Online Monitoring of Crude Oil Biodegradation at Elevated Pressures

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Abstract:

In order to study the biodegradation of crude oil spilled in the deep sea, incubations of deep-sea-bed sediments and crude oil were carried out in a high-pressure reactor, but monitoring the biodegradation of oil at high pressure is limited by sampling because the volatile crude oil components are partly lost during depressurization. Moreover, the seawater-oil-sediments multiphase system cannot be sampled representatively. The aerobic oil biodegradation can also be monitored indirectly by measuring the oxygen consumed and the carbon dioxide produce. In this paper, the O_2 and CO_2 concentrations were monitored in a reactor with transparent windows using chemical-optical sensors. To compare the effect of pressure on the biodegradation of oil, two pressure regimes were compared: atmospheric pressure (1 bar) and 150 bar, corresponding to 1500 m depth of the Deepwater Horizon´s well at the Gulf of Mexico. Only in the experiments where deep-sea sediments were added, the oxygen concentration decreased while the carbon dioxide and the bacterial concentration increased. In experiments where no sediment was added, the values for the oxygen and carbon dioxide remained constant. This proved that deep-sea sediments contained microorganisms, which could degrade crude oil at both 1 and 150 bar. To our knowledge, this is the first time where O_2 and CO_2 were monitored online during crude oil biodegradation at high pressure in the laboratory.

Keywords: biodegradation, chemical sensors, image analysis, monitoring O_2 / CO_2, oil pollution, sea floor