Tapping Into Resources

Organizations that work with us are accessing a wealth of expertise and resources. In addition to the experience of our award-winning researchers, we possess a considerable collection of intellectual property developed through more than three decades of work with the federal government and other research sponsors.

We also seek to optimize our resources through collaborations with industrial and university research organizations. We have established productive research relationships with many industrial and university partners.

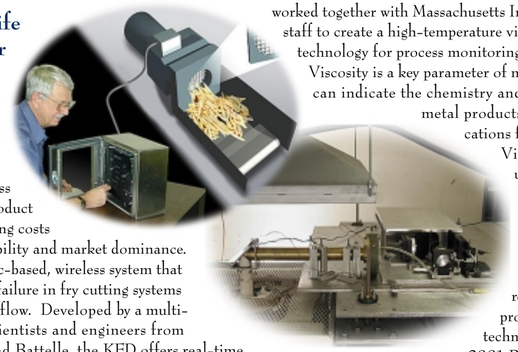
From the customer's perspective, special needs or applications are no problem; our experts can develop custom process monitoring and control systems tailored to very specific client requirements.

Whatever the need, whatever the problem set, we are uniquely suited to finding the proper combination of resources—expertise, technologies, connections—for ultimate success.

Award-winning Technologies

In recent years, Battelle researchers at PNNL have won accolades for their process monitoring and control technologies.

Multi-blade Knife Failure Detector (KFD)



In the potato processing industry, the French fry market is so competitive that improvements in process technology that add product value or reduce operating costs are essential to profitability and market dominance. The KFD is an acoustic-based, wireless system that instantly detects parts failure in fry cutting systems and redirects product flow. Developed by a multi-disciplinary team of scientists and engineers from Lamb-Weston, Inc. and Battelle, the KFD offers real-time equipment and process monitoring and substantially reduces cutting losses. The device received an R&D 100 Award as one of the significant technology advances for the year 2000, as well as a Federal Laboratory Consortium Award for excellence in technology transfer. It is in use at potato processing plants worldwide.

MilliWave Viscometer

In another example of collaboration, a Battelle researcher worked together with Massachusetts Institute of Technology staff to create a high-temperature viscosity measurement technology for process monitoring of molten materials. Viscosity is a key parameter of molten materials that can indicate the chemistry and quality of glass or metal products. Potential applications for the MilliWave Viscometer, which utilizes millimeter-wave electromagnetic radiation to probe the movement of liquids, include glass manufacturing, metals refining, and other melter produced materials. This technology was honored with a 2001 R&D 100 Award.

For More Information, Contact:

Dr. Walter C. Weimer
Environmental Technology Division
P.O. Box 999 MS: K9-09
Richland, WA 99352
Phone (509) 375-6922
Fax (509) 375-2029
e-mail: walter.weimer@pnl.gov

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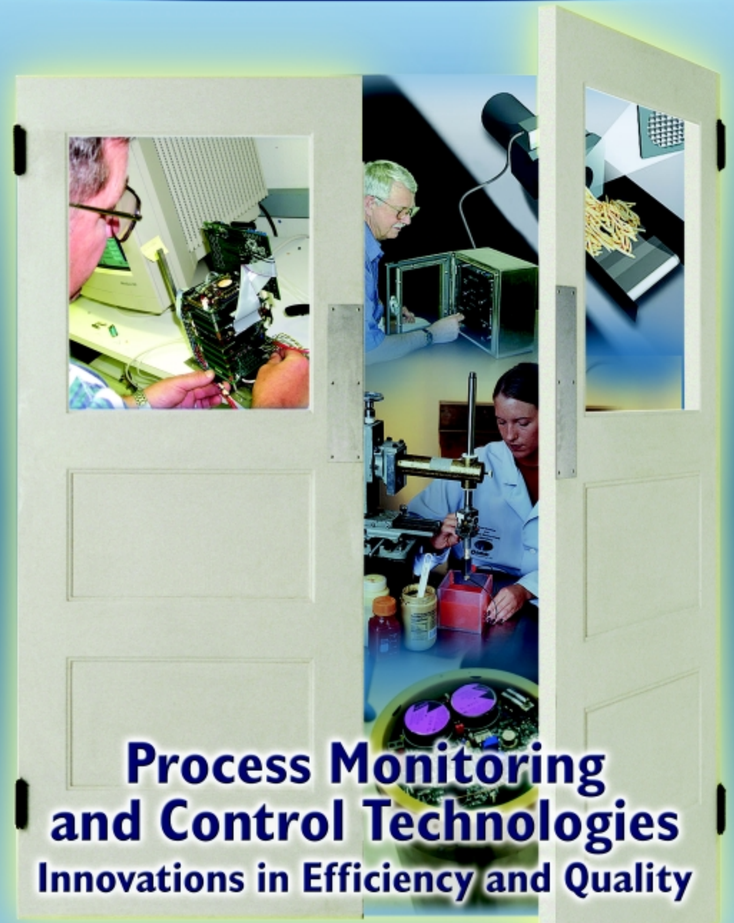


Process Monitoring and Control Technologies

Innovations in Efficiency and Quality

Battelle

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

About Us . . .

Battelle, a research organization focused on the development and deployment of innovative science and technologies, is based in Columbus, Ohio. Through the years, we have successfully met the needs of industry and government customers, providing new technologies, products and solutions. With access to state-of-the-art research facilities and 7,500 employees worldwide, Battelle offers the extensive, unique expertise and resources that result in cutting edge, quality products.

Battelle has operated Pacific Northwest National Laboratory (PNNL) for the U.S. Department of Energy (DOE) since 1965. PNNL is focused on meeting DOE needs in the areas of fundamental science, environmental science and technology, energy and national security. Battelle's use permit at PNNL allows private research and development work to also be conducted at the facility.

Pacific Northwest National Laboratory, Richland, WA

In addition to PNNL, Battelle, in partnership with other contractor organizations, manages DOE's Brookhaven National Laboratory, Oak Ridge National Laboratory and the National Renewable Energy Laboratory.

Capabilities of Ultrasonic Technologies for Physical Property Analysis

We are a leader in the field of ultrasonic technologies, which offer on-line, real-time analysis of many physical properties:

- **Particle size distribution, concentration, settling and plug formation**
- **Viscosity, density and sheer rate**
- **Fouling and pipeline wall buildup detection**
- **Liquid-liquid interface detection**
- **Solidification and solid-liquid interface detection**
- **Chemical identity confirmation**
- **Chemical storage container monitoring**
- **High-resolution imaging of materials.**

The Densimeter monitors radioactive fluid or slurry density and provides data that can be used to analyze conditions during waste transfer processes.

Capabilities. Vision. Success.

In a changing, competitive world, innovation is the name of the game.

- Consumers demand high-quality products at reasonable prices.
- Industry pursues technologies that bring consistency, efficiency and cost-effectiveness to production.
- The government sector is seeking creative solutions for existing national needs, with the purpose of strengthening the country and building a solid economic future.

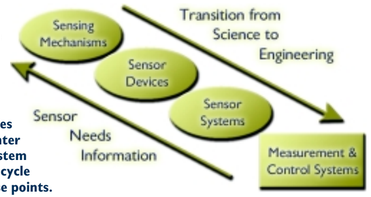
In the field of process monitoring and control technology, Battelle researchers at Pacific Northwest National Laboratory are at the intersection of consumer, industry and government needs, supplying innovative, cost-effective ideas and technologies for the 21st century.

Process monitoring and control relates to virtually any type of process—from vegetables being diced and sliced on production lines, to the conveyance of industrial waste to storage containers. In each case, special needs exist for innovative technologies that can quickly and accurately monitor various aspects of the process, identify needs or inconsistencies, communicate data and ensure quality and safety.

Our researchers, utilizing unique technical capabilities and drawing upon knowledge gained through many years of government- and industry-sponsored research activities, are developing and deploying advanced sensor and measurement systems for the monitoring and control of process operations. We excel in a wide range of technical areas and possess particular strengths in:

- Non-invasive, on-line and real-time technologies that use ultrasound and radioanalytical characterization to measure the physical and chemical properties of flowing materials, such as liquids and slurries.
- Smart, wireless transponders for sensing and conveying process information.

These attributes, combined with our expertise in chemical sensors, biosensors, infrared sensing, electronics and many other cross-cutting technical areas, help meet diverse client requirements and ensure the delivery of cost-effective solutions for process monitoring and control issues.



Our capabilities allow us to enter the sensor system development cycle at any of these points.

Technology Showcase

We are developing creative and cost-effective process monitoring and control solutions for government and commercial applications.

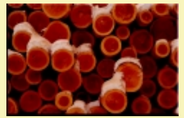
Consistent in Consistency

Ultrasonic Doppler Velocimetry uses ultrasound to measure the viscosity and other physical properties of liquids and slurries flowing through pipes. Developed by Battelle researchers at PNNL for the Department of Energy's Hanford Site in Southeastern Washington, the UDV initially was created to monitor the flow of waste streams—and identify potential plugging problems. This technology has shown itself to be even more versatile, with potential applications for a wide array of consumer and food products. For liquids like shampoo and sauces, the UDV can help take the guessing out of quality-related issues such as texture and consistency, ensuring that the complex physical properties that make a product popular with consumers are retained. The UDV is non-invasive and can be mounted on the outside of piping for continuous monitoring.

A Recipe for Food Quality

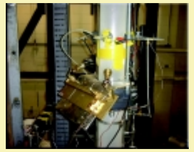
The UDV and other ultrasonic sensor technologies are housed in the Food Science and Process Measurements Laboratory, which opened in 2000. The laboratory, located at PNNL, features standard food processing equipment and flow loops fitted with sensors, which provide comprehensive data on processing approaches. The flow loops offer opportunities to mimic material transport operations that take place during the processing of foods, chemicals and other consumer products.

Getting the Right Charge



Electro-kinetic Sonic Amplitude, a technology bridging electromagnetism and ultrasound, is showing promise in meeting complementary objectives of the paper industry and the DOE Office of Industrial Technologies, which is funding development activities. ESA allows the non-invasive, on-line and real-time measurement of the electrical charge of large, low density fibers in wood pulp slurries. Measuring the charge demand and controlling chemical additives is important to minimizing the addition of special chemicals and reducing costs. Likewise, a more efficient process translates to savings of process water and energy, key aims of DOE-OIT.

Waving at Particles



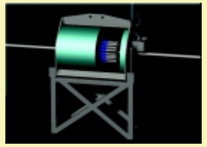
As part of another DOE-OIT project, researchers are developing techniques to measure velocity and particle concentrations in gas flows. At refineries, low value fuel oils are upgraded to gasoline in a process that contacts vapors with tiny catalyst particles. Battelle researchers at PNNL are using electromagnetic millimeter waves to non-invasively monitor particle velocities in a model reactor. The measurements provide key data for computer models, which in turn can be used to optimize the reaction process. Researchers also are developing ultrasonic technologies to work in conjunction with the electromagnetic waves and provide more detailed data.

Additional applications might include assorted chemical, industrial or food processes where measurement of solids in a flowing regime is critical.

Sizing up Slurries

The ultrasonic Densimeter, developed initially for waste transfer purposes at the Hanford Site, monitors radioactive fluid or slurry density, in-situ and in real time, by measuring signal changes that relate to the density of the slurry flowing through it. Data provided by this technology can be used to analyze conditions during waste transfer and diagnose process changes that could signal onset of solids settling, line plugging or other process anomalies. The radiation-hardened sensor is compact, rugged, accurate and inexpensive, and can withstand substantial radiation exposure.

Radionuclide Readings



In the area of radioanalytical characterization, we are developing effective solutions for needs at Department of Energy facilities. For the Savannah River Site, work is focused on creating monitors for in-situ, real-time determination of the concentration of Strontium 90, Cesium 137 and other gamma-ray emitting fission products, and transuranics in a processed waste effluent stream. The fission product measuring devices are based on high-resolution gamma-ray spectroscopy, and the transuranic measuring devices consist of nested annular layers of shielding, reflectors, detectors and moderators. These instruments help ensure that the processed waste stream does not exceed maximum allowable radionuclide content for delivery to a grouting facility and subsequent onsite disposal.

On the Lookout for Foreign Materials

Battelle researchers are working with industry on a solution for a long-standing problem: the presence of minute foreign materials—such as bone pieces, glass fragments, plastic and metal particles—on production lines in food processing plants and other manufacturing facilities. In many cases, existing technologies, such as X-ray devices, are not effective for detecting all types of foreign materials.

Through the use of sensitive ultrasonic technologies, it is possible to identify a wide range of foreign materials that inadvertently could find their way into finished products.

Touching Base with Wireless Communication Smart Sensor Systems

Wireless communications, coupled with sensor technology, have multiple government and commercial applications. In the industrial setting, where machinery and cables often impair accessibility and noisy operations hinder person-to-person interactions, the mobility of wireless communications can be particularly advantageous in rapidly sensing and conveying information from one area to another. Our researchers are focused on combining the latest wireless communications technologies with sensors capable of measuring a wide range of physical or chemical properties in real time.

For example, at the Hanford Site, our experts are developing a unique approach for monitoring plutonium products that will be stored in individual, protective canisters. Passive sensors placed inside the containers allow for the monitoring of internal pressure, while external sensors measure temperature and movement. Via wireless communications, this information can be transmitted to a central collection point where users interpret the data and verify the integrity of the container. In addition to container integrity monitoring, the sensors can tell users if a container has been moved or tampered with, which is useful for both safeguards accountability and inventory purposes.

Other uses of wireless smart sensor systems include maintaining security of safes and disk drives in restricted areas.

Work with Us—It's our Custom

We believe that every problem has a solution. For government and industry clients, we offer custom process monitoring and control systems tailored to meet specific needs or special applications. Our strong commitment to teamwork and communication—coupled with a focus on customer satisfaction—successfully addresses complex, challenging problems and helps deliver innovation.

Wireless communications technology combined with sensors can measure a wide range of physical properties in real time.