Analysis of Bore-hole Gas with Direct Quadrupole Mass Spectrometry

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Direct quadrupole mass spectrometry (DQMS) applied to analysis of bore-hole gas while drilling provides useful insight into petroleum systems, and can be used for reservoir characterization. Conditioned gas is continuously presented to the instrument through a standard gas line, and is sampled via a short capillary bleed without boiling point separation, allowing complete analysis of C1-C10 and inorganics in 90 seconds. Interpretation of DQMS data benefits from the large body of information available from fluid inclusions trapped in rock material, and the analysis of these fluids with analogous instrumentation. Five potential application areas are discussed. 1) Petroleum Type and Quality: Applications include distinction between oil and gas, wetness, fingerprinting of multiple oils or gases in stacked pay reservoirs, and identifying and quantifying undesirable gases. 2) Fluid Contacts: DQMS has been used to identify oil-water, gas-water, and gas-oil contacts using variations in hydrocarbon wetness, inorganic species, and water soluble species such as benzene and toluene. Concomitant increases in selected species, and decreases in others (in response to solubility, for instance) are particularly useful. 3) Water Saturation and "Proximity to Pay": The selective concentration of certain hydrocarbon and non-hydrocarbon species in water is well established, and this concept has been used for many years to assess proximity to charge, and transitions from petroleum columns to water bearing intervals. Water-soluble halos typically extend several miles away from the petroleum-water contact, providing a method of detecting nearby accumulations from water bearing reservoirs. If producible water is localized, and can be isolated or avoided in tight or fractured formations, then water treatment and disposal issues may be less severe. 4) Porosity/ Permeability and Fracture Detection: Porous intervals in tight rock often display characteristic light-end enrichment arising from differential mobility of species as a function of molecular size. Faults or fractures have variable chemical character on DQMS data, depending on whether they are open, and whether they are localized within the penetrated formation or are throughgoing to shallower or deeper formations. If not vertically sealed in horizontal wells, these fractures can represent leak points that may cause production problems, including water production. 5) Compartmentalization: Changes in fluid chemistry often correlate with differences in rock characteristics that may impact completion and affect production characteristics. Constraining stages wholly within sections of rock that have similar fluid chemistry, rock chemistry, and rock properties (particularly conventional or fracture porosity) generally results in more efficient distribution of induced fractures; thus more effective use of stimulation materials. If water, CO_2, or unwanted heavier hydrocarbons are shown to be localized, those zones can be avoided.