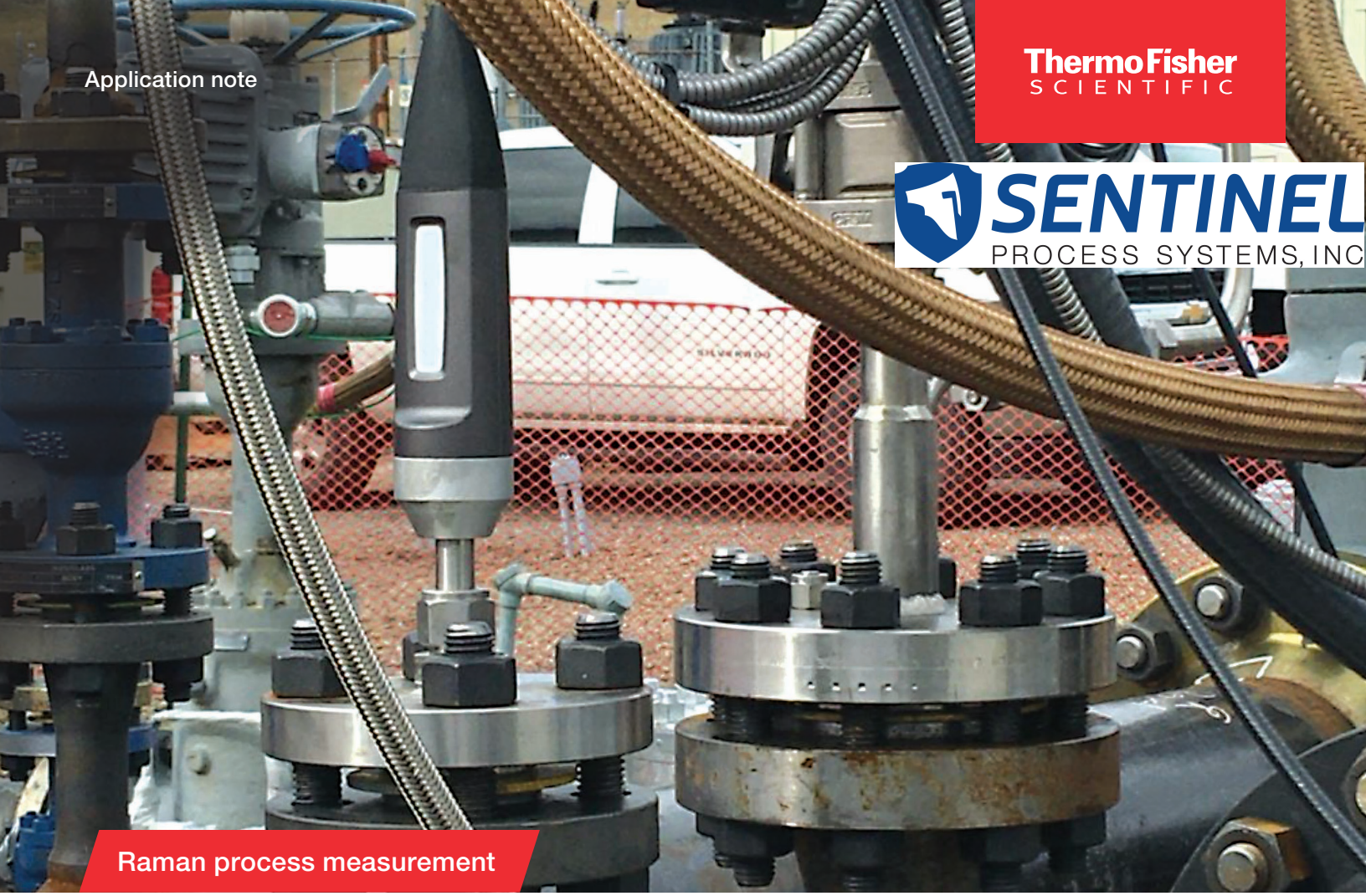
Application note



Raman process measurement

In-line, on-line, at-line, or off-line: how solid-state Raman analyzers can be adapted for any point of need

In-line, on-line, at-line, and off-line: these are the four primary classes of measurement used in process analysis. Modern process analytical technology (PAT) needs to be reliable and accurate. Perhaps most importantly, PAT needs to be adaptable enough to analyze the process regardless of location and interface. This article will help define the four classes of process measurement and demonstrate how a solid-state Raman system can deliver quick, consistent, and accurate compositional data whether you are sampling in-line, on-line, at-line, or off-line.

Defining process production

Process Production or Process Manufacturing can be defined as a production method that creates goods by combining supplies, ingredients or raw materials using a formula or recipe. It is frequently used in industries that produce bulk quantities of goods, such as food, beverages, refined oil, gasoline, pharmaceuticals, chemicals, and plastics. In practice, this definition implies that equipment and methods used in 'process' applications must be robust, highly tested, and tightly controlled as they directly contribute to the final product quality.

Advantages of solid-state Raman

Before we dive into the different classes of process analysis, let's discuss why solid-state Raman systems are particularly well-suited for process measurement. Solid-state Raman systems, like the stable, compact Thermo Scientific™ Ramina™ Process Analyzer have very few moving parts and are ideal for continuous process monitoring and routine lab analysis. As a result, these systems can be placed at any point of measurement. Ramina process analyzer can take advantage of numerous, application-specific sampling interfaces that can be changed in seconds, without the need for recalibration. This makes it easy to find an interface that will work for sampling in-line, on-line, at-line, or off-line in any industry.

Disclaimer: The interfaces that we discuss in this article are adaptable to a wide variety of applications. We may highlight certain probes in conjunction with a specific form of measurement, but that does not mean it is the only type of measurement that the probe can be used for. Nor does it mean that there is only one probe that can be used for each type of measurement. Each probe has a variety of applications. Please keep this in mind as we discuss each class of measurement and sampling interfaces.

In-line measurement

In-line measurement involves placing a probe or sampling interface directly into or in-line with the process or product flow. Usually, this involves placing a probe in a flow system or into a bioreactor. In-line measurement allows customers to measure the product constantly and continuously without removing the Raman "probe" or samples from the process. Some customers elect to use in-line Raman measurement at several different locations in parallel to determine product consistency throughout their process.

In partnership with MarqMetrix we offer several probes designed specifically for in-line sampling. The original BallProbe® sampling interface is probably the most well-known and comes in a variety of sizes, materials and lengths. One example that is particularly well-suited for in-line measurement is the BioReactor BallProbe® that features a 12mm outside diameter and standard Pg13.5 fitting to easily integrate with industry-standard bioreactors. The BioReactor BallProbe is designed to be fastened directly into a bioreactor for continuous compositional measurements during a bioprocess.

On-line measurement

On-line measurement is very similar to in-line, though there are some key differences. On-line analysis, like in-line, measures the process without taking samples to a separate location. However, it usually involves separating some of the product from the main process line and performing measurements on just a portion of the product. Often this is done by adding a sampling loop where you can analyze the process using an on-line Raman interface. The diverted sample can be re-introduced to the process stream, or wasted, depending on the application.

While there are many probes that can be used for on-line measurement, the most prominent example is the FlowCell®. The FlowCell takes spherical sapphire lens technology and incorporates into a housing designed to be integrated into a flow system for effective sampling of a flowing sample. For on-line measurement, simply divert a portion of the product through a FlowCell and sample continuously without process interruption.

At-line measurement

When we discuss at-line and off-line measurement, there is a key differentiator that stands out right away. In-line and on-line measurement both offer the ability to continuously measure the process in real-time. At-line and off-line measurement usually requires manually collecting a sample or samples and performing analysis separate from the process. We can further differentiate at-line and off-line measurement by the distance between the production facility and the analytical measurements being performed. When measuring at-line, analysis is still completed at or near the process. However, that analysis is being done apart from the process after a sample has been removed for testing.

For at-line measurement, we recommend a versatile probe that can handle a wide range of sample types, including liquids, solids, powders, pastes, and gels. The standard MarqMetrix BallProbe® offered by Thermo Fisher is the ideal probe for this purpose. The spherical sapphire lens enables what is called TouchRaman® sampling. When the lens of the probe is in contact with the sample, you are accurately and reproducibly collecting data-rich compositional information of the at-line samples.

Off-line measurement

Off-line measurement involves the most physical separation between the process and analysis of the sample. Like at-line, off-line measurement involves removing an analytical sample from the process. But instead of analyzing the sample at the production facility, off-line measurement involves taking a sample, or sometimes multiple different samples to be analyzed in a formal lab setting. The Ramina Process Analyzer was designed to produce effective measurements in a lab or process setting.

Capability for any application

No matter where you decide to perform measurements in your process, we have a Raman system and sampling interface that will improve your compositional measurements. Modern, solid-state Raman systems allow for flexibility in placement, interface, and sample type without sacrificing performance. For the best results and performance, it is imperative to choose the correct sampling interface for each of your applications.

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Learn more at **thermofisher.com/ramina**

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