

Outsmarting Chemical Leaks

New sensor-driven piping system detects and warns of toxic emissions.

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A new sensor-enhanced piping system could soon improve the ability of heavy industry and local utilities to detect chemical spills, natural gas leaks, and groundwater contamination.

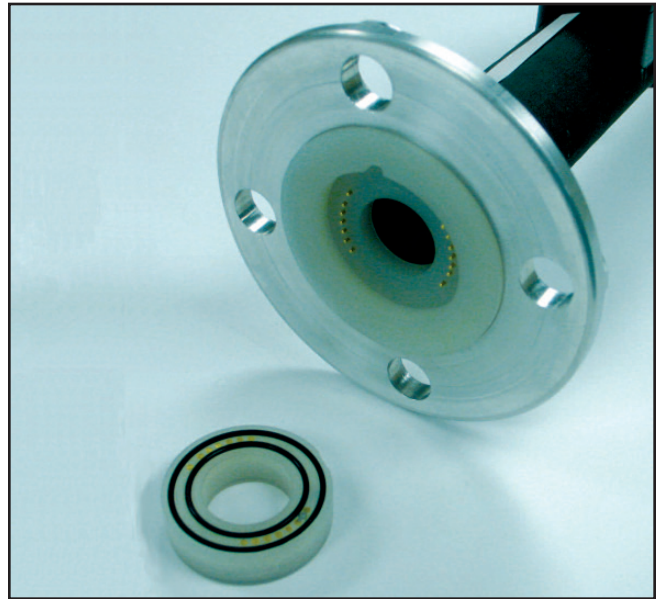
Odyssian Technology, LLC (South Bend, IN), is developing “smart” pipes, an innovative tubing system with embedded wireless, networked sensors that could be widely used for detecting chemical leaks of any kind. Smart pipes are manufactured from lightweight composites and could easily be installed to replace aging metal or copper piping, such as natural gas lines or piping used in municipal water systems.

MDA originally funded Odyssian’s smart piping system through a 2005 SBIR Phase II contract for developing a lightweight containment system to detect imminent leaks in high-energy, chemical-oxygen-iodine laser systems used aboard military aircraft. Odyssian is now doing further work through an extension to this Phase II project, due to be completed by August 2008.

The primary purpose of Odyssian’s smart piping system is to protect onboard personnel, electronic systems, and aircraft structure through leak detection of corrosive and toxic chemicals, such as chlorine. If leaked into the aircraft cabin, such chemicals can be a serious health and safety hazard to confined military personnel. Leaking of corrosive gases also can pose a threat to the structure and electronic systems by corroding aluminum, titanium, and nickel components. Odyssian’s sensor-laden seals and pipes that make up the smart-piping system have redundant containment structure and sealing surfaces as well as a sensor placement scheme that provides leak-progression detection, allowing for the detection of an imminent leak before a leak occurs. The smart piping system also allows the operator to monitor the operational status of the plumbing system by measuring and reporting system pressure, temperature, and vibration at each fitting and pipe segment.

The technology’s advanced sensor system uses an array of MEMS (microelectromechanical system) and other micro- and mini-sensors that are located inside the pipe’s composite laminar flow structure as well as within the specially developed seals. The sensor system is made up of networked sensor nodes that have unique addresses to provide correlation of sensory data to specific seals, gaskets, and pipes within the plumbing system.

Odyssian President Barton Bennett said his company’s smart piping system provides the added benefit of reducing weight. Because the system has sensors that detect the



▲ Odyssian’s “smart” seal and pipe technologies incorporate advanced sensors to detect and warn of chemical or toxic leaks.

presence of corrosive chemicals, Odyssian can use lighter-gauge metal and composite materials that would otherwise degrade from prolonged exposure. The company estimates that it can provide weight savings of between 30 percent and 40 percent over a baseline metallic piping system.

Having a solution that helps reduce global warming caused from greenhouse gas emissions is a significant commercialization priority for Odyssian. To help accomplish this goal, the company is developing smart seal and smart piping system technology for use with natural gas lines. A major constituent of natural gas is methane, which is a large contributor to global warming, second only to carbon dioxide. Odyssian’s work has included developing sensor-enhanced two-piece “boots,” which can be placed around the welded joints of pipelines.

Although the smart piping system for natural gas still needs a commercial benefactor, Odyssian has forged ahead, working with officials in South Bend, IN, to develop low-cost composite piping with integrated sensors and seals for the city’s municipal water system. The technology will provide almost instantaneous detection of leaks and early-warning notice of structural deficiencies in water lines. Such functions are not currently available with conventional infrastructure.

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The company also is considering applications in the automotive industry, specifically in the area of environmental cleanup. One potential application using the smart pipe technology involves developing smart gaskets—such as head gaskets, oil-pan gaskets, and fuel-filter gaskets—that could alert a driver of oil or fuel-system leaks. Bennett said the sensors' ability to do this could help prevent possible groundwater contamination if the defective gaskets are promptly repaired.

Odyssian is interested in teaming with suppliers to develop smart systems that detect an imminent leak within an automotive air-conditioning system. Bennett said that mobile refrigerant-containment systems, such as those used in automobiles, are subjected to vibration and large swings in temperature that can cause leakage at threaded fittings. Refrigerants are known to cause depletion of the stratospheric ozone layer, and some of the new replacement refrigerants are potent greenhouse gases—up to 1,300 times as potent as carbon dioxide.

Another technology that the company has developed is a sensor veil for use with automobile fuel tanks. This technology integrates a sensor grid, or veil, that can detect the presence of leaks. Sensors in current technology are found only in

dual-wall tanks, simply providing notice if gas already has leaked somewhere within the inner-wall space. The advantage of Odyssian's sensor-grid technology is that it identifies the location of the leak within the tank, helping reduce the cost of repair.

Other opportunities envisioned for Odyssian's smart-pipe technology include aircraft, naval vessels, chemical factories, and industrial refrigeration and chiller systems.

Odyssian was recently issued a patent on its smart-seal technology, and the company awaits further protection of other related technologies. Bennett said that to achieve commercialization, Odyssian will license its recently issued patent to seal and gasket companies. The company will also pursue contracts to engineer and install advanced containment systems and will entertain offers for exclusive partnerships. 

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