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Chemical and Physical Sensing in the Petroleum Industry

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World-scale oil, gas and petrochemical production relies on a myriad of advanced technologies for discovering, producing, transporting, processing and distributing hydrocarbons. Sensing systems provide rapid and targeted information that can be used for expanding resources, improving product quality, and assuring environmentally sound operations. For example, equipment such as reactors and pipelines can be operated with high efficiency and safety with improved chemical and physical sensors for corrosion and hydrocarbon detection. At the interface between chemical engineering and multiphase flow physics, "multi-scale" phenomena such as catalysis and heat flow benefit from new approaches to sensing and data modeling. We are combining chemically selective micro-cantilevers, fiber optic sensing, and acoustic monitoring with statistical data fusion approaches to maximize control information. Miniaturized analyzers represent a special opportunity, including the nanotech-based quantum cascade laser systems for mid-infrared spectroscopy. Specific examples for use of these new micro-systems include rapid monocyclic aromatic molecule identification and measurement under ambient conditions at weight ppb levels. We see promise from emerging materials and devices based on nanotechnology, which can one day be available at modest cost for impact in existing operations. Controlled surface energies and emerging chemical probes hold the promise for reduction in greenhouse gas emissions for current fuels and future transportation and energy technologies.