Method for Fluid Phase Typing Using Real-time Mud Gas Data

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Abstract

Predicting hydrocarbon fluid phase during drilling is an important factor that can guide logging and testing decisions, which lead to improved operational efficiency. Typically, fluid phase cannot be determined accurately until, pressure, volume and temperature (PVT) samples are collected and analyzed during logging operations. This study presents an approach to identifying hydrocarbon presence and phase from advanced mud gas data based on a comparative analysis to pressure, volume and temperature (PVT) fluid data trends. The approach consist of three main steps, (1) data quality assurance, (2) gas oil ratio (GOR) prediction from mud gas data and (3) creation of PVT fluid profile reference envelopes. Mud gas data conditioning, focusing on determining zones of significant hydrocarbons, based on an established total gas cut-off was carried out for a number of representative datasets. This was followed by evaluating drill-bit metamorphism (DBM) for each data set using an ethene index [$C_2H_4/(C_2H_4 + C_2H_6)$], this index is noted to increase in zones with high mud-cracking. Total gas cut-offs below a threshold value along with high ethene index zones were eliminated from the phase prediction analysis as they signify non-representative gas shows. The resulting conditioned datasets were then used to calculate dryness index [$nC_1/(nC_1+nC_2+nC_3+iC_4+nC_4+iC_5+nC_5)$] values. This index is demonstrated to show a predictable correlative relationship with changing PVT gas oil ratio (GOR) measurements for a series of fluid types from stratigraphically distinct reservoirs. Finally, eight normalized PVT fluid profiles were created by dividing every individual normal alkane by the sum of the nC_1 to nC_5 alkanes for a series of representative fluids. The fluid profiles range from heavy oil to dry gas and act as reference envelopes upon which normalized mud gas data are plotted to predict fluid type. Conditioned advanced mud gas data profiles plotted against sampled PVT fluid data profiles show a high-level of correspondence suggesting a reliable method has been put forward for fluid phase prediction from mud gas data. This method's reliability of predicting fluid phase is noted both in oil-based and water-based mud systems (leading to wide potential deployment), where a comparison between PVT and advanced mud gas data dryness index values, for the studied wells, resulted in an R2 of >0.90. The methodology presented in this work suggests that conditioned advanced mud gas datasets represent accurate and reliable means for determining both hydrocarbon presence and phase. It is further suggested that this relatively inexpensive dataset can be increasingly used to verify, and in some cases prevent the need for, PVT data sampling.