ARC '16

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http://dx.doi.org/10.5339/qfarc.2016.EEPP2211

Sensitive Spectroscopic Analysis of Isotopes for Characterization of Crude Oil and Well Gas Samples

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Oilfield reservoir characterization with a nonradioactive Kr isotope tracers with collinear fast beam laser spectroscopy (CFBLS) has been developed in our laboratory and has unprecedented sensitivity, selectivity and dynamic range. It provides efficient method of reservoir mapping, which is much safer than commercially available radioactive isotope based enhanced oil recovery approaches. Our approach can be used in far and near borehole surveys and to quantify fracturing efficiency. The analytical system uses mass separation in conjunction with highly selective laser excitation and sensitive optical detection. For similar applications we also implemented a novel optical spectroscopy based on frequency comb lasers (FCL) that have a regular comb structure of millions of laser modes for ultra broad band detection. Especially in the infrared, a plethora of green house and other gases have molecular fingerprint spectra that can be studied with FCL, based mainly on the Er-, Yb-doped fiber lasers with their wavelength ranges extended by optical parametric oscillation processes, supercontinuum or difference-frequency generation. We present our work on trace isotope detection that utilized both techniques. As examples we describe analysis of crude oil and well gas samples based on the research in Qatar, and the monitoring of the methane content of seawater in the aftermath of the oil spill in the Gulf of Mexico. This work was supported by the by the Robert A. Welch Foundation grant No. A1546 and the Qatar Foundation under the grant NPRP 5-994-1–172.

Cite this article as: Kaya N, Rahman J, Strohaber J, Amani M, Schuessler H. (2016). Sensitive Spectroscopic Analysis of Isotopes for Characterization of Crude Oil and Well Gas Samples. Qatar Foundation Annual Research Conference Proceedings 2016: EEPP2211 http://dx.doi.org/10.5339/qfarc.2016.EEPP2211.