Interface

Detection and Control

The Application of Imaging Technology to Measure a Liquid-Liquid or Liquid-Gas Interface

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Continuous measurement of a liquid-liquid or liquid-gas interface is vital to a variety of vessels and separation processes spanning across every industry. This measurement is typically handled by an operator walking out to inspect a gauge glass indicator to estimate the position of the interface of interest before having to then go back to make changes to the process based on that information. This takes time, is not always accurate, and does not provide continuous feedback.

This paper explores the application of CANTY's interface camera system, a field-deployable imaging technology, to detect and measure the presence of an interface in real time while providing visual verification to those same operators without ever having to step out into the field. Measuring the position of these interfaces using this technology results in highly repeatable data that can be used to automate control of these processes and minimize time and exposure of operators in the field.

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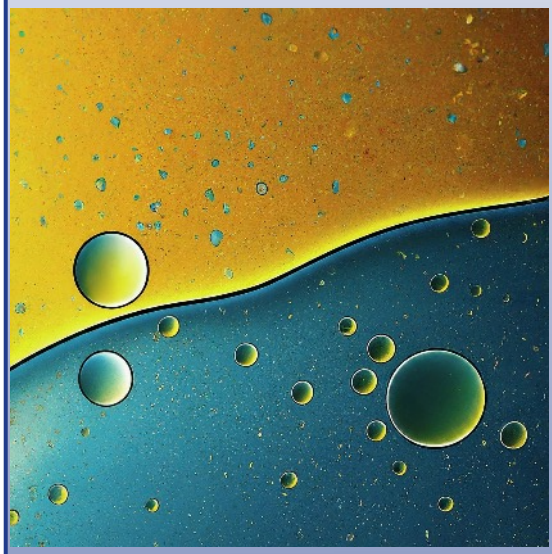


Introduction

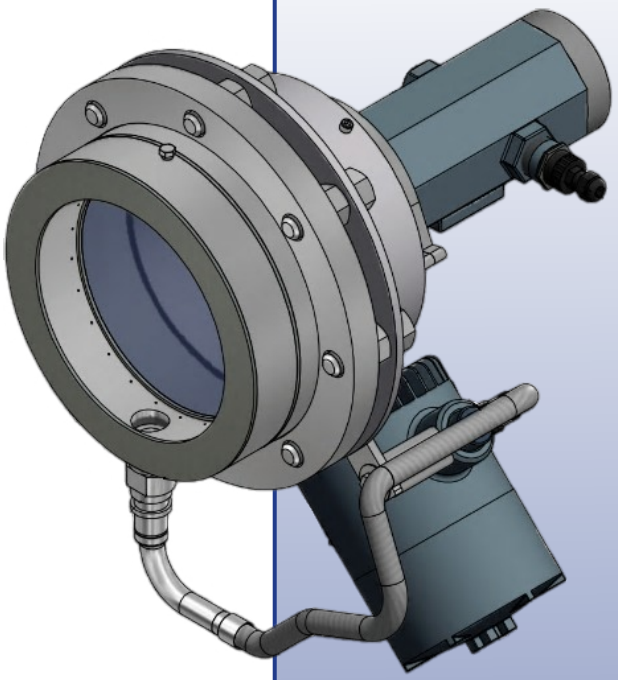
In many vessels where there is an anticipated separation of materials, facilities will employ the use of a gauge glass or sight glass that allow individuals a view into the process. This is done so that operators can track the location of interfaces between different materials, like an aqueous and organic phase.

It is important to track this for a variety of reasons, depending on the application. If running a continuous liquid-liquid extraction, one may have to adjust their operating conditions if the interface is too high or low. If there is a holding tank with material that may have contamination in another phase, tracking the interface between the desirable and undesirable materials may inform when the tank needs to be pumped out.

The application of imaging technology to measure interfaces in these processes requires both hardware that produce continuous, high quality, images as well as software capable of analyzing those images to detect and quantify the position of one or more interface. Taken together, these two requirements create a complicated engineering problem that, when resolved, provides operators and engineers with reliable and unbiased data that can be used to control a process and verified visually on the images provided.

CANTY provides process-imaging systems used to make this measurement across a variety of industries. With multiple types of systems, these camera systems can be used to retrofit onto existing equipment allowing for this technology to be easily integrated across different industries.

Overview of Interface Tracking



Interfaces are the position at which 2 or more phases of material come in contact with one another. This may occur between 2 types of liquids, such as when there are aqueous and organic fluids together, a liquid and foam phase, or a liquid and gas phase. While each of these interfaces may occur in a different type of process, measuring there position is often critical.

Traditionally, this measurement is estimated by an operator looking at a sight glass or gauge glass on a vessel. While this method does provide some rudimentary feedback, it has a large number of drawbacks. In order to make the "measurement," an operator would need to leave the control room and make their way over to the vessel of interest. This takes time away from other tasks that they could otherwise be doing that actually require their involvement. Once at the vessel, the operator is standing in front of a gauge glass or sight glass which, if it fails, puts them at risk. The actual measurement is typically just estimated based on where they think the interface is. This is subjective and often results in different operators obtaining differing results. The measurement is typically then written down or called in, which is also subject to error in translation. Finally, the operator must choose how to react to the position of the level, which also may vary from person to person.

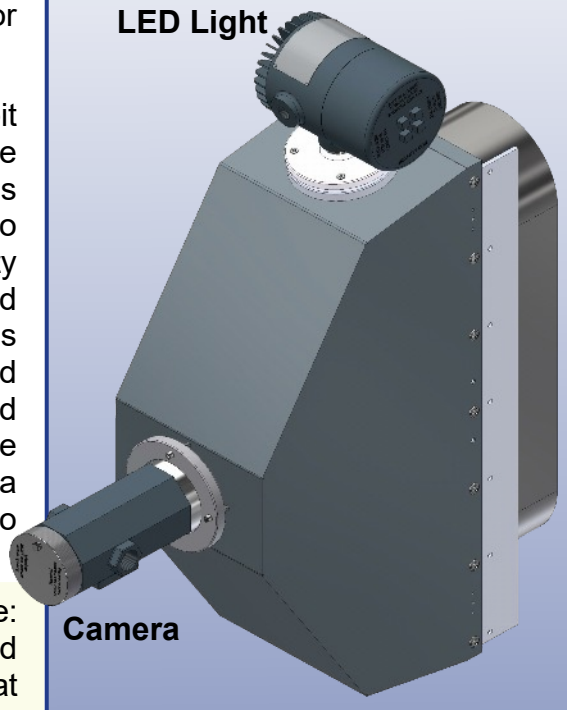
A better option for making this measurement is to integrate a CANTY interface camera system. The systems are adaptable to existing equipment, allowing the technology to be applied almost anywhere. A typical system consists of a metal shroud, optional light source, camera, and Vector Control Module (VCM). Taken together, the hardware produces real-time, high quality video images of the interface. This video can be displayed live, streamed across a network, and/or recorded for later use. Each image is analyzed to determine the position of the interface(s) which is then output to a control system to automate the response to changes in the interface position.

By automating the measurement in this way, one resolves every problem presented by the traditional, manual method. The measurement occurs continually, so there is never a risk of missing a high or low reading. No one needs to go stand in front of the sight glass or gauge glass. Results are reliable and repeatable, and they output directly to the control system. Finally, if there is every a question or concern about the validity of the measurement, a person can always look at the video, either live or a recording, and visually verify that the interface is actually where the camera says it is.

Interface Control Camera System Hardware

The hardware involved in CANTY's Interface control systems include 4 main key technologies: the camera, lighting, shroud, and Vector Control Module (VCM).

The cameras used in every CANTY system 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 system. The housing that the camera is contained in is also critical to ensuring the longevity of the system. All cameras are housed in enclosures that are weatherproof and rugged, designed to last. One of the keys to Canty's to this design is CANTY's fused glass technology which serves as the protective glass barrier that the camera optics look at the process through. Fused glass is a technology unique to CANTY that provides larger, safer views into processes.



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 their interface control systems. The LED light used is the brightest in the industry with a guaranteed lifetime of 5 years. While not required for every interface control system where existing lighting may be sufficient, CANTY consistently finds that customers prefer to replace their existing light sources with CANTY lights both to optimize their image, but also because the lights are maintenance free and typically far exceed their guaranteed 5 year lifetime.

Due to the dependence of image analysis on controlled lighting, CANTY provides shrouds for systems where where external lighting is not otherwise blocked out. These shrouds are made to allow the Interface Camera systems to attach to almost any existing equipment while providing a convenient way to mount and position the camera and light source for the best view of the process.

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 camera systems 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.

Vector Control Module

How Interface Image Analysis Works

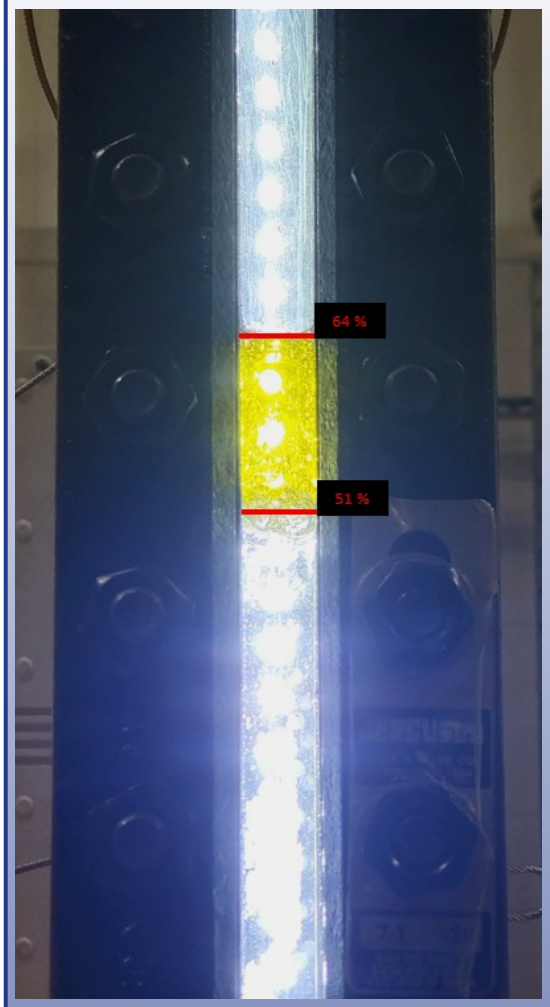


Image analysis makes use of the video images coming from CANTY's Interface Camera Systems. The captured images of the interface are transmitted back to a Vector Control Module (VCM) which hosts the software that performs the analysis.

For every image that comes into the VCM, the software looks through the image within an area of interest to identify where there is an interface using a combination of edge detection and pattern matching. While those algorithms work well for a majority of processes out of the box, users can also teach the software the types of interfaces that they want to track so that it can be trained for their specific application.

Once an interface has been detected, the software then calculates the position of that interface in pixels, converts it into a real-world value, and outputs that value via a number of different available control signals.

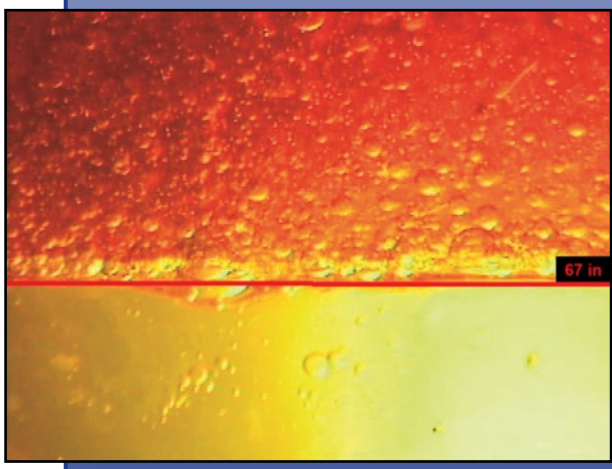
The calibration of the system is done based on the needs of the user. The raw measurements comes in as a position measured in pixels. Each pixel can be calibrated to reference a distance, volume, percent, etc… This requires a minimum of 2 calibration points to be entered into the software, though more are recommended for a higher level of accuracy.

Data Outputs For Interface Systems

Outputs from the system include measurement values and troubleshooting values. Measurement values include:

- Calibrated Interface Position/Volume/Percent For Each Interface

  This is the main measurement that the system is making. The measurement



The troubleshooting outputs include:

- Camera Temperature

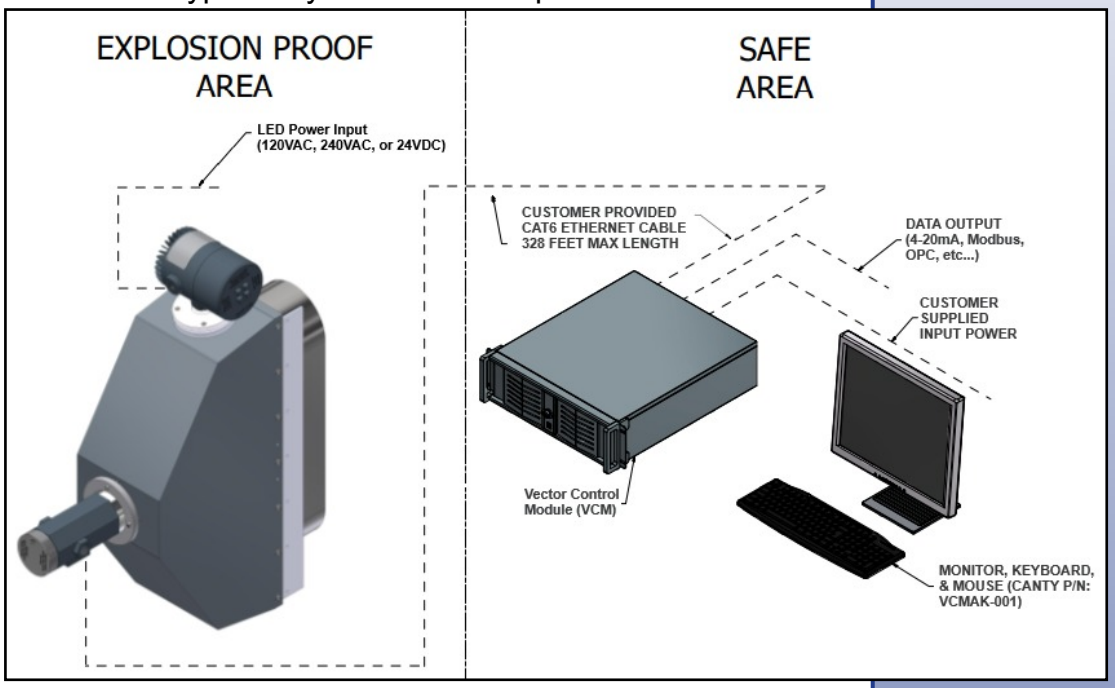
  This is the onboard

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

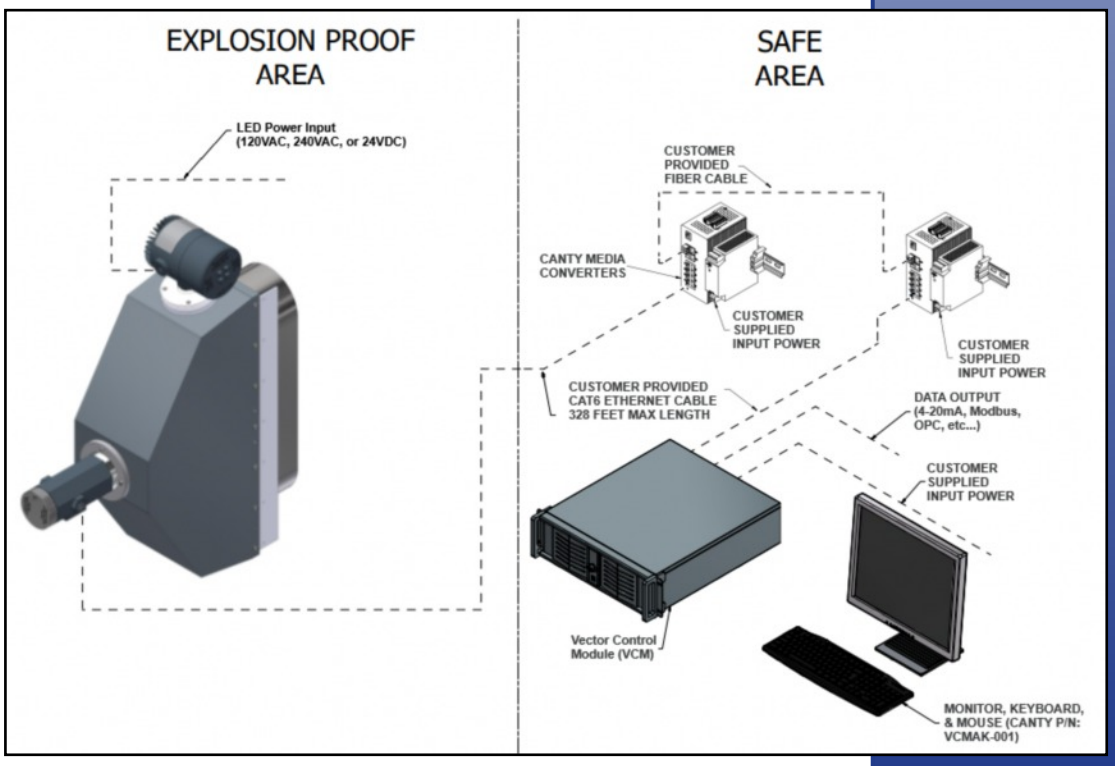
Each of these outputs can be trended over time in a data historian to monitor the rate of growth of the polymer and provide historical context. To communicate between the analyzer and your control system, outputs including OPC UA, Modbus TCP/IP, Modbus RTU, and Analog (4-20mA) are available. Reference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

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 directly back to the VCM. Due to the high throughput of uncompressed video data, the analyzer should not be networked through a switch. A typical layout of the components can be seen here.

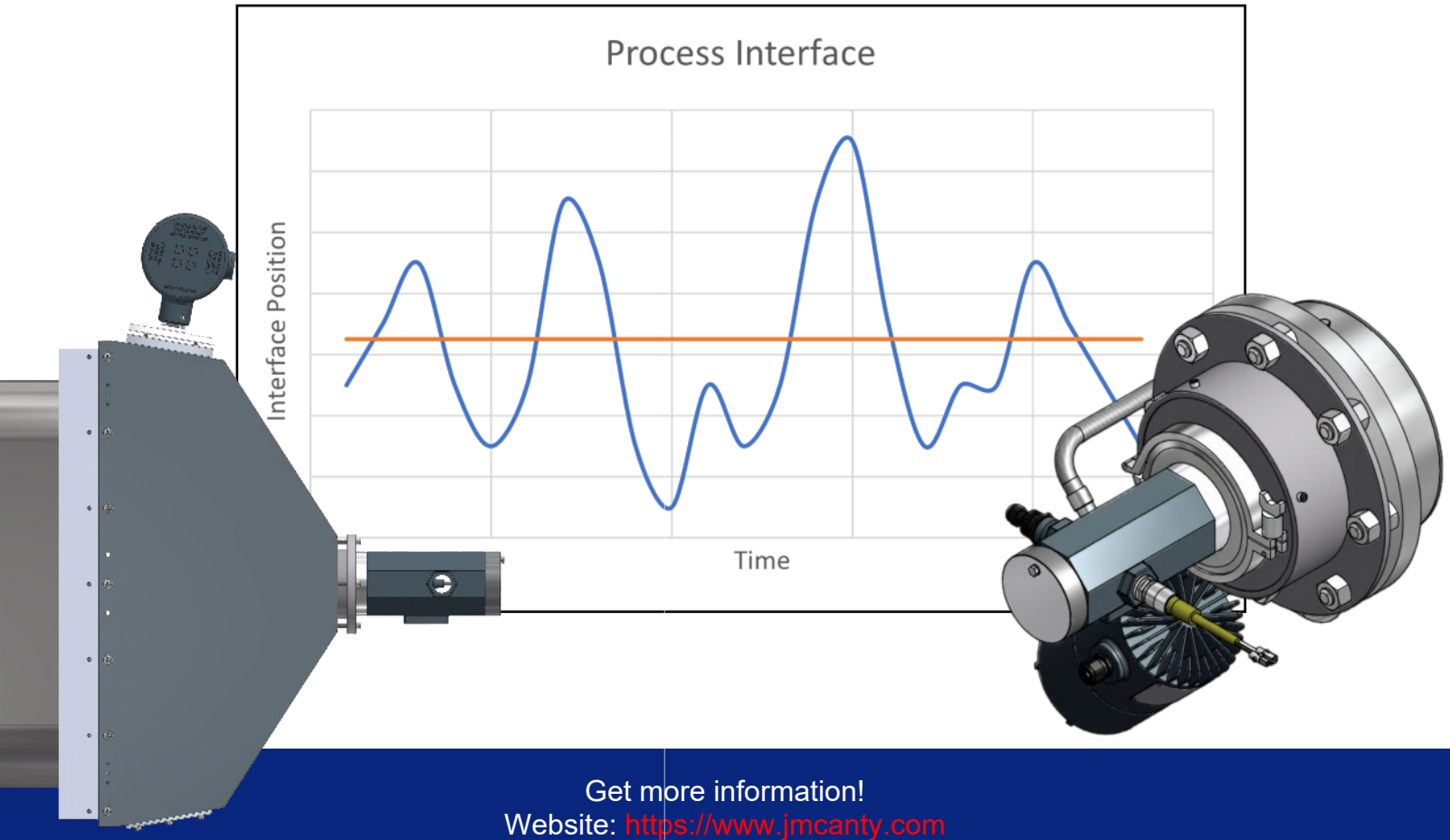


CAT6 Ethernet, however, has a distance limitation of 100m before there is signal loss that can interrupt analysis. In those situations, it is possible to convert the CAT6 Ethernet to fiber via CANTY's media converters. Refer to document TA11950-1024. Using this method, it is possible to run a fiber line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



Conclusion

CANTY's Interface control camera systems are a powerful and cost-effective way to measure and output the positions of liquid-liquid and liquid-gas interfaces. With analyzers that can mount onto existing gauge glasses or replace sight glasses, CANTY's systems can retrofit on almost any process with ease. This provides repeatable and reliable control backed by video that provides visual verification of all measurements.



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