Quantification of Low Levels of Mercury in Gas Reservoirs Using Advanced Sampling and Analysis Techniques

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Abstract

In addition to health, safety, and environmental issues, the presence of mercury can potentially have a huge impact on the economics of a gas development project. A mercury removal unit (MRU) must be designed in order to reduce mercury concentrations to below detectable levels to prevent such issues as liquid metal embrittlement (LME) which could lead to catastrophic events. It is therefore imperative to accurately quantify levels of mercury in a gas reservoir to design gas processing and mercury removal equipment accordingly.

Without consistent and precise procedures, accurate quantification is challenging with current technologies used in laboratory apparatus, especially when concentrations of mercury are very low. The conventional method of mercury content quantification is by analysis of samples captured either with wireline formation testers or while drillstem testing (DST) a well. However, these measurements are rarely in line with what is observed once a field is put on production. Loss of mercury due to adsorption by a DST string or by the metal surfaces of sample chambers and sampling tools is significant, especially when the sampling point is thousands of feet away from the producing reservoir. In addition to reaction with metals, test results have also shown how mercury can go undetected if reservoir fluid samples are compromised by small amounts of drilling fluids or mud filtrate. There have been a number of catastrophic failures in gas processing plants attributed to liquid metal embrittlement, such as the explosion at the Skikda LNG plant in Algeria in 1973, or the more recent 2004 New Year’s Day Moomba gas plant fire which was confirmed to be due to LME in an aluminum vessel.

Workflows detailing procedures for capturing, storing, if required, and analyzing representative gas samples for the quantification of low levels of mercury have been developed, tested, and proven. Results of recent experiments conducted simulating downhole sampling conditions reveal the reasons why there have been numerous cases in which false negative results were obtained from laboratory analyses. Advanced focused sampling methods together with accurate downhole fluid analysis with wireline formation testers have been applied in the field to provide representative reservoir fluid samples for quantification of mercury levels.

Introduction

Mercury is a naturally occurring component found in trace amounts in most natural gas fields around the world. Although the concentration of mercury in natural gas was better understood and accepted. The catastrophic failure at Skikda that led to the explosion occurred in one of the six trains of the LNG plant which lacked a mercury removal section. It was later found that the corrosion was caused by mercury in aluminum tubes, constructed of aluminum alloy 6061 (Bingham 1990). After the Skikda failure, similar corrosion issues were discovered in the gas gathering system of the Groningen field in Holland, where CO₂ was initially thought to be the reason, but later investigations indicated the cause was mercury contained in the produced gas, in concentrations of up to 180 μg/m³ (Phannenstiel et al. 1976). In Australia, the cause of an explosion of a gas processing facility was traced to the liquids recovery plant where a flange weld on an inlet manifold failed due to corrosion by mercury (Government of South Australia 2011).

Two major types of mercury corrosion are known to occur; these are amalgam corrosion and LME. Metals capable of forming an amalgam with mercury suffer from the former type. If an oxide layer is formed on a metal surface, it becomes