Mining: Analysis of Dry Solids

Particle Size, Shape, Spec and Color of Dry Solids in the Lab

The Application of Dynamic Imaging to Measure Particle Size Shape, Spec, and Color of Dry Solids in the Lab

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Quality control of final product is vital to deliver repeatable product each and every time to customers that meets their desires and needs. This is especially true for the mining industries when customers can range widely from jewelers looking for the best gem stones to the glass industry looking for repeatable batch material and everything in between. Product specifications that exist for particle size distribution, product color, number of specs present in the powder, and particle shape. Manual methods exist to measure all Specifications, but due to the ever growing cost of manual labor, dwindling experience in the work force, along with the ever growing number of samples desired to be run, automated methods have become the preference of many lab. This paper explores the application of CANTY's solidsizer, a dynamic imaging technology, to automate, improve repeatability, and remove sources of human error of existing manual test methods used to detect particle size, shape, spec, and color

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Introduction

Dynamic imaging involves passing material through an analyzer that takes microscopic images of the particles in the material as it passes through the analyzer. A specific type of dynamic Imaging analyzers exist that are designed to analyzer powders. During the image analysis of the particles in the powder the size, shape and color of the particles can be measured for each and every particle that is falls in the field of view of the microscopic camera while it is capturing images.

Well defined product specifications exist for the size, shape, color, and number of specs for each grade of product. From the image analysis of many particles in a sample, all of these parameters can be measured, output, and stored in a laboratory information management system. Once output and stored, the measured parameters of the samples can be compared to the specifications and a determination can be made if the sample that was tested meets the specifications. If the sample meets the specifications, then it may be sent to customers. If it does not then it must be reprocessed until it meets the specifications which allow it to be shipped to the consumer.

In addition to allowing product to be shipped by performing final product inspection, testing may also be performed on the product currently being produced to ensure that it is within specification coming from particle size reduction equipment such as a mill or crusher.. In mining, many product specifications including color, particle size, and particle shape are checked on an hourly basis to ensure the product being produced is within specification to allow for the process to be optimized if needed as well as minimizing the amount of out of specification product from being produced that would need to be reprocessed in order to met the specification.

Overview of Dry Powder/Rock Analysis

Historically manual testing has been conducted to measure parameters of dry mining solids in order to determine if it meets the specifications to ensure what is delivered to customers is what they need and desire each and every time. Some tests that have been performed manually determine the size of the particles, the shape of the particles, the color of the particles, and the number of specs in the particles.

In order to determine the size of the solids, sieves are often used to measure the amount of solids that are retained on each screen. To perform this test, an operator adds solids to a set of pre specified screens. These screens are then shaken to allow particles to fall through openings in the screens that are larger that the size of the particles. Eventually the particles reach a screen where the mesh opening size is smaller than the particles or it reaches the bottom of the stack where a solid metal pan is located. Once it reaches a location on the stack of screen where it can no longer fall through it is retained on those on that screen or the pan. Devices to shake the screens are very loud and most procedures requires the shake time to be between 10 and 15 minutes. After shaking, an operator measures the weight of solids that is retained on each screen and the pan recording the weights in order to determine the particle size distribution. Once the test results are recorded, the operator must clean the screen before performing another test which is very labor intensive and time consuming. To determine the shape of the sugar, a manual microscope is used where is a slide is prepared to look at the particles. The shape of the particles can be used to determine how the particle size reduction (mill, grinder, crusher) is performing where odd shaped particles and a wide distribution of shapes typically denoted wear with the particle size reduction equipment.

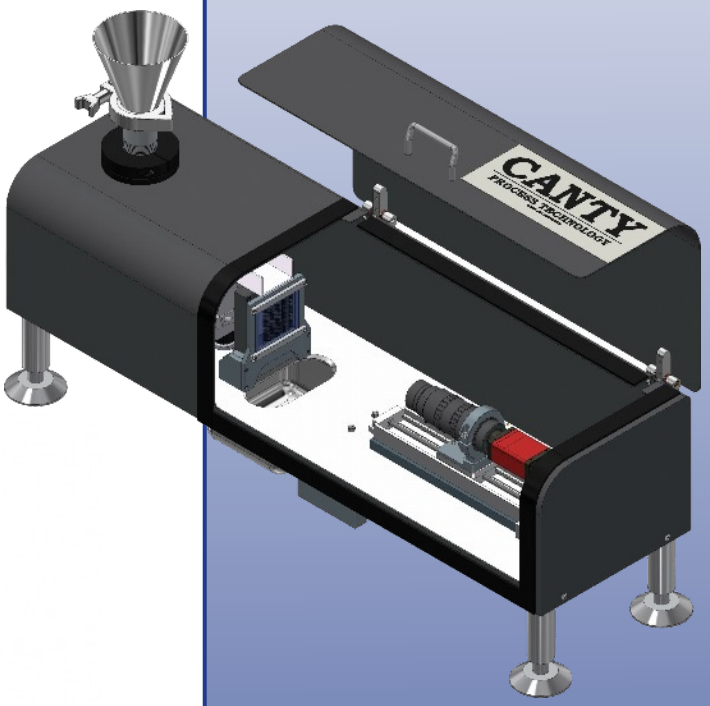
In some situations, the powder is expected to be a uniform color such as white for pot ash. Using pot as as and example it is expected to be free of colored or black specs as specs are often contamination. To determine the number of specs in a given amount of pot ash is poured into a large tray and an operator manually counts the number of specs present. Similarly for gem stones or abrasives, the distribution of colors is highly specified and operators typically manual inspect given number of particle to ensure the desired color distribution is within specifications.

Using dynamic imaging, the CANTY solidsizer, can measure particle size, shape, color distribution , and number of specs at the same time automatically. As such, it reduces the labor cost, increases repeatability, and increases the number of tests that can be

Solidsizer Hardware

CANTY laboratory systems, such as the solidsizer come in a modular design with many key components. One such key component is the analyzer itself. The major sub components of the analyzer there are:

- Funnel for sample loading
- Vibratory feeder for sample presentation
- High resolution optics on an auto focusing stage for image analysis

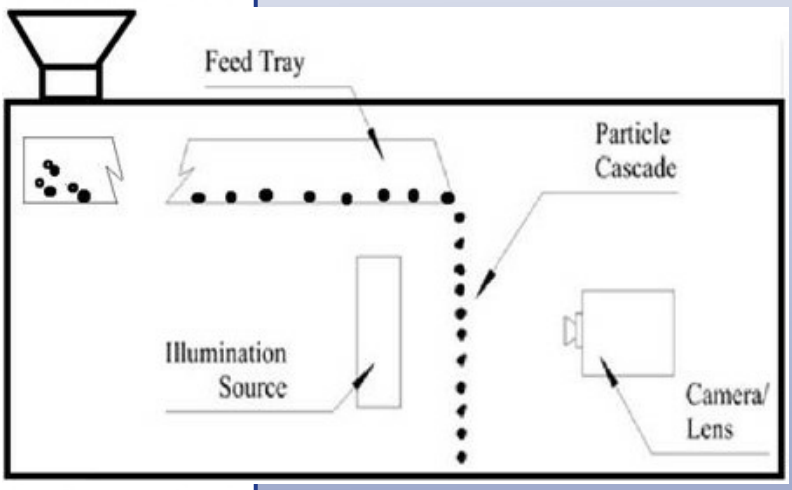


Powering and controlling the analyzer is the core unit. Ideally constructed for lab environments, the core unit contains uniquely pinned electrical connections such that the few provided cables that run between the core unit and the solidsizer can only be connected one way allowing for easy assembly.

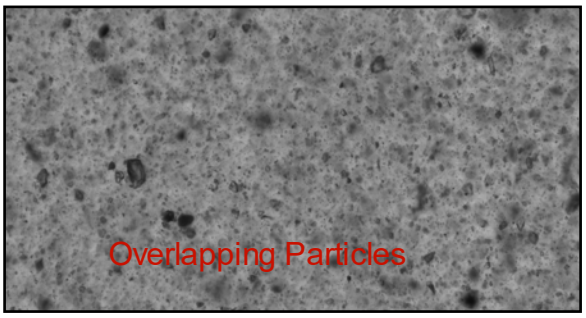
Seated on top of the core unit is the vector control module (VCM). The VCM platform is a series of powerful processors that host the CantyVision software. These machines are configured with the analyzers at the Canty factory prior to shipping to make obtaining an image plug-and-play out of the box. In an age of remote connections, the VCM's have the ability for users to allow Canty personnel to remotely access the unit to provide support and help troubleshoot the analyzers. Easily mounted into a specifically designed slot on the core unit a monitor is connected to the VCM for local display of CantyVision software. The data generated is stored locally on the VCM and can also be output to a laboratory

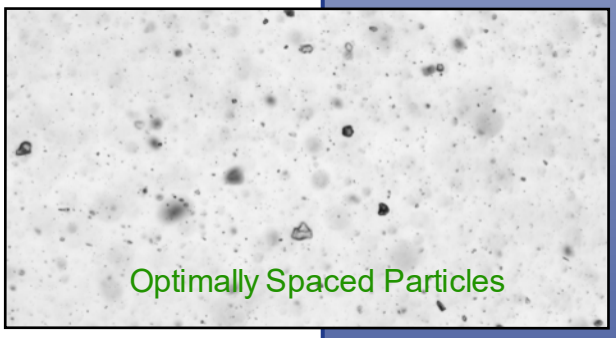
How Dry Powder Dynamic Imaging Works

By using a vibratory feed tray to automatically pass a particle cascade between an illumination source and camera, 2D images of the crystals can be captured and measured for particle size, shape, and color data.

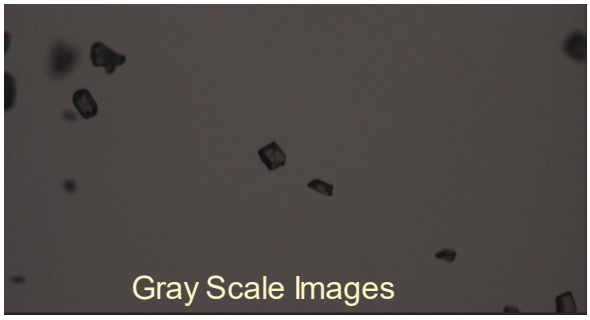


Given that the speed of the feeder can be controlled based on the number of particles seen on the image, overlapping particles on the image can be avoided allowing each particle to be independently measured for particle size, shape, and color while also allowing analysis to occurring as quickly as possible.



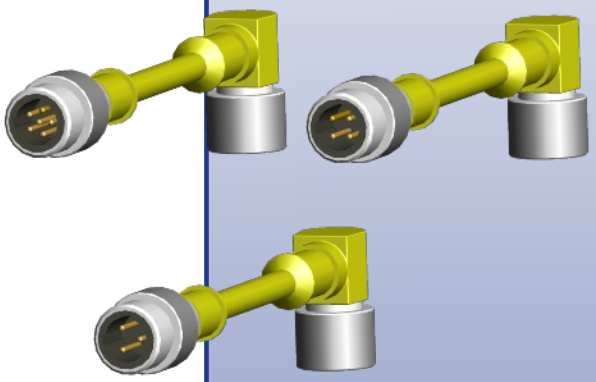


Using only a back light allows for a grayscale images to be obtained. Using a front allows a color image to be obtained where specs and the color distribution of the sample can be measured.



Connectivity

Once the Core unit and solidsizer are setup on a lab bench connecting them is simple. On the core unit and solidsizer are unique pinned receptacles which only allow them to be connected one way with the provided cables allowing for easy straight forward wiring.



The Ethernet connections on the core unit and analyzer are connected to the VCM in the labeled Ethernet ports.

Connecting the USB connection from the solidsizer (for the automatic focus adjustment) to any USB port on the VCM as well as connecting the USB dongle for the keyboard and mouse is super easy.

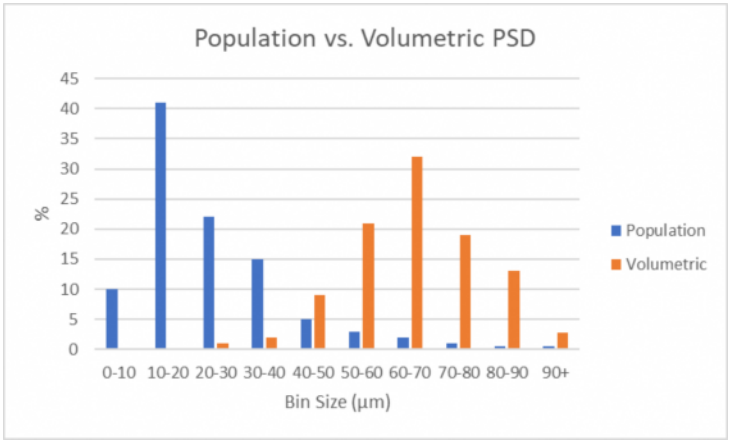
The monitor comes pre wired from Canty's factory with the display cable and power cable wired through the mounting pole that easily slide into the core unit. Therefore simply connecting the display cable to the VCM will allow for the CantyVision Software to be displayed on the monitor. Lastly, connecting the core unit and monitor to a standard wall outlet powers the system allowing for samples to be analyzed right away with data storing locally on the VCM.

If desired the VCM can be connected via ethernet to the customer's network to allow for the data to be store into a laboratory information management system.

Data Outputs For Dry Solid Analysis

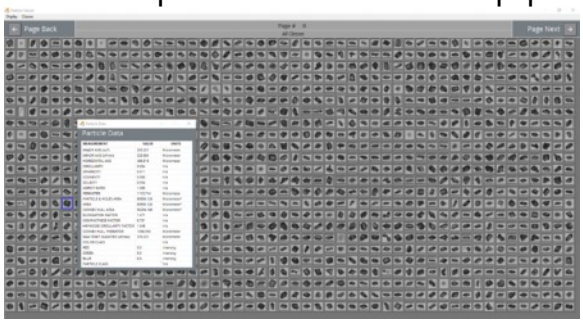
The data output from the solidsizer is automatically stored locally on the VCM and if the VCM is connected to the end user's network the sample data can be uploaded to a laboratory information management system. The data output is as follows:

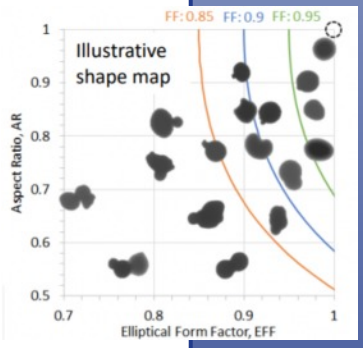
Particle Size Distribution: The analyzer can output the size distribution of the particles analyzed as a volumetric distribution, population distribution, percentiles of either cumulative distribution (Dv50, Dv100, Dn 10, etc) or a correlation to a distribution from a set of sieves. When correlated to sieves the distribution can be reports as a percent retained curve, percent passing curve, or a volume percent on each virtual screen.



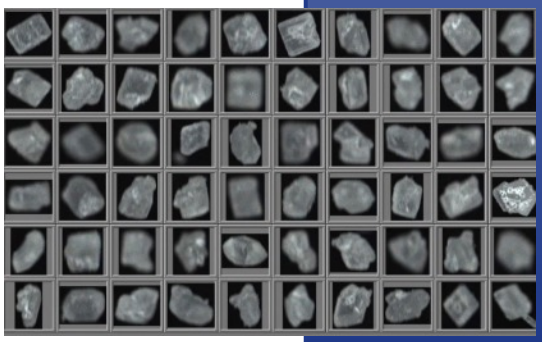
Mesh Size	% Retained		Difference
	Sieve	Dynamic Imaging (D.I.)	(Sieve-D.I)
20	3.3	3.7	-0.4
30	7.2	6.7	0.5
35	14.7	12.3	2.4
40	13.1	13.4	-0.3
50	24.1	25.9	-1.8
60	11.3	11.3	0
70	8.5	8.8	-0.3
80	7.8	7.5	0.3
100	4.3	4.4	-0.1
Pan	5.7	6	-0.3

Particle Shape Distribution: The Solidsizer analyzes over 40 different particle shape parameters parameters. Distribution of these shape parameters such as aspect ratio or sphericity and or ordered pairs of shape parameters can be output to evaluate the performance of the particle size reduction equipment.





Color: The distribution of colors or the color of the individual particles can be output. This allows for current methods determining color distribution and spec count to be replaced with one analyzer and method.



Conclusion

CANTY's SolidSizer is an effective tool for the measurement of particle size, shape, and color for dry mining solids. It's simple setup, quick run time, and automated nature makes replacing sieve particle size analysis and other lab methods for color distribution and spec count easy. This will result in higher lab throughput at a much lower cost while getting more accurate, precise, and meaningful data.

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