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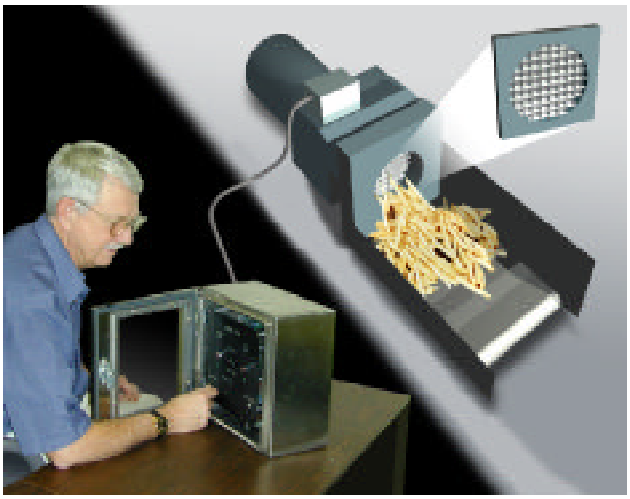
Multi-Blade Knife Failure Detector (KFD) for Food Processing



Potato processing plants worldwide are using the KFD system to instantly detect blade breakage in knife grids. This real time monitoring technology is now available for other industrial applications where measurements are difficult to obtain.

The KFD technology brings high performance, computer-based instrumentation to the plant floor without crippling amounts of capital investment.

—2000 R&D 100 Award

The French fry reigns as one of the world's most popular foods. Americans alone consume more than 15 billion pounds yearly, according to the U.S. Department of Agriculture. The 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. Cutting mechanisms are a good example. Although tension grids of paper-thin blades are extremely efficient, they also are easily damaged. In one hour, a single broken blade can reduce 80,000 pounds of prime potatoes into truckloads of defective strips the manufacturer often must pay to have removed for animal feed. The remaining potato sludge adds to the plant's waste processing burden.

A multi-disciplinary team of scientists and engineers from Lamb-Weston, Inc. and the Pacific Northwest National Laboratory (PNNL) operated by Battelle solved the problem. The team developed the Multi-blade Knife Failure Detector (KFD) for Food Processing. The KFD is an acoustic-based system that instantly detects parts failure and triggers redirection of product flow. Now operating in eight Lamb-Weston plants worldwide, the KFD takes less than one second to identify a blade break, trigger an alarm, and signal blade replacement. On one line at one plant, the new system has reduced annual cutting losses by more than six million pounds.

The severe environments of food processing and industrial manufacturing plants often restrict the use of advanced detection technologies. Plants are wet and noisy with numerous sources of equipment vibration and electrical interferences. The KFD technology overcomes these obstacles by bringing real-time equipment and process monitoring to industry—without crippling amounts of capital investment.

This achievement earned the KFD an R&D 100 Award as one of the most significant technology advances for the year 2000, as well as a Federal Laboratory Consortium Award for excellence in technology transfer.

System Operation

The KFD is rooted in acoustic and wireless communications technologies developed by PNNL for the U.S. Department of Energy and the Nuclear Regulatory Commission.

Pacific Northwest National Laboratory

Operated by Battelle for the U.S. Department of Energy

The modular KFD system consists of a controller box (A), acoustic sensor (B), and wireless base station (C). The system takes less than one second to detect a blade break and initiate corrective actions, thus ensuring product quality while cutting costs and reducing waste.

The KFD operates continuously, checking for a knife failure and maintaining an electronic log of background noise activity. Unlike typical industrial monitors, the KFD operates at 300-400 kHz, high enough to be unaffected by plant noise, yet well within the range of a blade break. The unit also uses signal duration to separate the sound of blade breaks from plant noise and transient electrical interferences.

The system consists of three modular components: a controller, an acoustic sensor, and a wireless base station. The sensor is installed permanently on the knife blade assembly. The base station is mounted on the process piping and is hard wired to the control unit that also is connected to the main plant control system. A pair of radio frequency power couplers and infrared transceivers in the sensor unit and in the base station creates the wireless connection to the knife. When the sensor detects a broken blade, the wireless base station sends a signal to the control unit that alerts the plant control center to initiate automatic replacement of the broken blade assembly.

Distinguishing Features

Advantages of the KFD technology include:

- Acoustically based, no tedious calibration requirements
- First industrial acoustic device designed to operate submerged and wireless
- Selective operating frequency ignores extraneous plant noise
- PC-based software permits tailoring to specific plant and product parameters
- Modular configuration promotes efficient maintenance and operational support
- Designed for extended use in harsh environments
- Single-day installation capability, usually during a regular maintenance cycle
- Major capital investment not required.

Impact on Industry

The KFD is an important step in bringing high performance, computer-based automation to the plant floor. This real-time monitoring technology can be used to ensure product quality, cut costs and reduce waste in many industrial situations where measurements are difficult to obtain.

The passive acoustic design and signal discrimination software can help detect leaks in piping and containment vessels. The wireless power and communications link may be applied to other industrial equipment operations where access prevents the use of cabling. Such applications include the monitoring of rotating machinery for failure, misalignments, loose parts, and process stream properties.

Many types of sensors are compatible with the KFD wireless communications component. Thermocouples, strain gauges, chemical sensors, and pH probes now can be placed midstream in process lines for reliable, long-term monitoring.

The award-winning knife blade failure detection system exemplifies the technologies being developed in collaboration with industry, government, and universities in the new Food Science and Process Measurement Laboratory at PNNL. Patented as the Acoustic Emission Severance Detector and Method, the KFD demonstrates a high technology solution to a commonplace problem that is economically attractive to the private sector, even to industries with a very small profit margin.

For further information on the Acoustic Emission Severance Detector technology, contact:

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