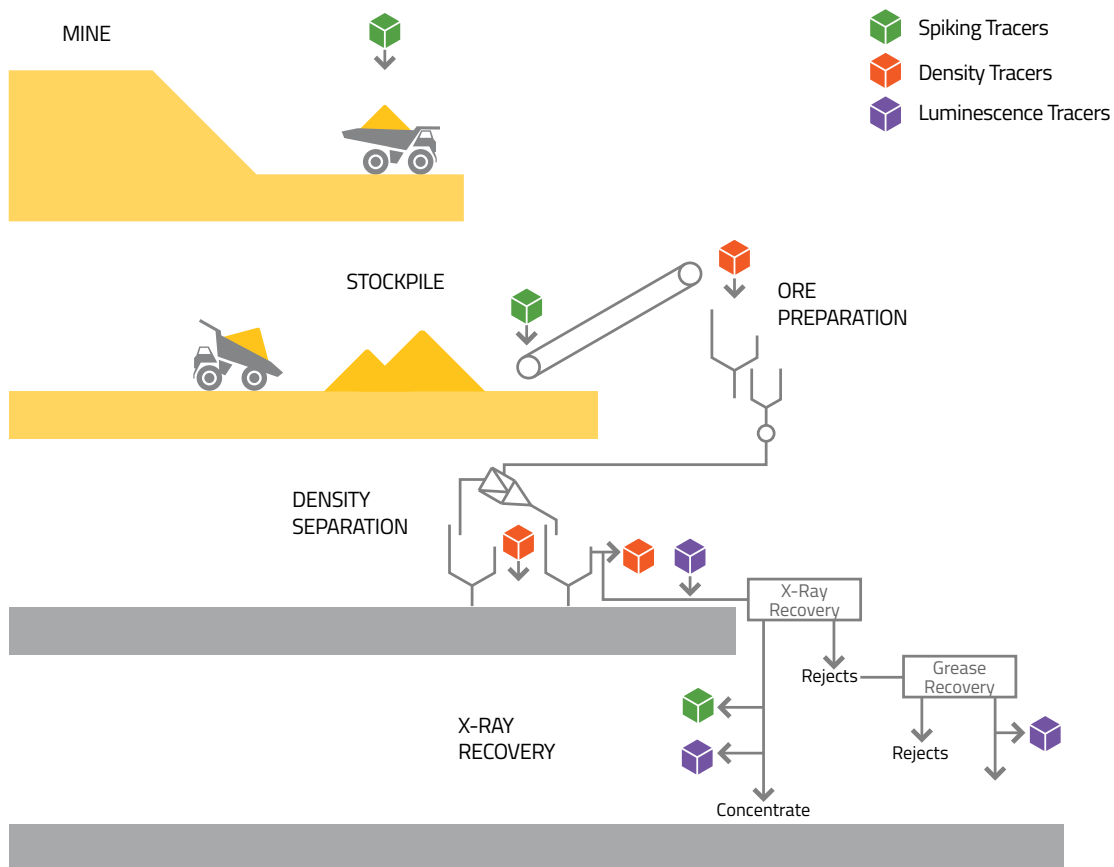
WHY USE TRACERS?

Tracer Technology

Tracer testing is a tool used by metallurgists in optimizing circuit performance to maximize profits. They are used in circuits which separate the valuable mineral from the gangue or waste by virtue of differences in particle densities. Process circuits commonly utilize dense medium drums, dense medium cyclones, jigs or pans. The objective is usually to strike an appropriate compromise between:

- minimising losses of valuable mineral to rejects
- minimising the contamination of product with non-valuable material

Tracer Insertion & Collection



TYPES OF TRACERS



Density Tracers

Density Tracers are particles having precise densities to mimic the densities of particles in a plant feed stream:

- valuable minerals such as diamond (3.53 g/cc) or coal (1.25 g/cc).
- low-value gangue such as sandstone (2.3g/cc), shale (2.7g/cc), kimberlite (2.25g/cc).
- composite particles such as a piece of coal attached to some shale. The density of the particle is an indicator of the proportion of valuable mineral.

Density tracers with densities spanning the range of interest are added to the circuit feed and retrieved from the product and rejects streams, manually or with the assistance of magnets. For statistical confidence, a test may utilize some thousands of tracers in selected sizes and densities. Additional properties such as bright colour or ferromagnetism facilitate retrieval. After retrieval they are sorted into their various densities, and the resulting data are used to plot a partition curve.

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.



Spiking Tracers

Spiking Tracers mimic the density of a valuable mineral and are used in situations where the mineral particles are well liberated. Their most common application is to test for recovery of free diamonds from an alluvial deposit. They can be inserted in the ore stream anywhere between the pit and the final sorting stage. If that final sorting stage utilizes X-ray sorters, the tracers should luminesce strongly under X-rays to ensure none will be rejected at that point. Thus, if 100 spiking tracers are added to a plant feed conveyor and 90 are recovered by the sorters, one may estimate that 10 percent of diamonds are being rejected by the processing units between those points.

The metallurgist may then seek the cause of those rejections by conducting further spiking tests, with different addition points, or a density tracer test (as illustrated bottom left) to determine the partition curve.



Luminescence Index Tracers

Luminescence Index Tracers mimic diamonds in terms of density and are offered in seven luminescence levels to simulate the response to X-rays of high-luminescent and low-luminescent diamonds. Like diamonds, they should be translucent to light, so that the luminescence is a volume effect, not just a surface effect.

They are commonly passed through a sorter to provide a basis for adjusting the sensitivity of the photomultiplier tubes which detect the presence of diamonds. Those adjustments are usually made with no feed gravel passing through the sorter. It is important to also conduct tests with feed on to check for diamond losses which may result from overloading or other causes.

QUALITY ASSURANCE

Partition curves or other results derived using tracers with imprecise characteristics can lead to reduced plant performance in terms of product yield and contamination.

Partition Enterprises' reputation rests largely on its ability to demonstrate to clients that our quality control procedures are reliable.

To maintain precise control of density and other characteristics, we find it important to work with small production batches. For our standard density tracers for coal, density is accurate to 100% within +/-0.005 g/cc.

For diamond density tracers, from every production batch we test 50 tracers, each with a volume of approximately 0.5cc. If the estimated density (including experimental error) of even one of those tracers differs from the nominal by more than 0.02 g/cc, the entire batch is rejected.

To demonstrate this precision, every shipment of these tracers includes a test certificate showing each of the 50 test results for every batch in every size and density fraction. Such a test certificate for a sample order is shown below.



Partition Enterprises
DIMS Solutions

Quality Control Certification for Client XYZ
Density Tracers for Diamond Related Applications

The densities of 50 cubic tracers packed with a volume of approximately 0.5cc from each production batch are individually estimated using the "weigh-in-air/weight-in-water" technique. If, at any batch, the density of one or more tracers are more than 0.02 g/cc (cc) off range, the entire batch is rejected (and not reported here). Within each batch, tracers are processed in order of increasing density. Tracers of similar sizes from the adjacent batch are single batch.

For tracers smaller than 200 mesh the QC technique is as follows: For tracers of densities below 2 g/cc and sizes above 200 mesh, tracers having a 1.57 g/cc density is considered. Further, densities for 200 mesh are considered only. These tracers are the subject of separate quality control procedures under the name of 100 Mesh.

Current as of: 3-Mar-18

Batch #	2.70	2.70	2.90	2.95	2.70	2.70	2.90	2.95	2.70	2.70	2.90	2.95
Nominal RD	2.70	2.70	2.90	2.95	2.70	2.70	2.90	2.95	2.70	2.70	2.90	2.95
Batch #	20160922	20160218	20170817	20170123								
Lowest RD	2.6804	2.6815	2.9025	2.9387								
Highest RD	2.7077	2.7121	2.9194	2.9627								
Average RD	2.6977	2.6976	2.9088	2.9547								

1 2.6804 2.6815 2.9025 2.9387
2 2.6810 2.6823 2.9030 2.9402
3 2.6841 2.6855 2.9039 2.9443
4 2.6878 2.6881 2.9043 2.9452
5 2.6889 2.6908 2.9044 2.9491
6 2.6894 2.6917 2.9044 2.9493
7 2.6897 2.6924 2.9046 2.9494
8 2.6912 2.6925 2.9046 2.9495
9 2.6917 2.6926 2.9047 2.9500
10 2.6938 2.6928 2.9050 2.9505
11 2.6943 2.6932 2.9053 2.9510
12 2.6947 2.6935 2.9062 2.9512
13 2.6949 2.6936 2.9062 2.9513
14 2.6950 2.6938 2.9064 2.9514
15 2.6954 2.6938 2.9064 2.9528
16 2.6958 2.6939 2.9066 2.9534
17 2.6962 2.6946 2.9069 2.9534
18 2.6964 2.6946 2.9075 2.9537
19 2.6967 2.6949 2.9075 2.9546
20 2.6970 2.6955 2.9077 2.9549
21 2.6973 2.6960 2.9078 2.9550
22 2.6974 2.6962 2.9078 2.9554
23 2.6975 2.6963 2.9080 2.9555
24 2.6976 2.6966 2.9083 2.9556
25 2.6977 2.6970 2.9083 2.9557

Quality Control Certificate

SERVICEABLE LIFE OF TRACERS

Serviceable life of Tracers

Partition Enterprises density tracers contain fine solid particles in a resin matrix. The particles are thoroughly dispersed, so wear or chipping has little effect on density unless the remaining material has volume less than that of a 1mm cube. However, reduction in volume by wear or chipping causes a tracer to behave like a particle smaller than the tracer nominal size.

Furthermore, much of the wear and chipping occurs on the tracer corners, altering the fluid drag characteristics of the particle. It is therefore recommended that a tracer be discarded if its volume has fallen to less than 80% of its nominal value. Quality control requires a simple mass determination of each tracer and comparison with the relevant figure in the table below. The 80% is an arbitrary value. Unless there is substantial breakage or particle retention within a cyclone, it should allow many passes through a dense medium circuit.

Minimum Acceptable Masses (in grams) of Partition Enterprises Density Tracers

Nominal Density (g/cc)	Colour	2mm	3mm	4mm	5mm	6mm	8mm	10mm	12mm	16mm	20mm
RD 2.50	Light Pink	0.016	0.054	0.128	0.250	0.432	1.024	2.000	3.456	8.192	16.000
RD 2.60	Lilac	0.017	0.056	0.133	0.260	0.449	1.065	2.080	3.594	8.520	16.640
RD 2.65	Blue/Green	0.017	0.057	0.136	0.265	0.458	1.085	2.120	3.663	8.684	16.960
RD 2.70	Grey	0.017	0.058	0.138	0.270	0.467	1.106	2.160	3.732	8.847	17.280
RD 2.75	Dark Blue	0.018	0.059	0.141	0.275	0.475	1.126	2.200	3.802	9.011	17.600
RD 2.80	Green	0.018	0.060	0.143	0.280	0.484	1.147	2.240	3.871	9.175	17.920
RD 2.85	Apple Green	0.018	0.062	0.146	0.285	0.492	1.167	2.280	3.940	9.339	18.240
RD 2.90	Cream	0.019	0.063	0.148	0.290	0.501	1.188	2.320	4.009	9.503	18.560
RD 2.95	Light Blue	0.019	0.064	0.151	0.295	0.510	1.208	2.360	4.078	9.667	18.880
RD 3.00	Orange	0.019	0.065	0.154	0.300	0.518	1.229	2.400	4.147	9.830	19.200
RD 3.05	Lime Green	0.020	0.066	0.156	0.305	0.527	1.249	2.440	4.216	9.994	19.520
RD 3.10	Dark Pink	0.020	0.067	0.159	0.310	0.536	1.270	2.480	4.285	10.158	19.840
RD 3.15	Brown	0.020	0.068	0.161	0.315	0.544	1.290	2.520	4.355	10.322	20.160
RD 3.20	Violet	0.020	0.069	0.164	0.320	0.553	1.311	2.560	4.424	10.486	20.480
RD 3.25	Peach	0.021	0.070	0.166	0.325	0.562	1.331	2.600	4.493	10.650	20.800
RD 3.30	Yellow	0.021	0.071	0.169	0.330	0.570	1.352	2.640	4.562	10.813	21.120
RD 3.40	Black	0.022	0.073	0.174	0.340	0.588	1.393	2.720	4.700	11.141	21.760
RD 3.53	Blue	0.023	0.076	0.181	0.353	0.610	1.446	2.824	4.880	11.567	22.592