Thickener and Clarifier

TSS and Turbidity Monitoring in Wastewater

The Application of Dynamic Imaging to Monitor and Control Thickener and Clarifiers

Hannah Sinnott

J. M. CANTY

Clarifiers and thickeners are widely used in a variety of industries for separating fluids and solids and to remove pollutants from water so it may be reused or released into the environment. Total Suspended Solids (TSS) is an important parameter for measuring the efficacy of this operation. With the aid of a flocculation agent the solids are separated out into a particle dense sludge, and the fluid can be re-used or released into the environment. If the TSS levels in the water are too high it indicates that insufficient separation has occurred, meaning the fluid cannot be safely re-used or released into the environment. Each industry has a standard dictating the acceptable TSS levels that must be met before a liquid can be released into the environment. Traditional methods of monitoring TSS and turbidity offered on the market face several technical limitations. These limitations include sensor or sampling point equipment becoming dirty or damaged, the effect of bubbles on turbidity measurement, and build up on tubing impacting results as it is released into sample stream. This paper aims to provide an overview of how Cantys Vision Technology can be used to monitor TSS levels, and control process optimization. Depending on the model ordered,the Canty InFlow™ Particle analyzer can be used for Turbidity Measurement, and also the shape, size, and concentration of TSS, giving a valuable insight into your process.

Contents

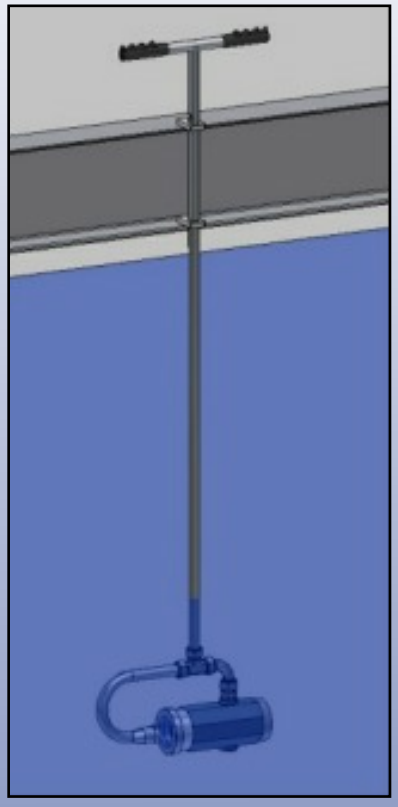
Introduction

Both Thickeners and Clarifiers work as gravity separators, they are used to settle solids which results in the separation of liquids and solids. They liquid produced is water that can be re-used as process water up stream in the process, or released into the environment. Too high TSS levels in the recycled process water can have deleterious effect on machinery and processes, leading to reduced outputs and increased maintenance costs. If TSS levels exceed environmental standards it cannot be released and further processing must be undertaken.

High TSS levels in process water can have a serious impact on the efficiency of the process, the purity of the end product, and maintenance and wear and tear on equipment.

Canty offers two solutions to monitor TSS levels; Turbidity measurement or percentage of TSS. Both systems use Canty's InFlow™ which is a dynamic imaging system. The difference between the two applications is the optical set up. Both systems detect particles as they pass between the high resolution CCD camera and LED light, and depending on optical set up specified when ordering output either turbidity (TU) or particle shape, size, and concentration (PPM) data.

Overview of TSS in Wastewater



Total Suspended Solids (TSS) refers to solids that are suspended but not dissolved in a liquid. As a result they can be filtered out using a variety of mechanical processes, with both Thickeners and Clarifiers operating on the bases of sedimentation. The water produced by both these systems can be discharged, or more recycled for use as process water in another on site process.

Traditional methods of monitoring TSS and turbidity offered on the market face several technical limitations. These limitations include sensor or sampling point equipment becoming dirty or damaged, the effect of bubbles on turbidity measurement, and build up on tubing impacting results as it is released into sample stream. Traditional Turbidity Measurement systems reply on a limited number of photocells and measure light intensity readings. As bubbles pass in front of the photocells they scatter the light, impacting on results. Additionally, as the number of photocells tends to be very limited, if one or two of them become fouled their reading will be blocked and this will throw the results off.

Canty's patented Dynamic Imaging systems have been designed to overcome these issues, it has:

- The capability thanks to its patented AI driven software to filter out bubbles from the analysis.
- In built cleaning system to prevent fouling of the lens or light.
- Can be immersed in the most turbulent, representative area.

Canty provides two options for the monitoring and control of TSS depending on your needs; Turbidity and/or Particle shape, size and concentration.

There are also two options for the installation of the system; Inline or immersion.

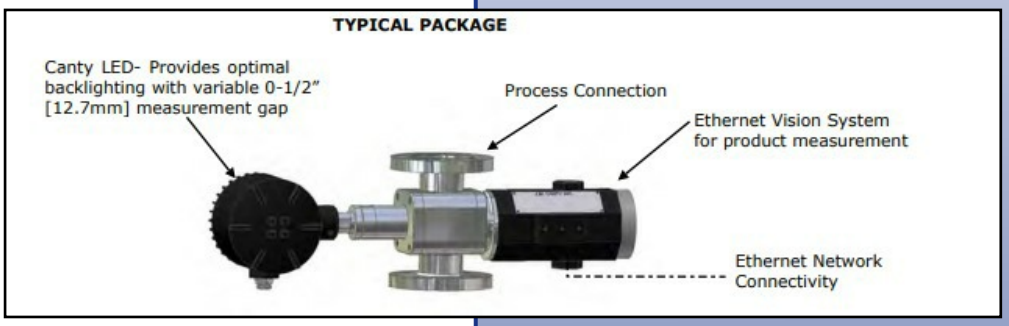
- The inline option is installed on the fluid outlet pipe, with analyses of the finished fluid.
- The immersion option is installed through the top of the clarifier or thickener vessel and immersed in the process fluid, allowing you to monitor the live process.

Both options can be used to automate the process, greatly improving process optimization.

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.

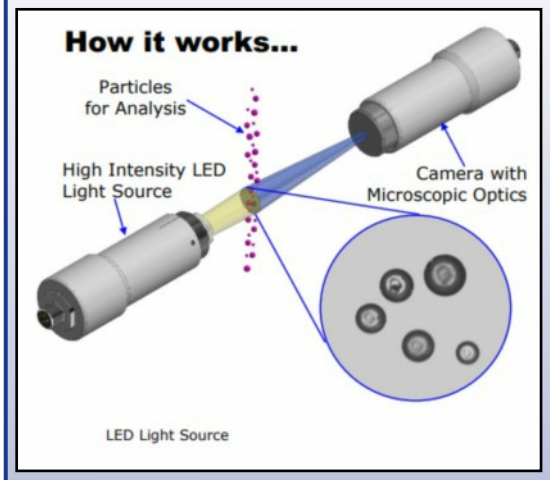


CANTY always says that there are three keys to a perfect image: lighting, lighting, and lighting. CANTY has been leading the industry and innovating in process lighting since the 1970's and applies all of that knowledge in the InFlow™ analyzer. The LED light used is the brightest in the industry with 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 high resolution camera that can pick up on particles as small as 1µm, depending on the analyser range selected.

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

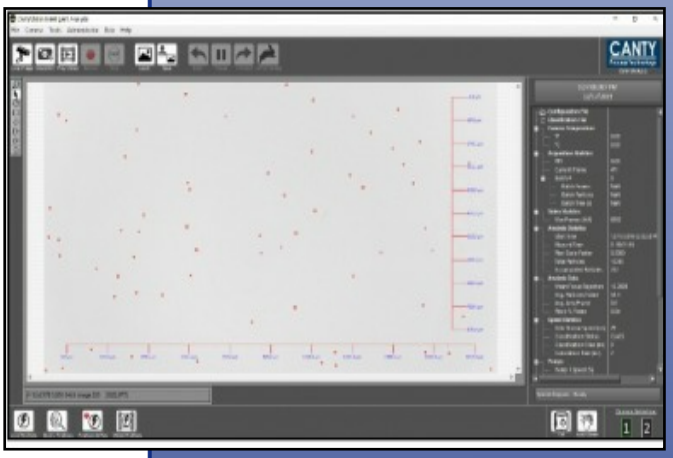


Dynamic imaging makes use of image analysis on a video stream of microscopic images. CANTY's InFlow™ captures images of the process fluid and potential contaminants. These images are then transmitted back to a Vector Control Module (VCM) which hosts the software that performs the analysis.

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 thrown out



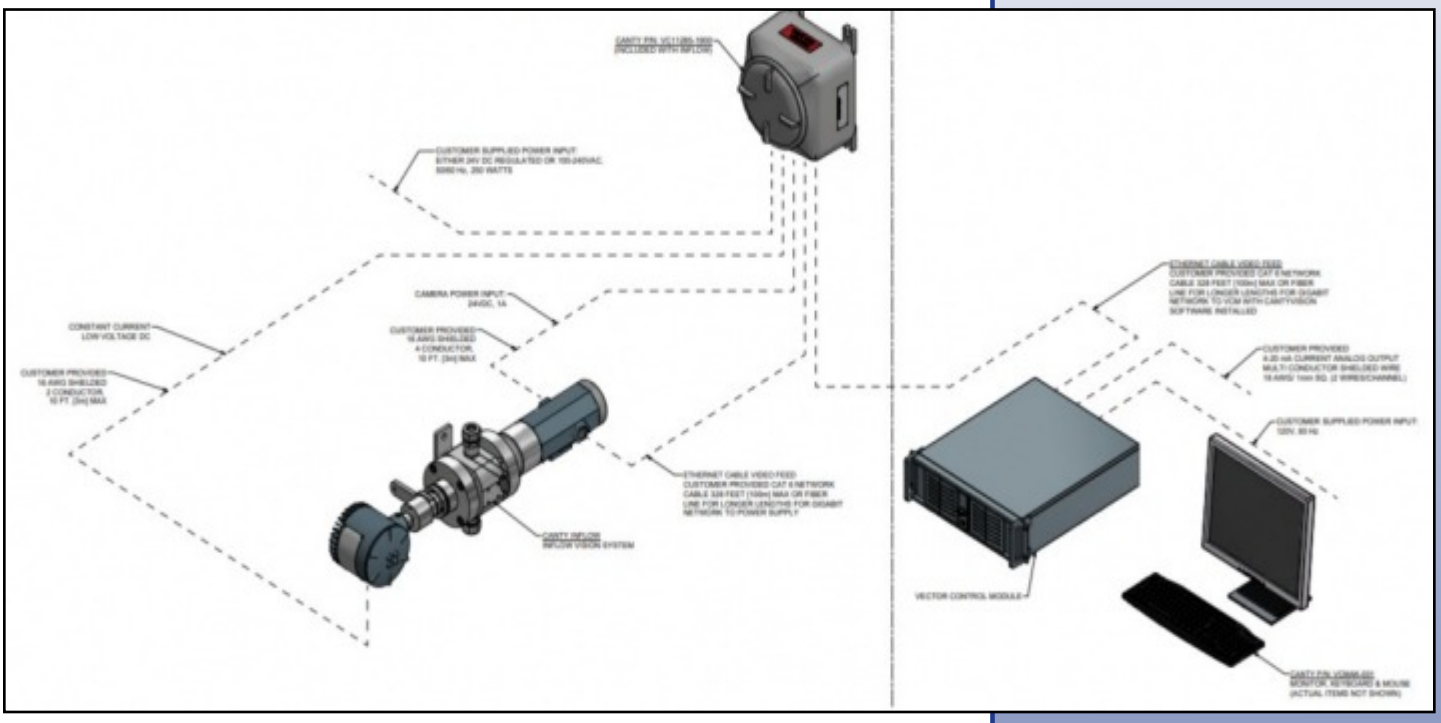
Each type of particle, solids, droplets, and bubbles, look morphologically different from one another. These differences are captured, numerically, in the various shape factors measured. The software is trained via AI to recognize the trends in these shape factors belonging to each type of particle.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

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.

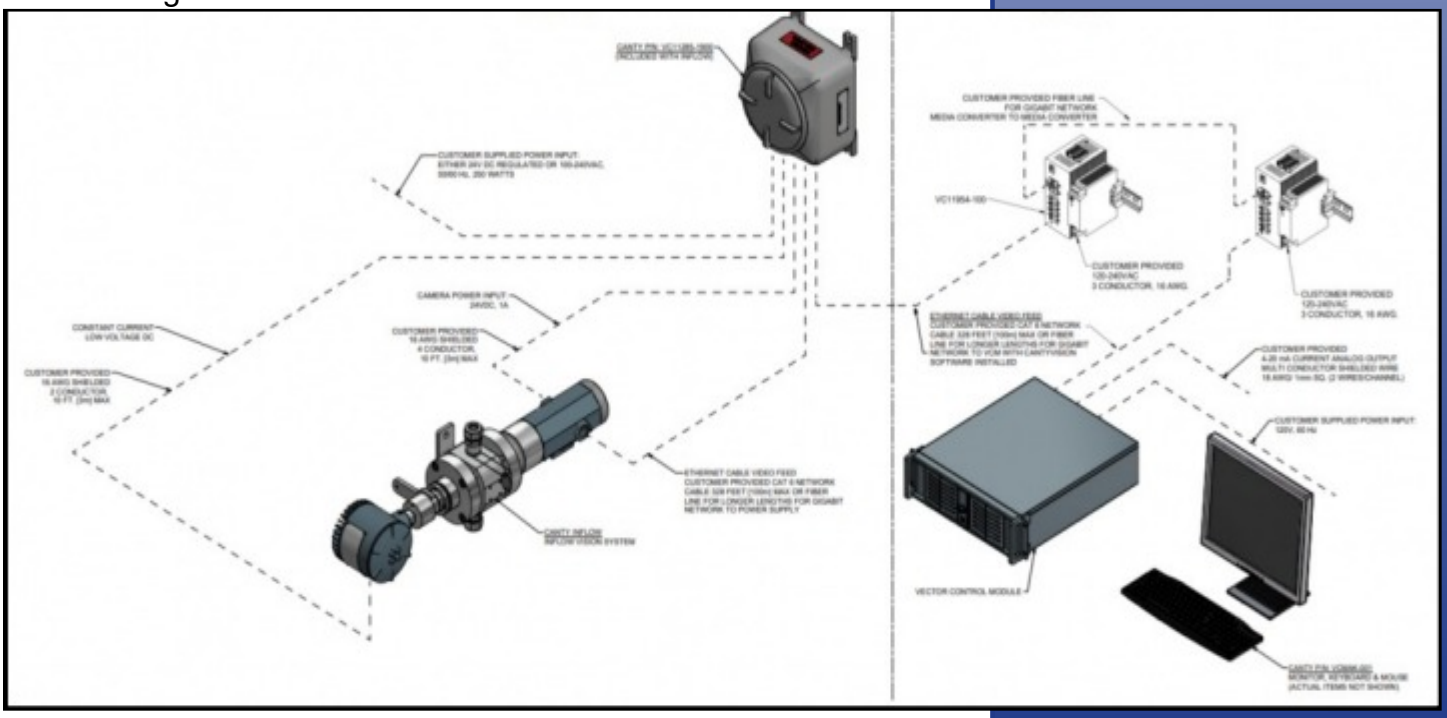
By averaging over hundreds of images, the InFlow™ is able to provide a representative concentration and particle size distribution for each particle class analyzed. Additionally, if there is ever skepticism about the reading, the images from the analyzer can be viewed live and/or saved as a recording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

Connectivity

Due to the amount of data being transmitted between the InFlow™ and VCM, CANTY requires the use of 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.



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 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 Particle Analyses and Turbidity

When solids are detected, it is critical that as much information as possible is learned as quickly as possible. The Canty InFlow™ will provide:

- Concentration of solids 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 solids is known.

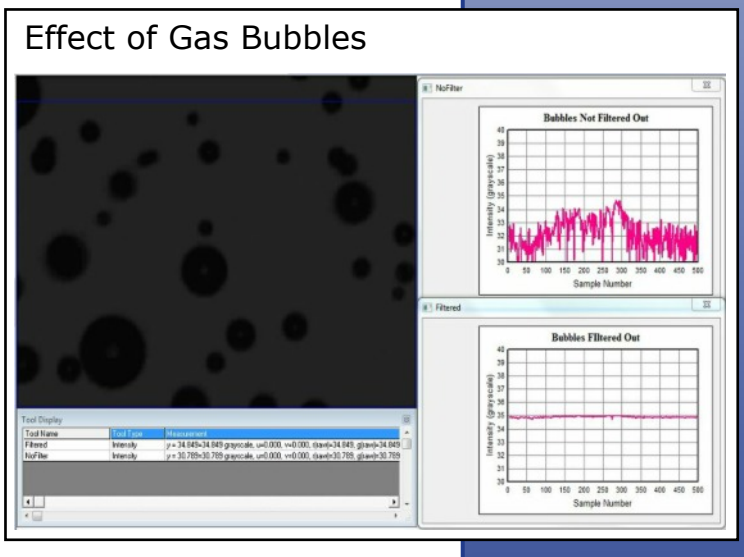
- Size distribution of the solids particles

  The size distribution of the solids will tell you if the solids is large enough to be clogging filters or fittings.

- Count of particles seen per volume of process fluid

Combined with the size and concentration, this information will help optomize the process and reduce the chemical additive use. This can provide a system payback in as little as two to three months.

Turbidity analysis using a high resolution image sensor that detects turbidity changes in fluids by measuring the transmittance of light. Using advanced software algorithms the system automatically removes gas bubbles from the analysis resulting in highly accurate and repeatable data outputs. This system is designed for inline use with varying pressures and pipe diameters. Data is output in Canty Turbidity Units (TU)

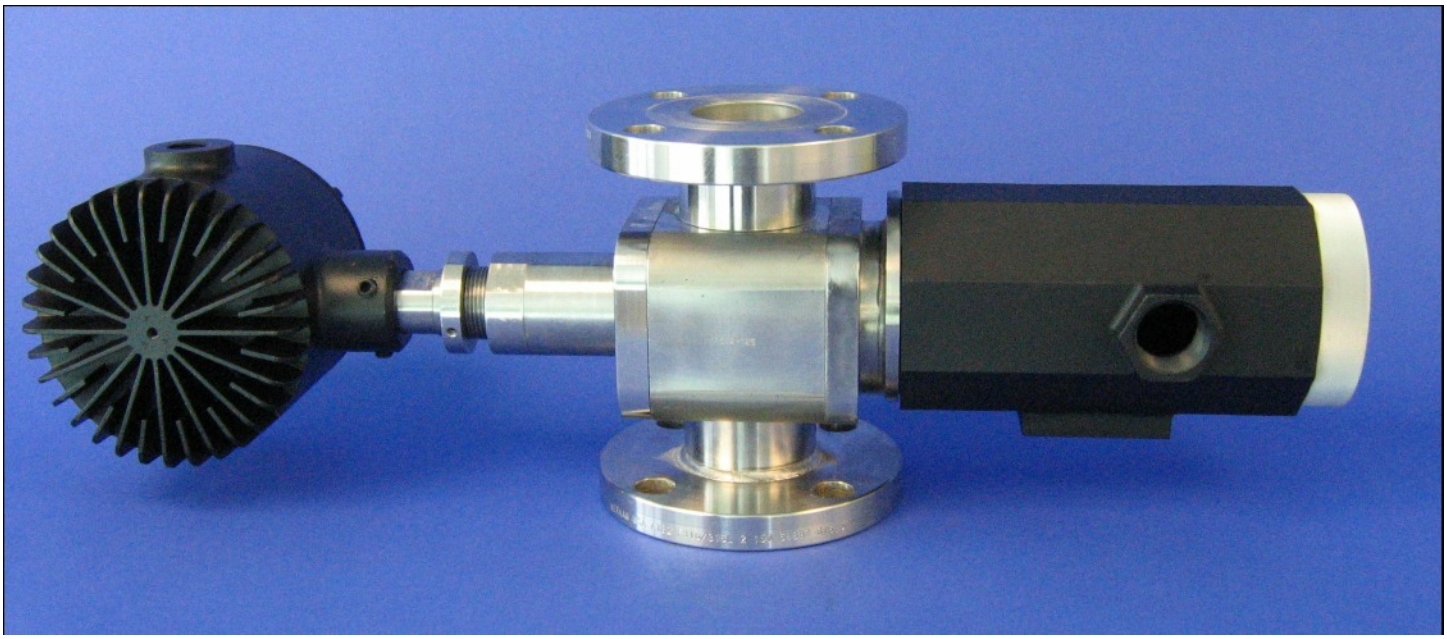


These outputs are in addition to system health alarms that would indicate if there is a problem with the analyzer, such as a stuck particle on the lens or camera communication signals. The software has the ability to eliminate stuck particles from the analyses so they do not impact on your results.

Each of these outputs can be trended over time in a data historian to monitor the Turbidity or particle concentration 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 monitoring and control of TSS levels in Clarifiers and Thickeners in a reliable, repeatable way. Canty's patented Vision Technology combined with our cutting edge AI powered CANTYVISION™ Software provides you with a reliable, repeatable measurement that overcomes limitations faced by traditional methods. By mounting either in your process vessel or on the outlet line you can effectively control your TSS levels and ensure your process is optimized and you meet environmental targets. You can be confident in the results produced and the reliability of your system as you reduce total costs while increasing product output and operation efficiency.



Get more information!
Website: https://www.jmcanty.com

North America
JM Canty, Inc.
6100 Donner Road
Buffalo, NY, United States
+1 (716) 625-4227
sales@jmcanty.com
techsupport@jmcanty.com

EU & International
JM Canty International, Ltd.
Ballycoolin Business Park
Blanchardstown
Dublin 15, D15 KV02, Ireland
+353 (1) 882-9621
+353 (1) 882-9622
Sales.ie@jmcanty.com
Techsupport.ie@jmcanty.com

Thailand Office
JM Canty Thailand Office
Phuket, Thailand
+66 83 9689548
Sales.ie@jmcanty.com
Techsupport.ie@jmcanty.com