

[OIL]

Challenge at the bottom of the sea

Oil exploration in the depths of the ocean includes a little-known obstacle and one that is capable of causing a lot of difficulties for oil companies: the presence of microorganisms that break down oil. In addition to the forces of nature, like sea currents and the pressure at the bottom of the sea that force the use of state of the art technology when it comes to installing oil rigs, they are yet another challenge to be overcome. Various species of bacteria live both in reservoirs as well as in the water found in oil wells and feed on oil breaking it down; they even secrete biofilms, molecular structures that they use to protect themselves against toxic agents and attach themselves to rocks and sediment.

With the start of underwater production, biofilms, which can also be formed by the agglutination of the bacteria themselves, are beginning to become attached to plastic and metal. These micrometric-sized structures accumulate and reach a thickness of up to 4 millimeters (mm). “The problem is that these biofilms hamper oil exploration because they stick to the inside of tubing and corrode pipelines, which are difficult to clean”, says Professor Anita Marsaioli, from the Institute of Chemistry (IQ) at the State University of Campinas (Unicamp), who is taking

part in several projects with Petrobras to identify and study these bacteria and the enzymes that produce them.

When it breaks down some of the highly valuable oil is partially or totally destroyed, thus reducing its commercial value. “The bacteria transform the hydrocarbons into fatty acids, making the oil heavier and of poorer quality”, says Anita. Better knowledge of this population of bacteria and the conditions that are favorable to them is going to contribute to the preparation of strategies for the company to reduce the exploration risk and act to detect and anticipate the problems they will encounter in the production process. There is also an immense potential for the future use of some of these microorganisms for cleaning up oil spills using biotechnology. “We know of the existence of bacteria, for example, that produce biosurfactants that have a dual function, to inhibit the growth of other bacteria species, which is good, and at the same time dissolve the oil.” Biosurfactants are molecules produced by bacteria that reduce the surface tension at the interface between the water and oil in the reservoirs, which facilitates the mixture of these liquids and the subsequent breaking down of the oil.

The studies being carried out at Unicamp in partnership with the Petrobras Research and Development

Petrobras and Unicamp are studying bacteria from oil wells that break down oil | MARCOS DE OLIVEIRA

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Center (Cenpes) are done with water and oil taken from the Campos Basin. The bacteria live both in the area between the oil and water in the wells, as well as separately in either of these environments, at depths of 2,800 meters, according to studies carried out so far, in temperatures close to 80° Celsius, as in the Pampo Field, which is almost 100 km offshore from the coast of Rio de Janeiro. “To study these materials we receive samples of water and oil direct from the rigs in sealed glass vessels. Here in our laboratories

in Campinas we grow these bacteria in various environments”, says Anita.

One of the scientific reasons for studying these bacteria is to find out if they are aerobic or anaerobic; the former need oxygen to live while the latter do not. This is fundamental for understanding the formation of these bacteria and the way of dealing with them in oil exploration. “Oil reservoirs are an anaerobic environment, but we believe that there may be micro-environments where oxygen is produced, mainly because of water that enters the wells or through chemical reaction”, says Anita. In the work being done by the group, which includes geologist Eugênio dos Santos Neto, from Petrobras, 29 bacteria of both types have already been identified and assessed; most of these bacteria showed a tendency to biodegrade oil. So far, the studies show that the strains of bacteria that produce a lot of biofilm, from the aerobic group, do not break down oil.

The researchers are working on the hypothesis that the coexisting relationship between the aerobic and anaerobic bacteria, such as, for example, the biofilm that is produced by the former, may serve as an oxygen “sponge” and act to increase or reduce the degradation activity of the others. All of the bacteria found in the wells and analyzed, many of them unknown to sci-

ence, form part of a Petrobras collection that is kept by Unicamp.

The research group’s activities include the participation of Professors Luzia Koike and Francisco Machado Reis, from the Unicamp IQ, and Professor Valéria Maia de Oliveira, from the Chemical, Biological and Agricultural Research Center (CPBQA), at the same university. Since 2003, the group has received more than R\$ 10 million for research from the Oil Sector Fund (CTPetro) and the Geochemical Theme Network, one of the Petrobras technology networks, supported with company funds that are the equivalent of 0.5% of the oil it produces from its highly productive fields, which by federal law, must be used for research purposes in partnerships with universities. ■

THE PROJECTS

1. Expansion of the analytical infrastructures in chemistry, metagenomics and biocatalytics by the organic geochemistry group of the Chemistry Institute and the Microbial Resources Division of the CPQBA at the State University of Campinas
2. Multidisciplinary study into biodegradation

TYPE

1 and 2 Thematic Network

COORDINATOR

1 and 2 Francisco Machado Reis - Unicamp

INVESTMENT

1. R\$ 3,504,189.57 (Petrobras)
2. R\$ 3,101,932.51 (Petrobras)

Scientific article

CRUZ, Georgiana F. da; SANTOS NETO, E.V.; MARSAIOLI, A.J. Petroleum degradation by aerobic microbiota from the Pampo Sul Oil Field, Campos Basin, Brazil. *Organic Geochemistry*. v. 39 p. 1.204-209, 2008.