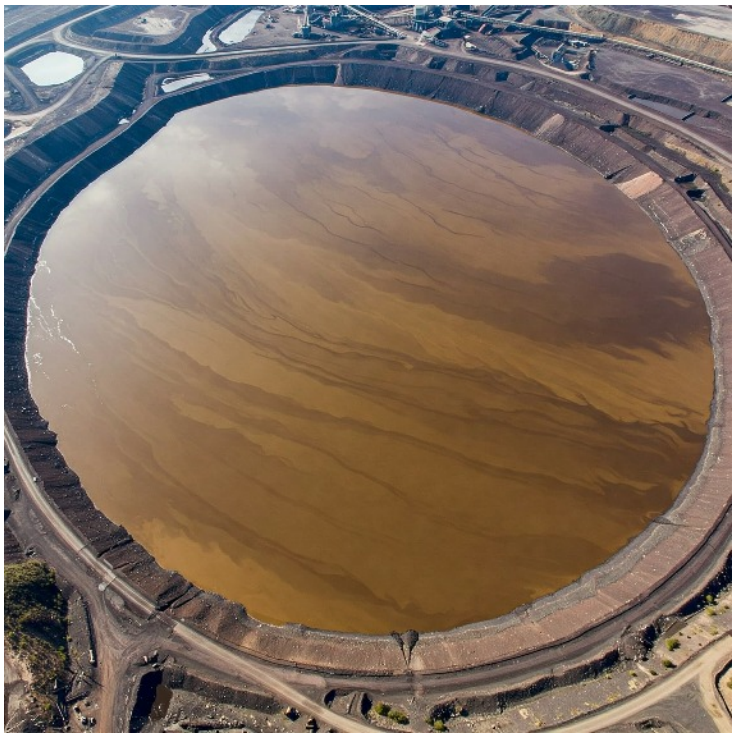
Tailings Measurement

Particle Size, Shape and Concentration of Tailings



The Application of Dynamic Imaging to Measure Tailings Particle Size, Shape and Concentration

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In mining applications there are many liquid streams with suspended solid particles in which it is important to measure the size, shape, and concentration of the suspended solids to understand and access the performance of separation equipment. For example by measuring the tailings of a flotation tank or a hydro cyclone the performance of the separation device can be accessed.

Additionally, having the measurement of the particles in real time is critical for automating the separation equipment which can lead to greatly reduced optimal cost. Lastly and potentially most important due to the hazardous nature of tailings, obtaining particle size, shape, and concentration is vital in determining the proper storage and disposal method.

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Introduction

Dynamic imaging involves flowing process material through an analyzer that takes microscopic images of the fluid and analyzes those images to detect the presence of “particles.” These particles could range from droplets to gas to solid materials. Since the acquired images are 2-dimensional and there is a physical difference in the appearance of these types of materials, dynamic imaging analyzers are capable of simultaneously detecting, sizing, and measuring concentrations of all of these materials independently from one another.

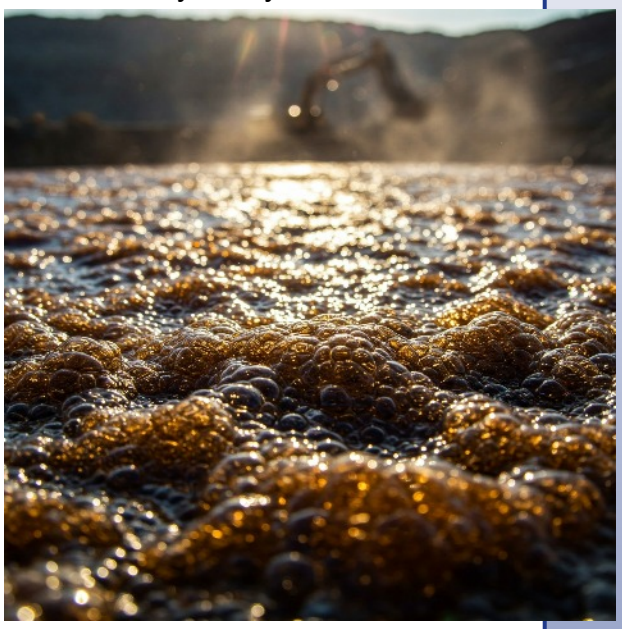
When a CANTY Inflow is installed inline where a liquid streams from the mining process is flowing, the analyzer is able to detect particles at a size of 1 micron and above. The analyzer can output a signal indicating the size, shape, and concentration of particles detected.

These outputs allow a control system to automate a response in real time which is far faster than detection via other common methods, such as checking filters for clogging or taking a sample to the lab for particle analysis by sieving.

Although suspended solids in many process streams can be measuring in the mining, a common use for dynamic imaging is for tailing because the size, shape, and concentration of the tailings can be directed related to the performance of the separation equipment allowing for the equipment to be easily optimized from this measurement. Additional because tailings can be hazardous measuring the size, shape, and concentration of the solids without sampling and testing in the lab is often preferred when determining the proper storage and disposal method for the tailings.

Overview for Tailings Measurement

During a mining process, after crushing, grinding, and milling the ore, the valuable minerals such as copper, nickel, or molybdenum are separated from the other non valuable materials through means such as floatation and or the use a hydro cyclone.

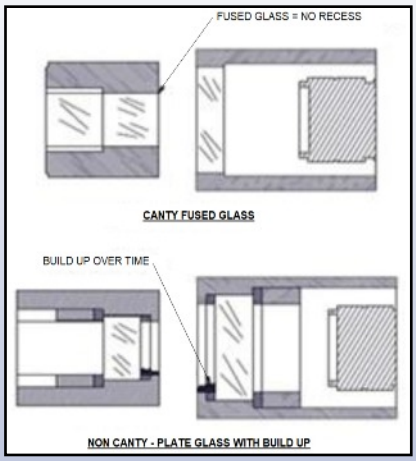


Critical measurements to determine the effectiveness of the separation and allow for automation and optimization of the separation the particle size and concentration of suspended solids in the valuable and waste (tailings) streams. By measuring the particle size and concentration of the tailings, it can be ensured that significant amounts of valuable mineral are not being discharged to waste due to improper performance due to failing or damaged equipment and/or improper operation of the equipment. Since the end products of mining operations must be very pure and are often of high value in small amounts, unnecessary waste can greatly impact the economics of the mine. Furthermore, tailings often contain hazardous materials and therefore are costly to store and dispose of adding to the cost of adding valuable product to a tailings stream.

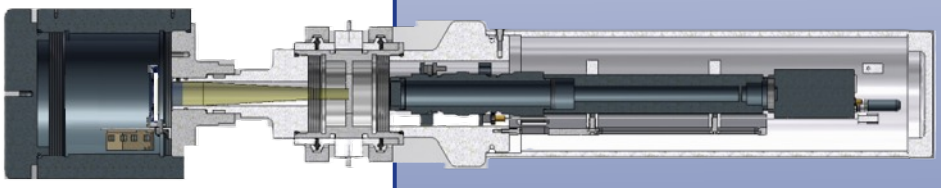
Lastly, since tailings are dangerous proper storage and disposal is critical. The particle size and concentration is paramount in determining the proper storage and disposal method. Using dynamic imaging to do determine the particle size, shape, and concentration without having to sample and run lab tests such as sieve analysis on the toxic tailings adds additional value to the dynamic imaging device.

Overview of Hardware for Tailings Measurement

The hardware involved in CANTY's Inflow includes 4 main key technologies: the flow cell, lighting, camera optics, and Vector Control Module (VCM).



The flow cell on an Inflow is designed to mount directly inline with standard sizes up to a pipe size of 3". (Note that custom units may be provided for line sizes greater than 3". Consult the factory for details). The flow cell is designed to orient particles such that the analyzer is always able to capture an image of the longest side of each particle. This is key to accurately sizing each particle seen. Critically, the flow cell seals the light and camera from the process using CANTY's fused glass technology. This fused glass barrier, unique to CANTY, can sustain extremely high temperatures and pressures while still allowing for a view into the process. Unlike with other analyzers, this fusion of metal to glass creates a hermetic seal and does not utilize gaskets or O-rings at the glass interface that the camera and light look and shine through. That smooth surface doesn't leave any crevices and makes it difficult for contaminants to stick to or build up on the surface of the glass which is extremely important for mining slurries.



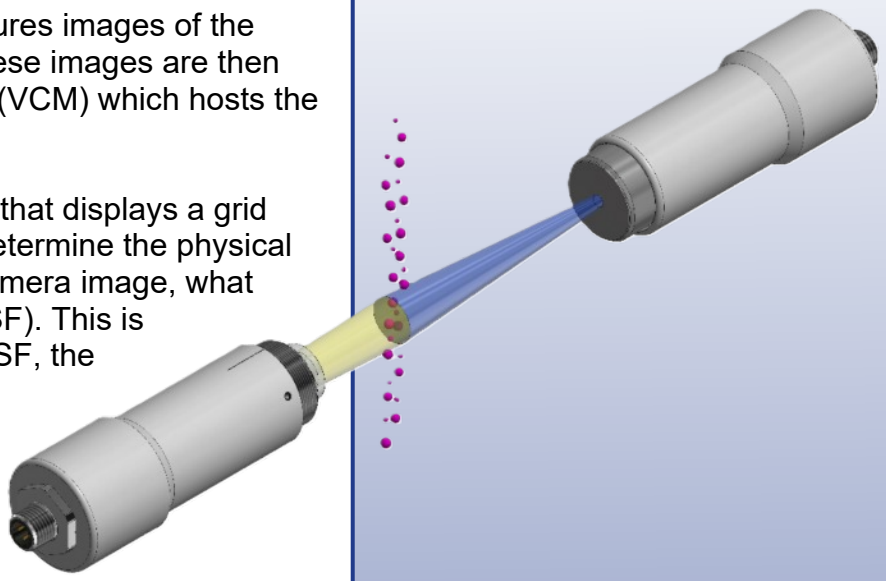
CANTY always says that there are three keys to a perfect image: lighting, lighting, and lighting. CANTY has been leading the industry and innovating in process lighting since the 1970's and applies all of that knowledge in the Inflow analyzer. The LED light used is the brightest in the industry with a guaranteed lifetime of 5 years. Unlike many other analyzers, the light in the Inflow back-lights the process, resulting in sharp, crisp images of each in-focus particle.

The camera optics used in each Inflow are high resolution gigabit Ethernet CCD's that undergo significant testing to ensure they will be robust for long-term use. Optics are always improving, so CANTY is constantly evaluating the latest and greatest cameras and lenses to provide the highest quality images without compromising on quality and reliability of the analyzer. Optics used in any given analyzer are picked according to the requirements of the application. The latest generation of optics used in the Inflow utilize a 4K resolution camera that can pick up on particles as small as 1µm.

Obtaining a high quality image of a process is only half of the battle. The magic happens when that image is processed on CANTY's VCM. The VCM platform is a series of powerful processors that host the CantyVision software. These machines are configured with the analyzers at the 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. These analyzers also provide the outputs to interface the data tags with a user's control system.

How Dynamic Imaging Works

Dynamic imaging makes use of image analysis on a video stream of microscopic images. CANTY's Inflow captures images of the process fluid and potential contaminants. These images are then transmitted back to a Vector Control Module (VCM) which hosts the software that performs the analysis.



The analyzer is calibrated by installing a tool that displays a grid pattern on the camera. This grid is used to determine the physical distance that each pixel represents on the camera image, what CANTY refers to as the pixel scale factor (PSF). This is typically reported in µm/pixel. Knowing the PSF, the 2-dimensional area of each frame can be calculated.

The lens utilized in an Inflow has a known depth of field (DOF). The DOF is a measurement of the depth in which subjects, such as the particles in a fluid, are in focus. This now allows CANTY to measure the volume of each image taken in which particles are in focus.

On each image, the CantyVision software determines what might be a "particle" from what is the background fluid. At this stage, the "particle" could be anything - a solid, droplet, or bubble. After finding something that could be a particle, the software next makes a measurement that grades whether or not the particle is in focus. If it is in focus, then this particle is within the depth of field of the lens used. That means it should be included in the analysis. If a particle is not in focus, it is disregarded.

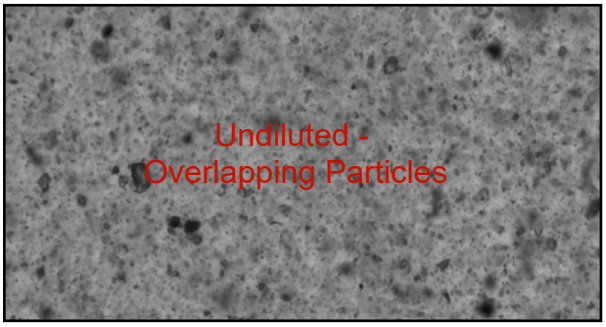
Each type of particle, solids, droplets, and bubbles, look morphologically different from one another. These differences are captured, numerically, in the various shape factors measured. The software is trained via AI to recognize the trends in these shape factors belonging to each type of particle. This is key because it allows CANTY to distinguish between different kinds of particles that were captured in the same analysis and quantify measurements for each class of particle differently. This is critical for tailings measurements, because the stream is a mixture of droplets (often times left over chemicals from the mining, particle size reduction, and separation), gas bubbles, and suspended solids. 1 dimensional particle sizing techniques measures all types of particles together and therefore are greatly affected by the gas bubbles and liquid droplets that are present when outputting the size and concentration of what is often marketed to be just the suspended solids. Dynamic imaging can output all the size, shape, and concentration of all classes measured independent of one another.

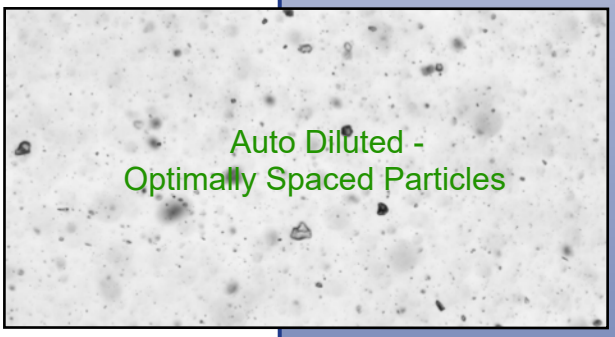
How Dynamic Imaging Works Cont.

After a particle has been sorted into its correct class, the software calculates a volume of that particle based on its class. Since we already have the volume of each image being analyzed, the concentration of any given class of particle can now be calculated on a volumetric basis and can be converted into a mass concentration using the bulk density of the particle class in question.

By averaging over hundreds of images, the Inflow is able to provide a representative concentration and particle size distribution for each particle class analyzed. Additionally, if there is ever skepticism about the reading, the images from the analyzer can be viewed live and/or saved as a recording for reference.

Lastly, when a process is too highly concentrated, particles begin to overlap. This overlap can make it impossible to distinguish where individual particles begin and end, reducing the accuracy of particle size analysis. To combat this, CANTY has developed a patented Auto-Dilution System.

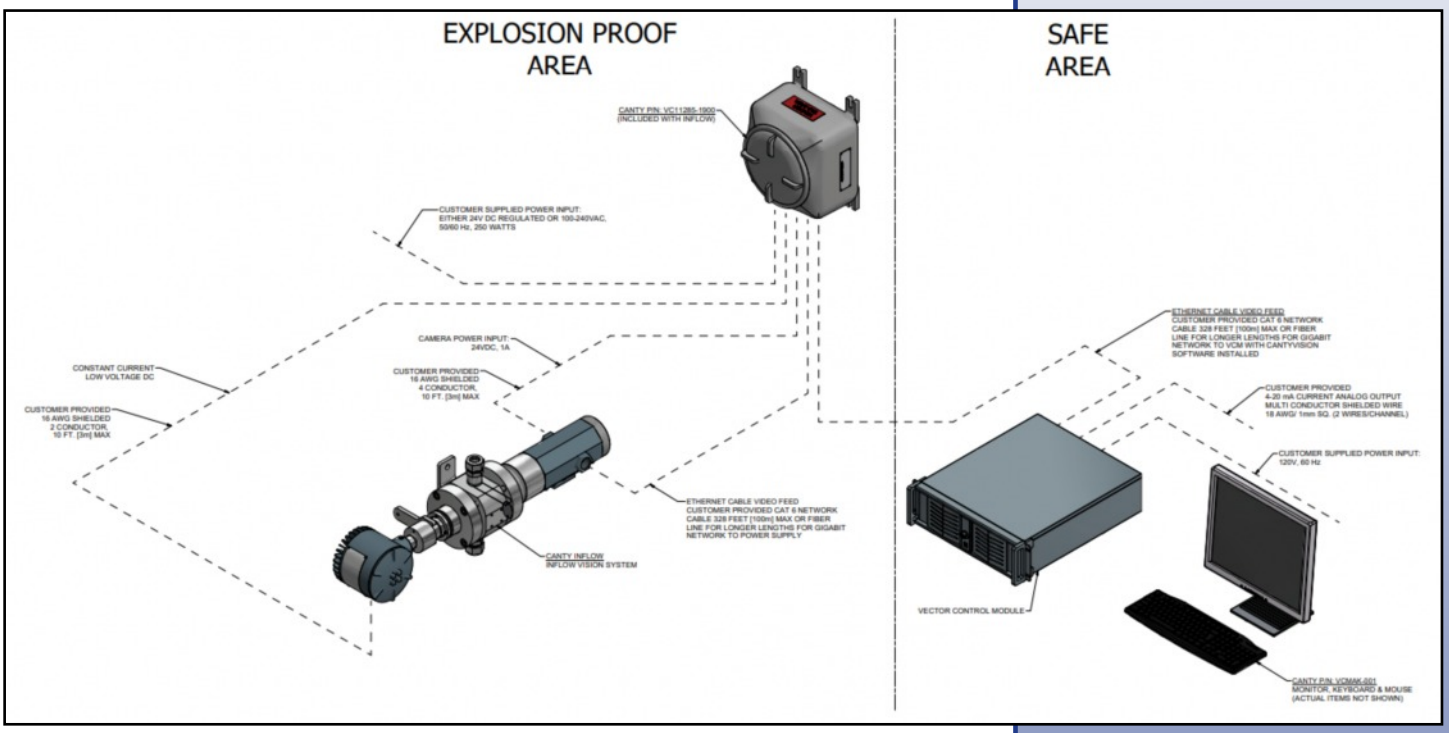




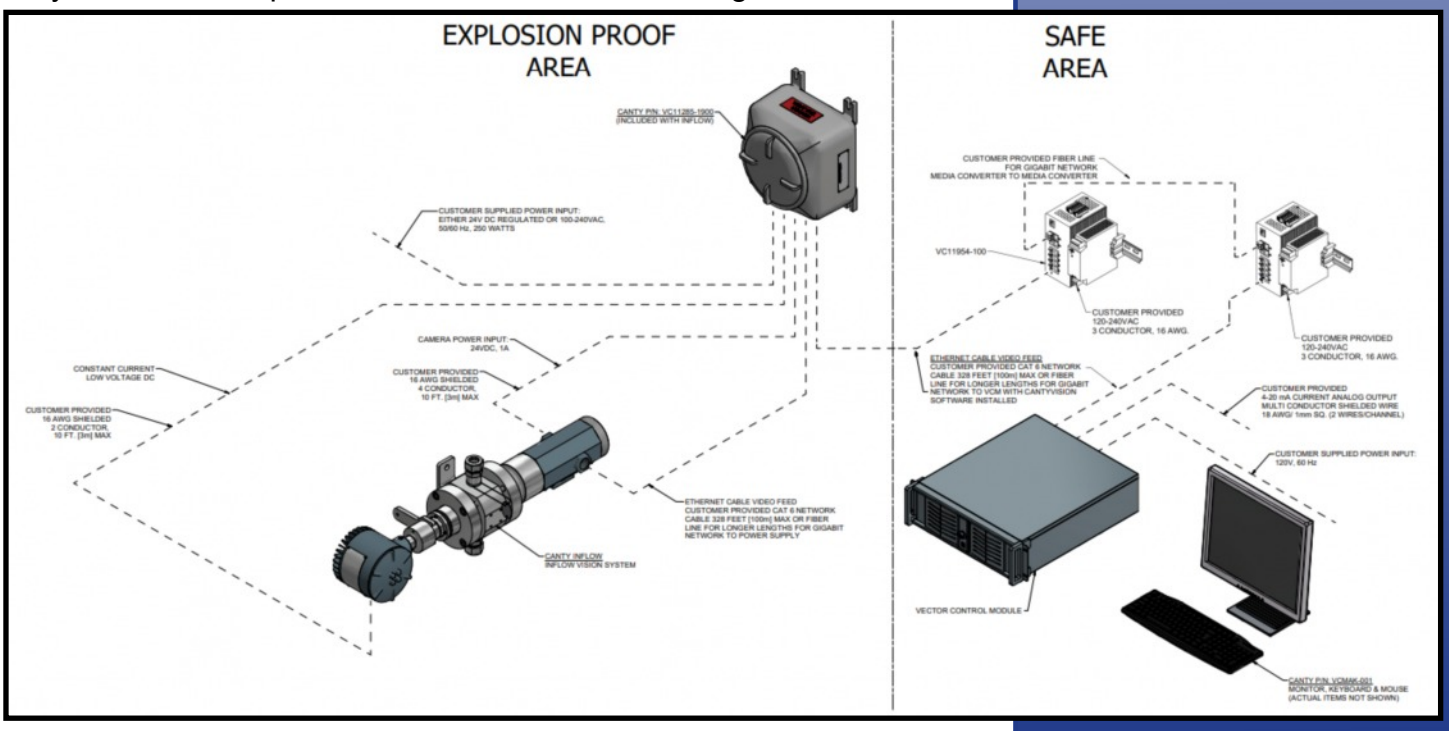
CANTY's Auto-Dilution System meters in known quantities of diluent based on the images acquired by the camera system. When there is extra space between particles, the software will lower the diluent flowrate. Conversely, if the image becomes too crowded, the software increases the diluent flowrate. By knowing the amount of dilution fluid added, if any, the concentration of particle before the auto dilution can be computed by the CantyVision Software and output to the end users control system.

Connectivity

Due to the amount of data being transmitted between the Inflow and VCM, CANTY requires the use of CAT6 Ethernet running from the analyzer to it's power supply and from it's power supply back to the VCM. A typical layout of the components can be seen here.

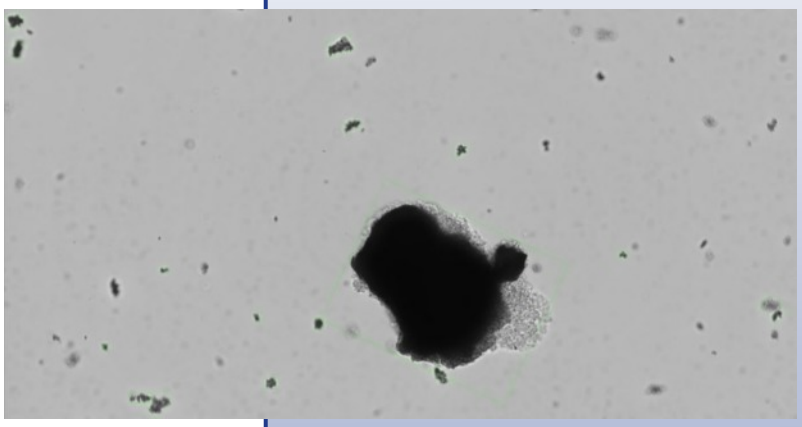


CAT6 Ethernet, however, has a distance limitation of 100m before there is signal loss that can interrupt analysis. In those situations, it is possible to convert the CAT6 Ethernet to fiber via CANTY's media converters. Refer to document TA11950-1024. Using this method, it is possible to run a fiber line up to 10km between the analyzer's power supply and then VCM. In this case, a typical layout of the components will look like the following.



Data Outputs For Tailings Measurements

When measuring the particles in the tailings stream, it is critical that as much information as possible is learned as quickly as possible. The Canty Inflow will provide:



- Concentration of suspended solids, gas, and liquid droplets present

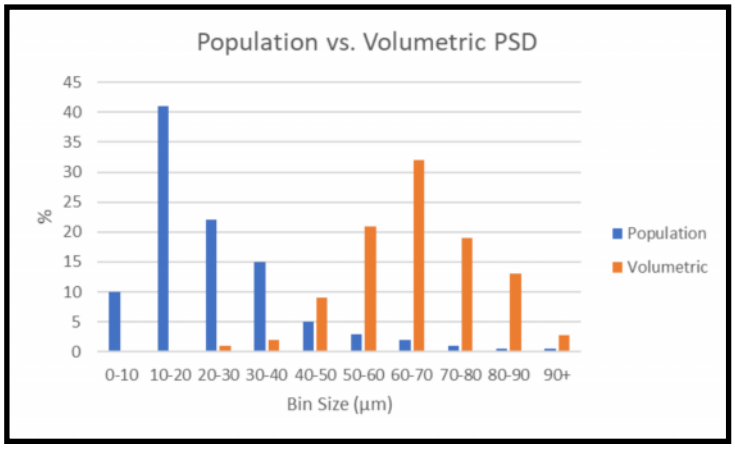
This is directly measured by the analyzer as a volume concentration and can be converted into a mass concentration if the bulk density of the particles being measured is known.

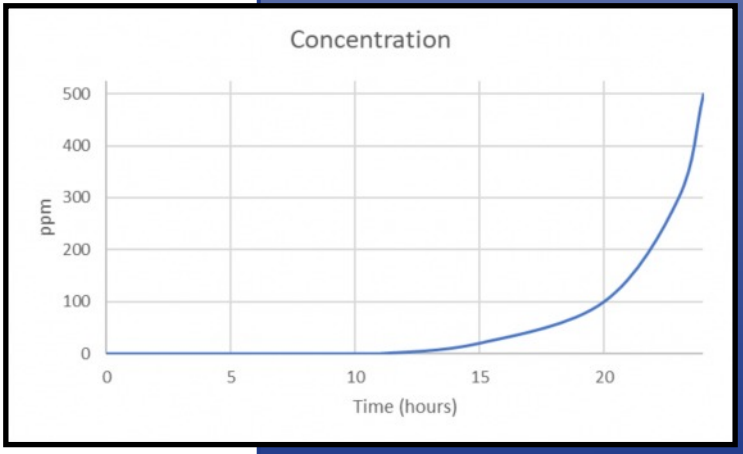
- Shape and Size distribution of the suspended solids, gas, and liquid droplets particles

The shape and size distribution of the suspended solids can give information on the type of particles and promote understanding of the chemical, and physical processes that form them. The size distribution can be output as a volumetric distribution, population distribution, percentiles of either cumulative distribution (Dv50, Dv100, Dn 10, etc) or a correlation to a distribution measured by a set of sieves. When correlated to sieves the distribution can be reported as a percent retained curve, percent passing curve, or a volume percent on each virtual screen.

These measurements are in addition to system health data that would indicate the well being of the analyzer, such as internal sensor health. Allowing for optimal preventative maintenance to occur in order to have zero down time with the analyzer or the process it is measuring.

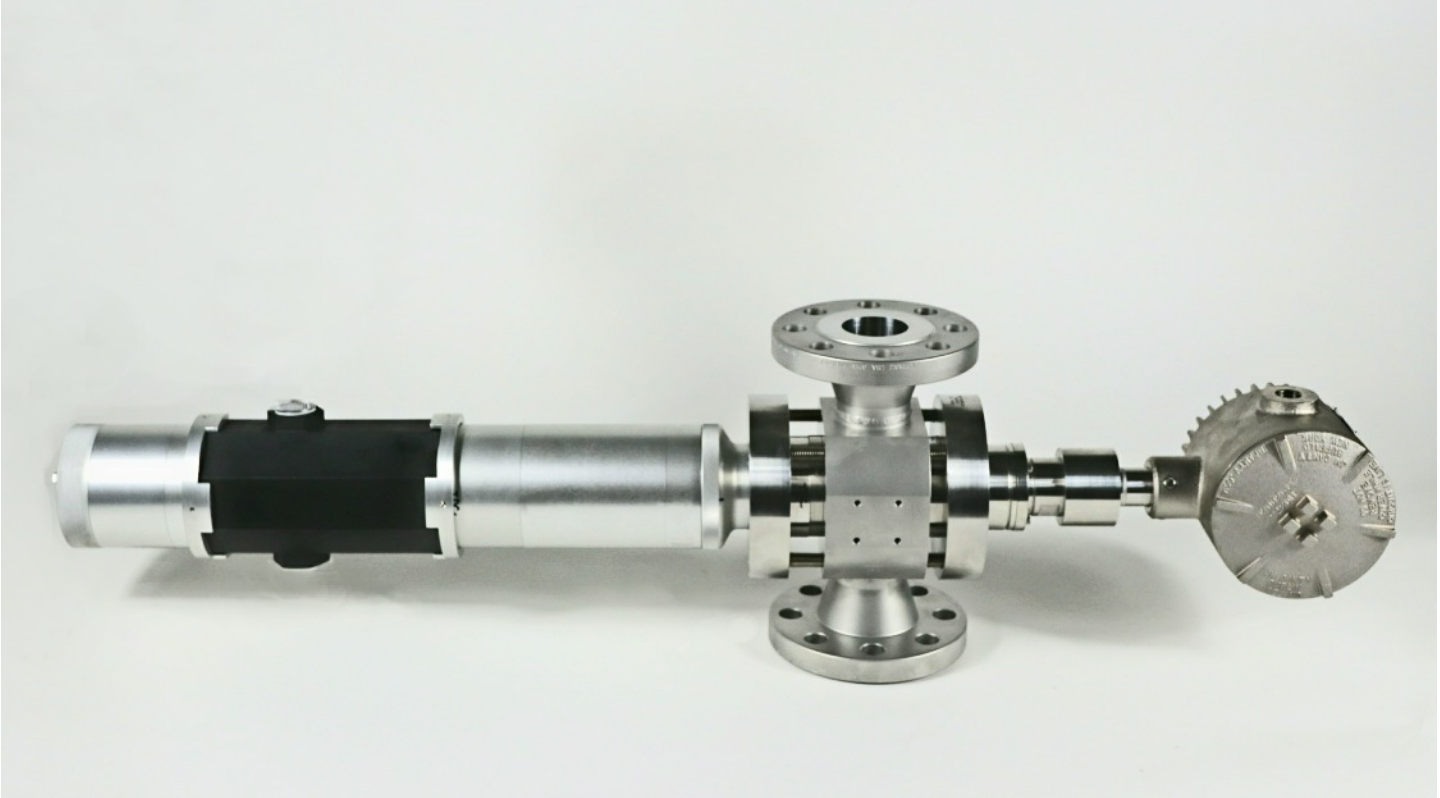
Each of these measurements can be trended over time in a data historian to monitor trends and provide historical context through data output integration with the VCM for future data analytics and monitoring of the process and it's separation equipment.





Conclusion

CANTY's Inflow analyzer is an effective tool for the automatic measurement of tailings in mining It is installed directly inline or at line and can measure particles at very small sizes, and has multiple outputs that can help inform how well a separation is occurring as well as provide data that can be used to determine how to store and dispose of the the tailing. These benefits lead to a more safe and profitable mining operation.



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