TSS in Mining

Detection Classification and Measurement

The Application of Dynamic Imaging to Detect TSS in the Mining Industry

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In mining applications, many liquid streams contain suspended solid particles. Accurately measuring their concentration is essential for understanding the stream and enabling effective purification later in the process. Continuous or sample-based analysis of these solids provides valuable data on particle size and concentration, supporting better decisions for downstream purification and upstream process control.

This paper examines the use of CANTY's InFlow™ analyzer—a dynamic imaging technology that measures solids as they pass through an inline flow cell or within a liquid slurry sample—to deliver real-time, objective insight into these challenging process streams.

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Introduction

Dynamic imaging involves directing process material through an analyzer that captures microscopic images of the fluid and analyzes them to detect the presence of particles—which may include droplets, gas bubbles, or solid materials. The acquired images are two-dimensional, defining the physical differences in appearance which allows the dynamic imaging analyzers to independently detect, size, and measure the concentration of each type of material simultaneously.

When a CANTY InFlow™ analyzer is installed inline within mining liquid streams, it can detect solid particles as small as 1–2 µm. Upon detection, the analyzer outputs a signal indicating the size, count, and concentration of the particles present.

These outputs enable a control system to automate responses much earlier and faster than traditional detection methods, such as monitoring filter clogging. Such measurements are valuable for tracking applications including—but not limited to—filter effectiveness, filter breakthrough, individual stream monitoring, surface runoff, and sedimentation.

Overview of TSS in Mining

Activities such as sorting, crushing, and washing of material can lead to an increase in total suspended solids (TSS) in flowing liquid streams which are important to monitor. Mining water can also contain large amounts of suspended solid sediment due to erosion such as clay or rocks detaching from surrounding surfaces. Particles may also be added to mining water through ore processing where particles build up in a stream following the crushing of ore. Suspended solids may have effects on the environment or on the process depending on the type of solid, resulting in the need for additional water consumption and a loss in efficiency. [1]

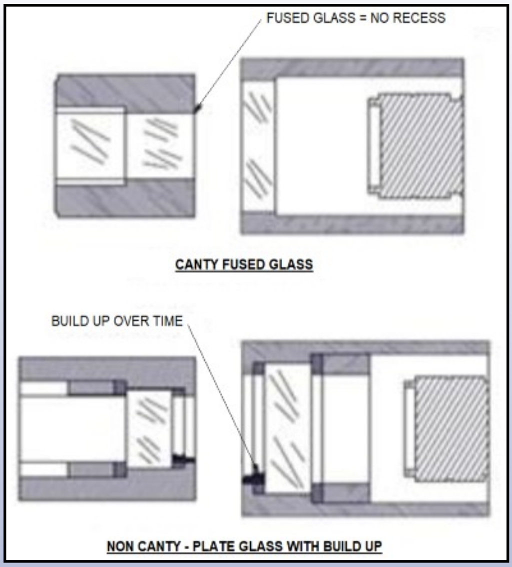
By definition, suspended solids are organic and inorganic material that is retained by a filter with pore size of 2um or less [2]. It is important to identify solids in the mining stream to be able to identify the concentration, size, and count of solids per volume of process fluid before and after filtration. This allows treatment processes such as sedimentation and filtration to be optimized as much as possible as real time data is received.

To improve filtration and process efficiency, a CANTY Inflow can be installed inline to pick up on these particles when they are as small as 1µm. This early detection is automated and does not rely upon human interaction. By detecting these particles in real time, the determination of whether a mining stream has been properly filtered can be made faster and filter breakthrough can be caught quickly, saving time and cost. The data calculated by a CANTY Inflow can easily be compared to water quality standards and regulations that are required by government bodies.

The Canty Inflow works on the premise of dynamic imaging. It is installed inline with process flowing through it. As particles are detected, the Inflow will quantify the size and concentration of the solid and output these values as tags to a control system. This system can then be set up to alert personnel if certain process parameters are out of spec and even begin measures to mitigate the situation.

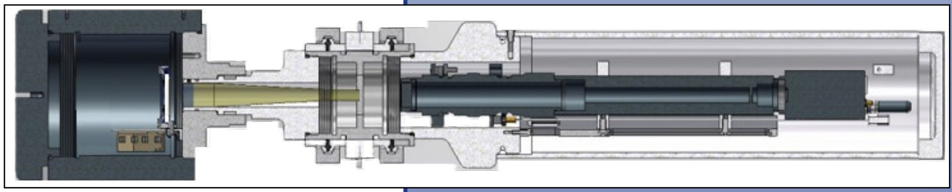
Inflow Hardware

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



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.

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.

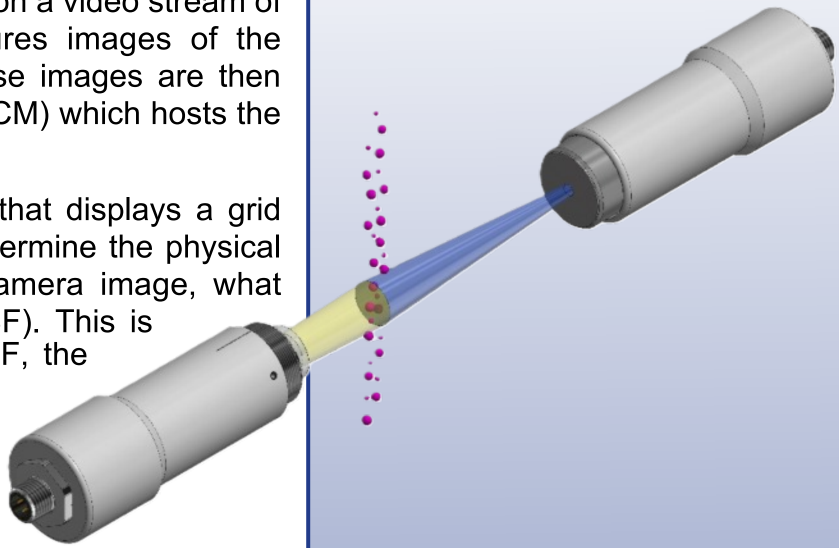


The camera optics used in each Inflow are high resolution gigabit Ethernet CCDs that undergo significant testing to ensure they will be robust for long-term use. Optics are always improving, so CANTY is constantly evaluating the latest and greatest cameras and lenses to provide the highest quality images 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 VCMs 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

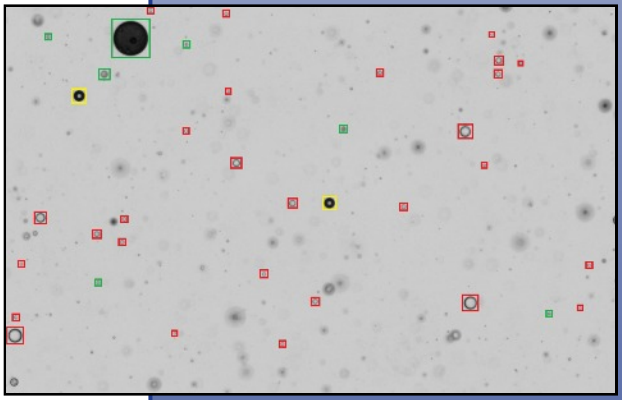
Dynamic imaging makes use of image analysis on a video stream of microscopic images. CANTY's InFlow™captures images of the process fluid and potential contaminants. These images are then transmitted back to a Vector Control Module (VCM) which hosts the software that performs the analysis.



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, rouge, biofilm, 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.



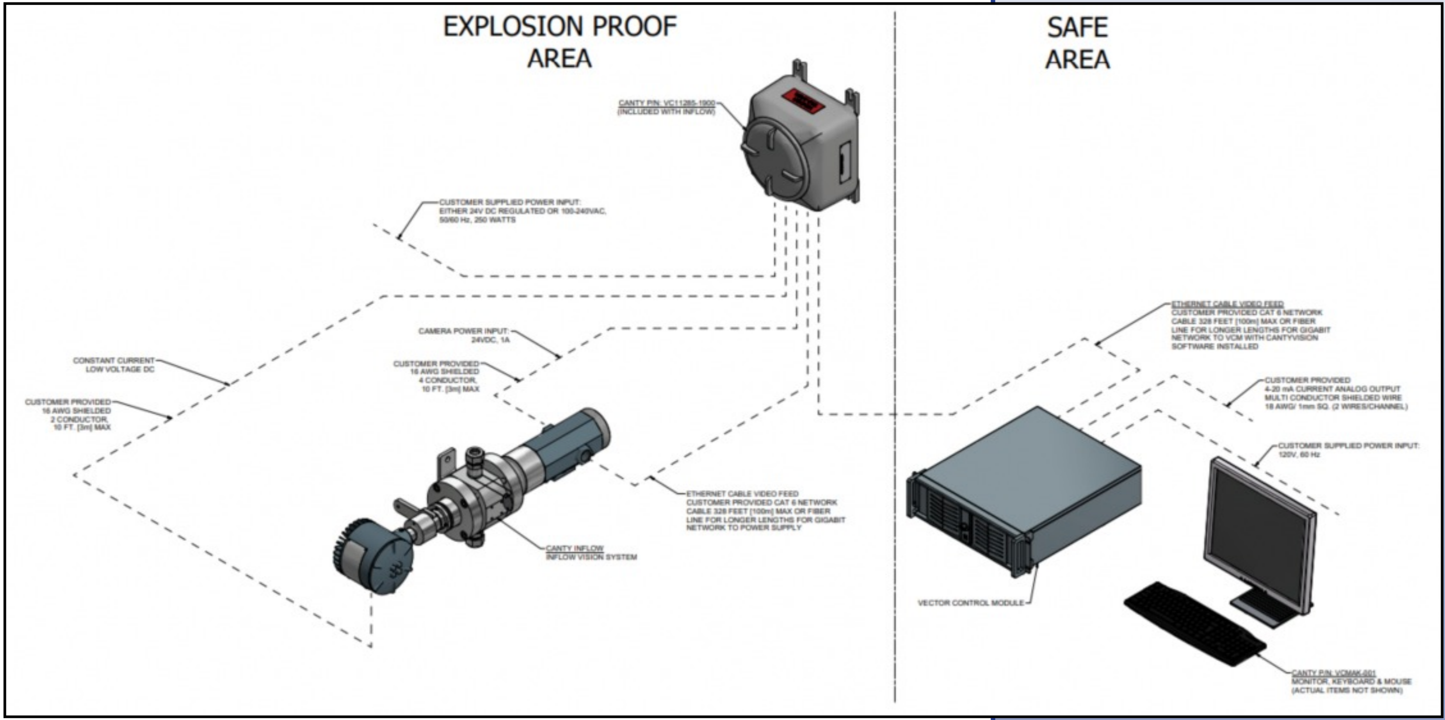
Each type of particle, solids, and bubbles, look morphologically different from one another. These differences are captured, numerically, in the various shape factors measured. The software is trained via AI to recognize the trends in these shape factors belonging to each type of particle. This is key 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.

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.

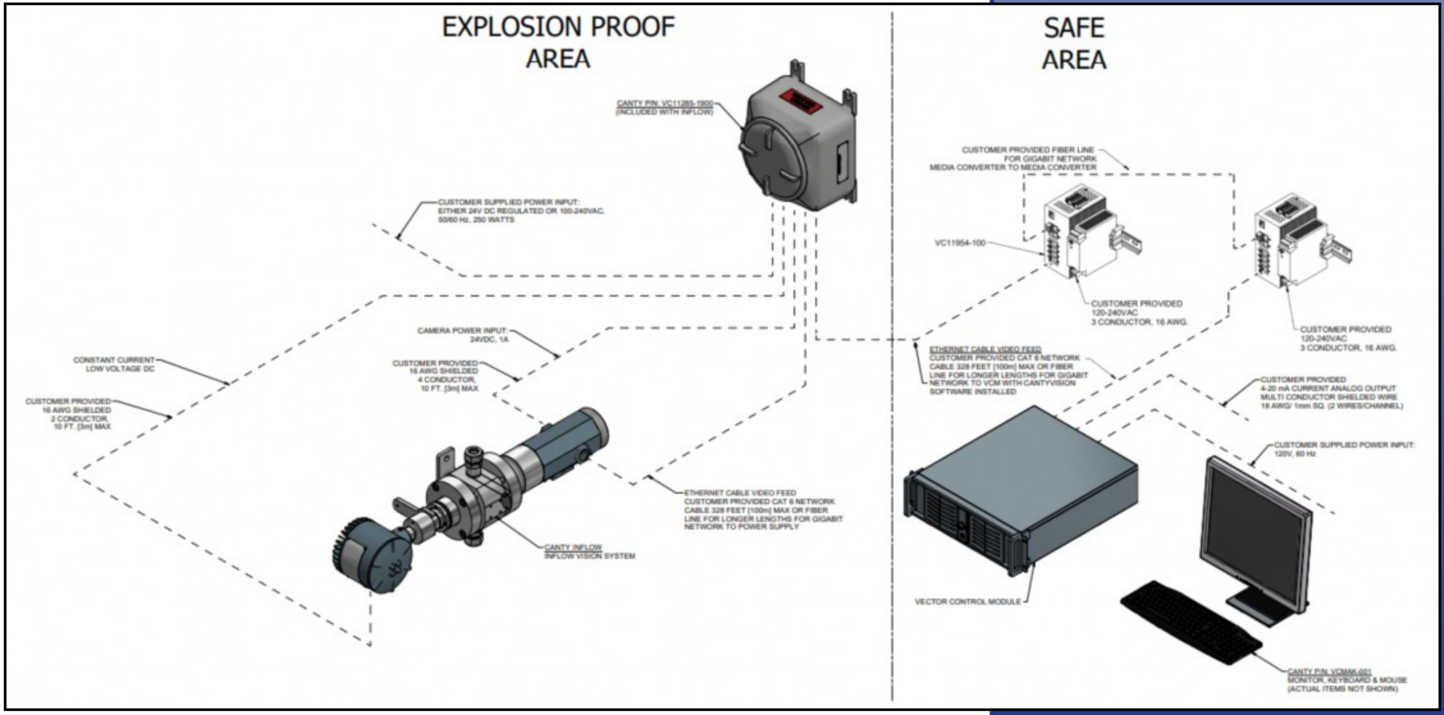
By averaging over hundreds of images, the InFlow™ is able to provide a representative concentration and particle size distribution for each particle class analyzed. Additionally, if there is ever skepticism about the reading, the images from the analyzer can be viewed live and/or saved as a recording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

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.

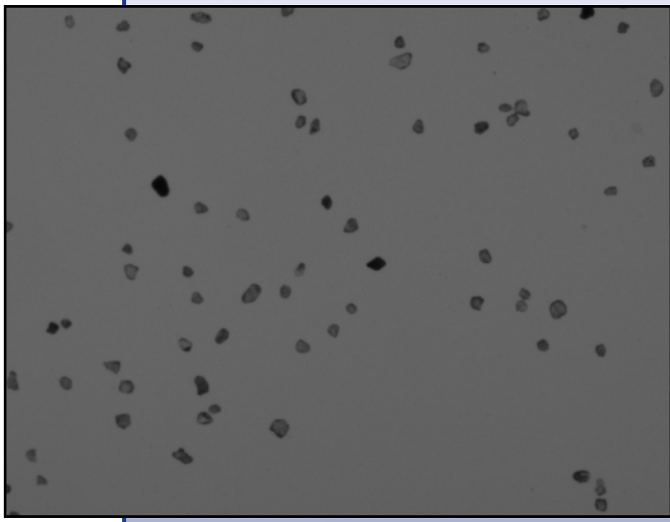


CAT6 Ethernet, however, has a distance limitation of 100m before there is signal loss that can interrupt analysis. In those situations, it is possible to convert the CAT6 Ethernet to fiber via CANTY’s media converters. Refer to document TA11950-1024. Using this method, it is possible to run a fiber line 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 TSS in Mining

When a suspended solid is detected, it is critical that as much information as possible is learned as quickly as possible. The Canty Inflow will provide:



- Concentration of suspended solid present in liquid

  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 solid is known.

- Shape and Size distribution of the solid particles

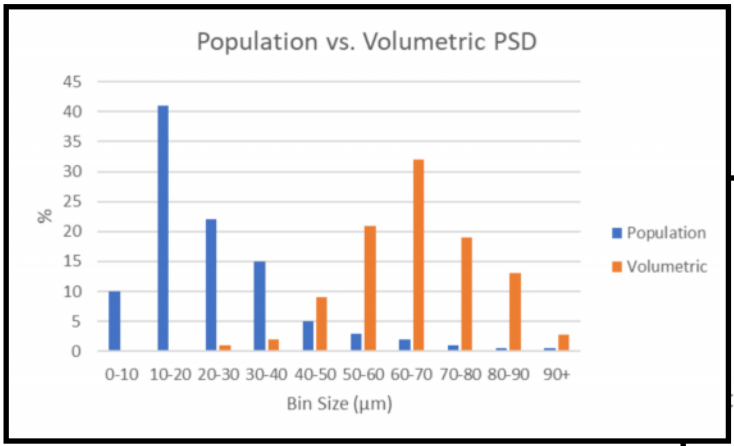
  The shape and size distribution of the suspended solids can give information on the type of solid and promote understanding of biological, chemical, and physical processes that form the solids.

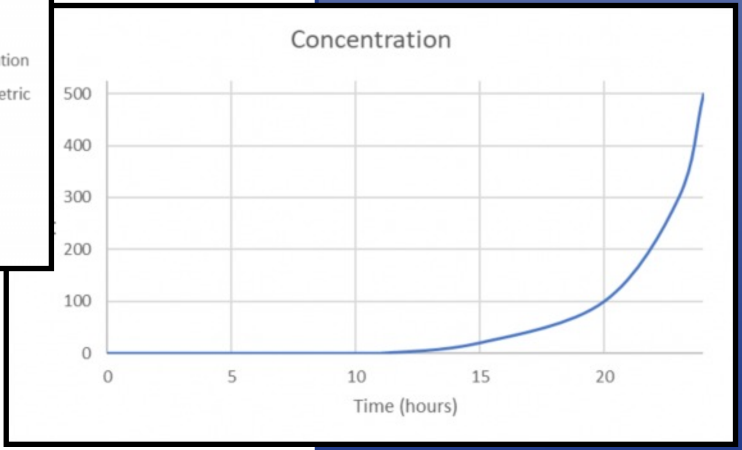
- Count of suspended solids seen per volume of process fluid

  Combined with the size and concentration, this information will help determine the amount of solids in a given process and allow for filter optimization and comparison of different mining streams.

These outputs are in addition to generic system health alarms that would indicate if there is a problem with the analyzer, such as camera temperature and communication signals.

Each of these outputs can be trended over time in a data historian to monitor TSS trends and provide historical context. To communicate between the analyzer and your control system, outputs including OPC UA, Modbus TCP/IP, Modbus RTU, and Analog (4-20mA) are available. Reference the VCM brochure, TA12100-1012, which outlines the available communication methods for each VCM.





Conclusion

CANTY's Inflow analyzer is an effective tool for the automatic measurement of TSS in mining fluids. It is installed directly inline, can measure particles at very small sizes, and has multiple outputs that can help inform how well a filter is operating, detect filter breakthrough, and trigger a response to optimize this process. This will result in a shorter time to filter, a confirmation that water quality standards are met, and increased savings.

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