Researchers Isolate Microorganisms That Convert Hydrocarbons to Natural Gas

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(PhysOrg.com) -- When a group of University of Oklahoma researchers began studying the environmental fate of spilt petroleum, a problem that has plagued the energy industry for decades, they did not expect to eventually isolate a community of microorganisms capable of converting hydrocarbons into natural gas.

The researchers found that the groundbreaking process—known as anaerobic hydrocarbon metabolism—can be used to stimulate methane gas production from older, more mature oil reservoirs like those in Oklahoma. The work has now led to the recognition that similar microorganisms may also be involved in problems ranging from the deterioration of fuels to the corrosion of pipelines.

A new OU initiative led by Joseph Suflita, Director of the Institute for Energy and Environment within the Mewbourne College of Earth and Energy, brings together researchers from multiple disciplines and departments to attack the corrosion problems affecting pipelines, storage tanks and tankers as well as the deterioration of fuels inside such facilities. Suflita says, "The OU initiative is the only major U.S. initiative of its kind devoted to the problem of biodeterioration and biocorrosion."

Biodeterioration and biocorrosion are fundamental microbiological processes that can cause pipelines, storage facilities and tankers to leak and contaminate the environment. "First, we have to understand how Mother Nature cleans up these spills and we can do this by studying the

way microorganisms interact with hydrocarbons," says Suflita. OU researchers have isolated some interesting organisms that metabolize hydrocarbons in the absence of oxygen—insight that was lacking for a long time.

OU researchers have extended their studies to how energy is produced in this country by investigating biocorrosion that leads to pipeline failures on the North Slope of Alaska. "We want to better understand how organisms eat through these pipelines. Several fundamental mechanisms cause this problem, but it is spotty and doesn't occur all of a sudden. Rather, biocorrosion occurs over a long period of time, and we are using a series of new molecular and chemical tools to find out why and how this happens," says Suflita.

"We think cells grow in communities that adhere to the inner surface of pipelines and form three-dimensional biofilms that can sometimes cause pitting. Once we understand what these microorganisms are doing, we can interrupt their processes or diagnose them more effectively. The science is rudimentary at this stage. The modern tools of molecular microbiology have not been applied yet, but a National Science Foundation grant, support from the DOE's Joint Genome Institute and the cooperation of the energy industry, allowed us to study pipeline biocorrosion on the North Slope."

Interruptions in energy supply are significant and cause price spikes that have global impact. Over 500,000 miles of pipeline that crisscross the United States carry over 75 percent of crude oil and 65 percent of refined product. Problems occur throughout the industry, in storage facilities, refineries and tankers, and have similar consequences. Microorganisms grow inside the pipelines because water often accompanies hydrocarbons pumped from the ground. As reservoirs age, more water is pumped creating an even greater problem.

"For many years, no one ever thought anaerobes could grow by metabolizing hydrocarbons in the absence of oxygen, but that is simply wrong. The organisms are actually quite good at it. The underlying mechanisms will be even more important as we introduce newer biofuels to augment our fossil fuel supply. We are putting new fuel combinations into the existing pipelines that service the entire country. The new biofuels can be less stable, so there is a different problem to deal with. The chemistry of biofuels may not allow us to store them as long and more research is needed to determine the stability, compatability and composition of such fuel mixtures."

While biocorrosion and biodeterioration can be problematic, anaerobic hydrocarbon metabolism also has an upside. The OU researchers found that they can use their organisms to convert hydrocarbons in oil reservoirs to natural gas. "Because two-thirds of U.S. oil is still in place, we can use these organisms to convert residual hydrocarbons into natural gas and create a new source of domestic energy. The concept of anaerobic metabolism is an innovative process and the OU initiative is the only one of its kind in the United States at the present time. We are also experimenting with shales and other unconventional reservoirs."

"Biotechnology can influence recovery and address some of today's problems if we can understand how microorganisms degrade hydrocarbons in the absence of oxygen. OU is one of the top universities in the world to study anaerobic microbiology with 14 experts performing research in some aspect of this field. It is rare for universities to have even a single individual with this specialization. OU is an exciting place to be if you are an environmental microbiologist. This initiative has unified this group of experts and led to the groundbreaking research we have just begun to understand."

"We know that bacterial cells communicate much like those that cause disease. If we know the language they use, we can send signals and

interrupt their communications so they will change their behavior. The best way to treat the biocorrosion problem has not yet been determined. Active ongoing monitoring of pipelines tells us there is an ongoing process, but we need to get to the problem before it gets to the critical stage. Some and perhaps most microorganisms are not routinely monitored, so we have to understand the role they play in this process—information we can use to more effectively diagnose and treat the consequences."

Provided by University of Oklahoma