Real-Time Detection of Drill Bit Metamorphism for Accurate Interpretation of Hydrocarbon Shows

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Abstract

In an ongoing effort to progress the understanding of advanced mud gas data we point out that failure to recognize bit burn gases can lead to severe misinterpretation of data. Bit burn gases form during drilling operations when the temperature at the bit rises to a level that enables thermal cracking of hydrocarbons. The alkenes ethylene and propylene that form during the cracking process do not naturally occur in hydrocarbon reservoirs and are hence a proxy for drill bit metamorphism.

Retention times for alkanes, i.e. ethane or propane, and alkenes are extremely similar when using a conventional mud logging gas chromatograph. The inability to distinguish the two types of gases can lead to overestimating the presence of alkanes in a well or in the worst case misinterpreting fluxes of purely bit burn gases as actual hydrocarbon shows.

As a mass spectrometer differentiates on the basis of molecular weight, alkanes can readily be distinguished from alkenes with this technique. We developed a fully automated algorithm that converts mass spectrometry data in to accurate concentrations for both alkenes and formation hydrocarbons even when the sample is contaminated with atmosphere and drilling fluid vapors. Mud gas analysis is done at the wellsite with calculations being performed each minute thus allowing real time interpretation of gas shows.

Application of the method on several wells has demonstrated a correlation between age of the drill bit, lithological properties, and level of bit burn gases being formed. Drill bit metamorphism is generally observed towards the toe of the well when the drill bit becomes worn. Moreover, in places where the formation is more resistant to the drill bit, alkenes are recorded shortly lagging the lithological change. This is due to the time needed for the bit to heat up to a temperature sufficiently high to crack hydrocarbons. Detection and quantification of bit burn gases with the method developed in this study leads to a better real-time assessment of the hydrocarbon potential of a well.