MICROTRAC MRB

PARTICLE CHARACTERIZATION

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Monitoring dust particles during the production of soft mineral granulates (a.k.a. cat litter).

Summary

Soft-mineral granulates such as clay cat litter is a dry, free-flowing bulk solid that has a size distribution ranging from a few millimeter to a few hundred micrometer and smaller. Traditionally, this material was measured by sieve analysis which can be a time-consuming process and prone to error. Replacing sieve analysis of this soft mineral material is possible with the CAMSIZER series using Dynamic Image Analysis for particle characterization. The CAMSIZER series offers excellent sieve correlation with shorter measurement, better reproducibility, and more information than traditional sieve analysis. The **CAMSIZER 3D** provides a benchtop in-lab solution, while the CAMSIZER ONLINE provides an industrial solution for measurement in the production stream. The **Retsch DustMon RD100** dust analyzer provides the dust index of the airborne dust which is critical for the cat litter industry. Both the CAMSIZER and DustMon measurements are non-destructive so the sample material can be retained or used in further testing.

Background

The performance of cat litter is measured by several related properties including particle size, ability to absorb and retain water, pH, cost, density (weight) and more. Particle size is especially important because most modern cat litter brands list a particle-size product claim right on the box: "99% dust-free" or similar. These claims provide pet-owners confidence that the product will have little-to-no amount of harmful or messy air-born dust. Some cat litter manufacturers aim to produce a litter of 90% volume between 250 µm to 2 mm and < 1 % volume of dust particles less than 250 µm [ASTM (-)60#].

Traditionally, the particle size of cat litter was measured by vibratory or rotational-tap sieve analysis. Sieve analysis is a simple and inexpensive method, but also time-consuming and prone to errors. A typical sieve analysis including prep, shaking, data collection, and clean-up can take around 10-20 minutes depending on the procedure. Many production operators can testify that sieves are susceptible to damage which broadens the mesh diameter over time, a systematic error. While other random errors can generate in sieving from operator-to-operator handling differences. Some production

managers may also desire higher resolution of data or larger sample volumes beyond what is possible on standard sieves with fixed mesh sizes. Opting for instrumentation in the lab bench or production line provides faster and simpler measurement with more reliable results than traditional sieve analysis. Online measurement can further shorten the time and frequency between sampling-to-analysis, removes human-error and increases operator safety.

To fully characterize the particle size and dust the cat litter industry uses both particle size distribution analysis and dust analysis. Due to the lightweight and low-density properties of soft mineral clay used to make litter, the dust <250 um can become air-bourn. This can be measured by dust analysis, an optical detection technique which measures airborne dust concentration as a function of time to yield a dust index. For the cat litter industry, a low-value dust index means a higher quality litter product.

Microtrac MRB's NANOTRAC product family consists of highly flexible Dynamic Light Scattering (DLS) analyzers that provide information on particle size, zeta potential, concentration, and molecular weight. Microtrac MRB is a pioneer of particle size analysis and has been developing DLS systems for over 30 years. The innovative design of the NANOTRAC series allows faster measurements with reliable technology, higher precision, and better accuracy. All of this combined into compact DLS analyzers with a revolutionary fixed optical probe. The unique probe design allows the user to choose from a wide array of measurement cells to satisfy the needs of any application. This design also allows for measurement of samples over a wide concentration range, monomodal or multimodal samples, all without prior knowledge of the particle size distribution.

Method

Clay-based cat litter sample was acquired from a grocery store for evaluation on the CAMSIZER 3D benchtop or Online for particle characterization and on the Retsch DustMon RD100 for dust index. A very dusty sample was created by milling material using mortar and pestle for comparison purposes.

CAMSIZER conditions: 40 mm stainless steel feeder, guidance sheet, nominal covered area 0.7%, 2D mode used with width $x_{c\ min}$ (shortest cord diameter) parameter (3D mode using x_{Sieve} (cord diameter) parameter also possible but not discussed in this report). Splits of the material was created using a closed-box riffle splitter (Retsch RT6.5).

Sieve analysis conditions: Retsch 8" x 2" stainless steel of ASTM mesh sizes: #8 (2.36 mm), #12 (1.7 mm), #16 (1.18 mm), #20 (0.85 mm), and PAN. The sieve stack with sample was shaken for 10 minutes.

Dust analysis conditions: 30 gram splits of sample where acquired using a closed-box riffle splitter (Retsch RT6.5). Measurement steps followed the standard dust index protocol using the Retsch DustMon RD100.

Results & Discussion

CAMSIZER measurement reproducibility and comparison to sieve analysis:
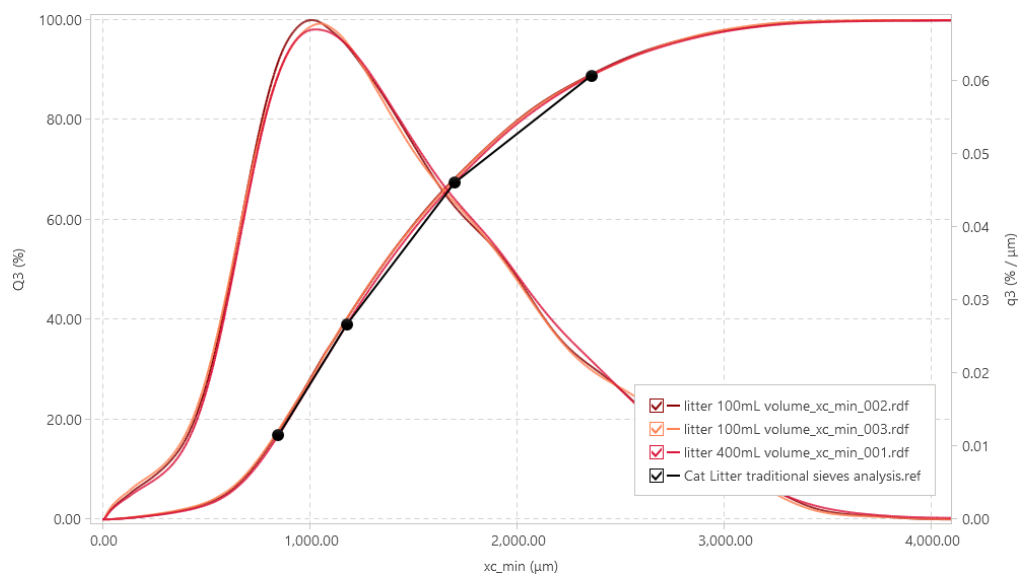
The Q3 distribution represents the cumulative % volume passing of the cat litter sample. The q3 distribution represents the frequency distribution in % / um. Multiple measurements of the CAMSIZER 3D width ($x_{c\ min}$; red curves) against traditional sieve analysis (-*-; black curve) are shown. The CAMSIZER 3D was able to collect highly reproducible results and the correlation to traditional sieve analysis was excellent.
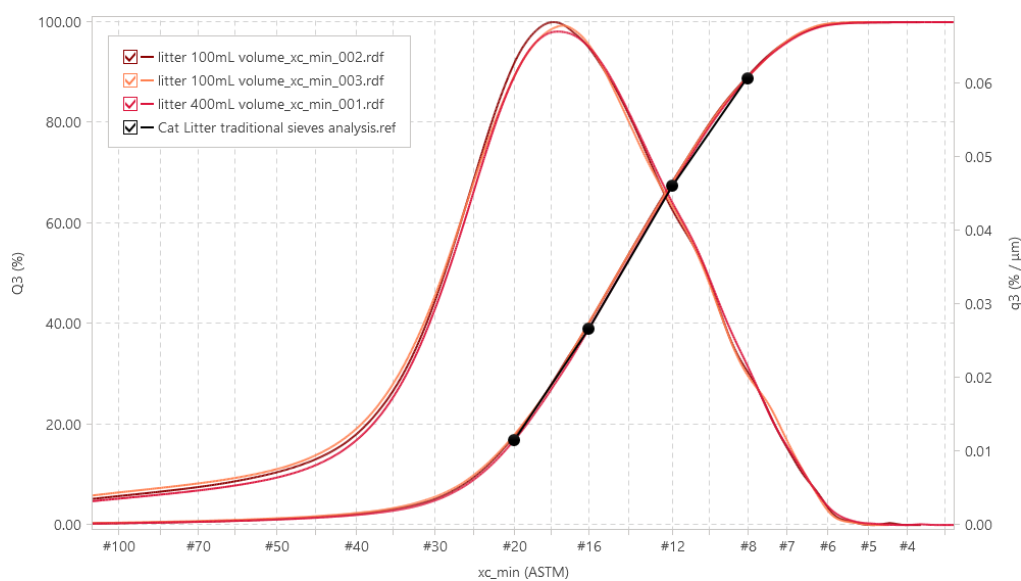
Same results as the previous graph displayed in ASTM mesh units and log scale.

CAMSIZER measurement of cat litter as received (few fines) versus cat litter doped with milled fines (more fines)

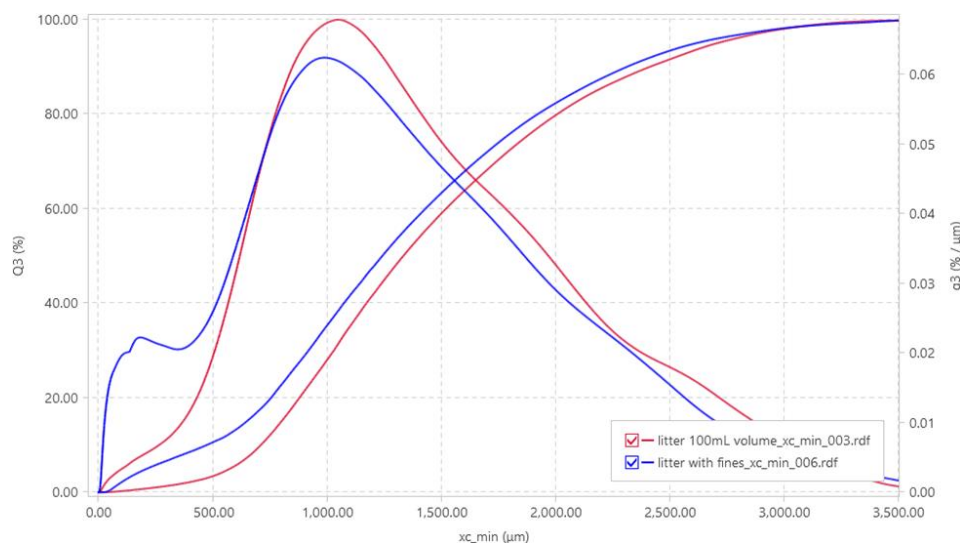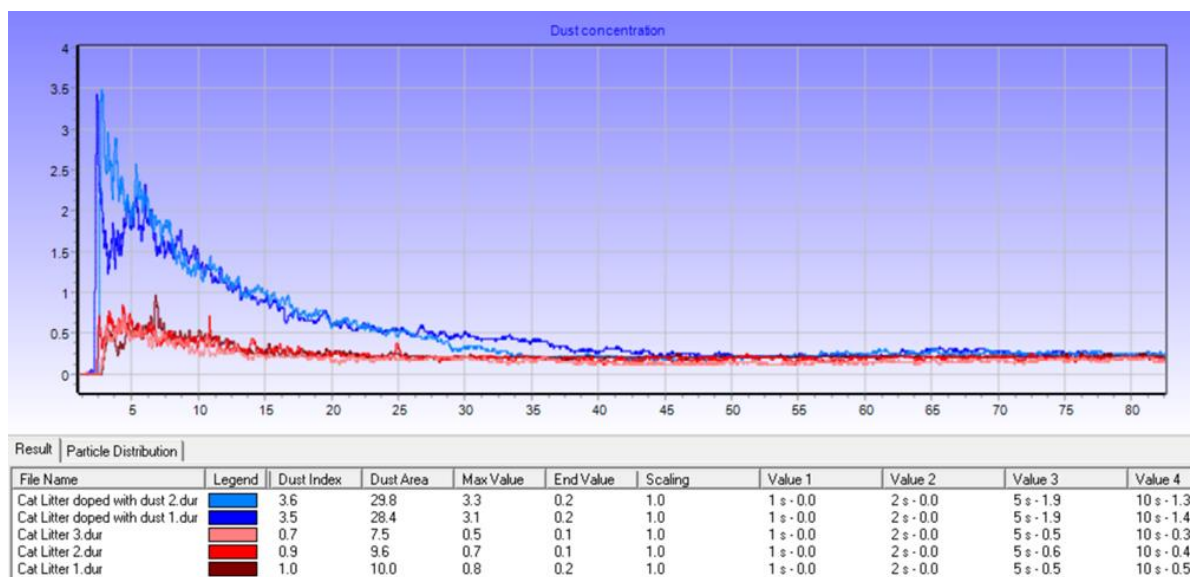Cat litter as received (**litter 100 mL volume_xc_min_03.rdf**) and cat litter doped with milled fines (**litter with fines_xc_min_006.rdf**) are compared. The Q3 distribution represents the cumulative % volume passing of the cat litter sample. The q3 distribution represents the frequency distribution in % / um. Both curves display the CAMSIZER 3D width ($x_{c\ min}$) measurement. The sample doped with milled fines shows a higher volume % of fine particles.

Data Table of Cat litter as received verse Cat litter doped with fines. The cat litter doped with fines has a higher volume of fines with 5.7% volume <250 um, while the cat litter as received has only 1% volume <250 um. The cat litter as received also as a larger volume of material within the specification of 250-2000mm range with 78.67% volume within this range.

Size class (um)		ASTM(+)	ASTM(-)	Cumulative % vol passing Q3 (%)		Aspect Ratio (b/l3)	
				Cat litter as received	Cat litter doped with fines	Cat litter as received	Cat litter doped with fines
> 2,360		> #8		100.000	100.000	0.726	0.734
1,700	2,360	#12	#8	88.935	90.927	0.708	0.715
1,180	1,700	#16	#12	68.082	71.865	0.702	0.710
850	1,180	#20	#16	40.317	46.276	0.688	0.700
	< 850	PAN	#20	17.886	25.619	0.662	0.674

Data File	Cat litter as received	Cat litter doped with fines
Duration	4 min 25 s	3 min 9 s
x(Q3 = 10 %)	713.24 µm	476.83 µm
x(Q3 = 50 %)	1,336.48 µm	1,244.51 µm
x(Q3 = 90 %)	2,414.14 µm	2,313.99 µm
Q3(250 µm)	1.00 %	5.70 %
Q3(100 µm)	0.23 %	2.02 %
Q3(50 µm)	0.04 %	0.35 %
p3(250 µm - 2,000 µm)	78.67 %	76.55 %

DustMon measurement of cat litter as received (few fines) verse cat litter doped with milled fines (more fines)

File Name	Legend	Dust Index	Dust Area	Max Value	End Value	Scaling	Value 1	Value 2	Value 3	Value 4
Cat Litter doped with dust 2.dur		3.6	29.8	3.3	0.2	1.0	1 s - 0.0	2 s - 0.0	5 s - 1.9	10 s - 1.3
Cat Litter doped with dust 1.dur		3.5	28.4	3.1	0.2	1.0	1 s - 0.0	2 s - 0.0	5 s - 1.9	10 s - 1.4
Cat Litter 3.dur		0.7	7.5	0.5	0.1	1.0	1 s - 0.0	2 s - 0.0	5 s - 0.5	10 s - 0.3
Cat Litter 2.dur		0.9	9.6	0.7	0.1	1.0	1 s - 0.0	2 s - 0.0	5 s - 0.6	10 s - 0.4
Cat Litter 1.dur		1.0	10.0	0.8	0.2	1.0	1 s - 0.0	2 s - 0.0	5 s - 0.5	10 s - 0.5

Cat litter as received (Cat litter 1 / 2 / 3.dur) and cat litter doped with milled fines (Cat Litter with dust 1 / 2.dur) are compared. The airborne dust concentration is measured as a function of measurement time. The cat litter as received has an average dust index of 0.9 and the cat litter doped with fines had an average dust index of 3.6.
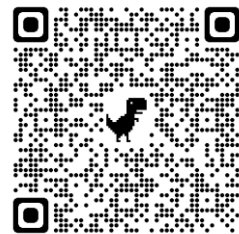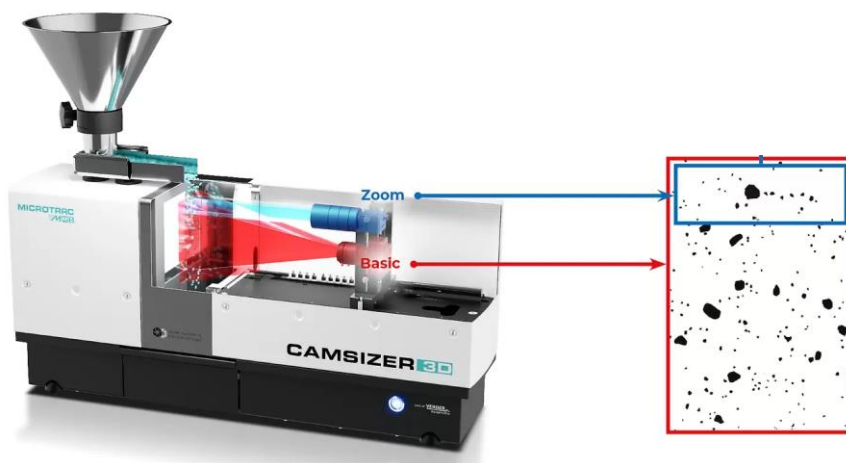
CAMSIZER 3D

The CAMSIZER 3D combines all the advantages of dynamic image analysis (ISO 13322-2) in a completely redesigned measuring system, setting new standards in the characterization of bulk solids.

Unique 3D analysis: thanks to the extended field of view and large droplet spacing, each particle is analyzed up to 20 times and in different orientations, making the actual, three-dimensional particle morphology accessible for analysis. The evaluation of the "3D tracks" also enables a much more meaningful shape analysis than ever before.

Proven 2-camera system: The new ZOOM camera in the CAMSIZER 3D (9 MPx) enables the evaluation of fine particles with high accuracy. In combination with the BASIC camera (5 MPx), this enables a large measuring range from 20 µm to 30 mm. The CAMSIZER 3D is the first choice for the analysis of dry, free-flowing bulk materials in both quality control and research applications.

- Patented 3D analysis with "Particle Tracking
- Up to 20 images of each particle
- Particle size and shape analysis from 20 µm - 30 mm without hardware adjustment
- Short measurement time of 2-5 minutes
- High sample throughput
- 100% detection of oversize particles
- Excellent compatibility with sieve analysis
- Excellent reproducibility
- Evaluation of > 250 images / s in real time (in 3D mode)
- Powerful, long-life LED light source
- Maintenance free

More information about CAMSIZER 3D: click or scan the code!

CAMSIZER 3D with ZOOM camera (blue) and BASIC camera (red).

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More information about DustMon: click or scan the code!

The DustMon RD 100 was designed to reliably measure the dustiness of granular products and powders and to determine the dust index.

The Dustmon RD 100 is an ideal system to measure the amount of dust and determine the dust index. This compact benchtop analyzer provides real-time analyses with high reproducibility and stability. The analysis method complies with CIPAC MT 171.

Dustmon can be used as a stand-alone device or can be connected to a computer and controlled with the Retsch measurement and analysis software available in different languages.

BENEFITS AT A GLANCE

- User-friendly interface with integrated display if used as stand-alone device
- Easy measurement setup and full data control when using the software: measurement data are saved, comparison of up to 10 different dust curves
- High accuracy due to adjustable measurement time
- Fast and reproducible determination of dust index, e. g. in 30 sec, thanks to 1000 measurements per second
- High reproducibility thanks to large measurement area of the white light source
- Simple user interface with integrated display
- Analysis complies with CIPAC MT 171 method

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