



INNOVATIVE ONSITE, INSTANT OIL-BASED MUD (OBM) CONTAMINATION MEASUREMENTS FOR NEWLY DRILLED WELLS

Well sampling allows you to assess and plan for the future production of your oil or gas well. When you are at the stage of exploration drilling and well appraisals, reliable representative fluid samples are critical for accurate analyses. Precise measurements lead to efficient plans for the life of your well or reservoir. For oil and gas wells drilled using an oil-based mud (OBM), reliable down hole sampling can be difficult to achieve due to the OBM contamination. A representative sample cannot be taken until the OBM is no longer present.

In many cases, weeks or even months of production are lost while operating companies wait for PVT and flow assurance analyses. Often companies learn weeks later that analyses could not be performed or that the data was compromised because of high drilling mud contamination. To avoid this, it is common practice for a drilling rig to flow a well for an extended period of time (from hours to days) for well clean up before taking the bottom hole samples that are needed for the analysis.

Recognizing the issues associated with OBM contamination SGS Upstream Services developed onsite services to ensure reliable, representative down hole samples can be collected from your well or reservoir at the earliest possible moment, saving you both time and money.

Drilling rig costs can run to one million or more US dollars per day. So reducing the time a drilling rig is used will greatly reduce your costs and bring your well into efficient production much sooner. Once we are onsite, we provide you with hourly OBM contamination information, pinpointing the exact time contaminant-free produced fluids from your newly drilled well can be extracted analyzed, and brought back online for production.

ABOUT OBM CONTAMINATION MEASUREMENT

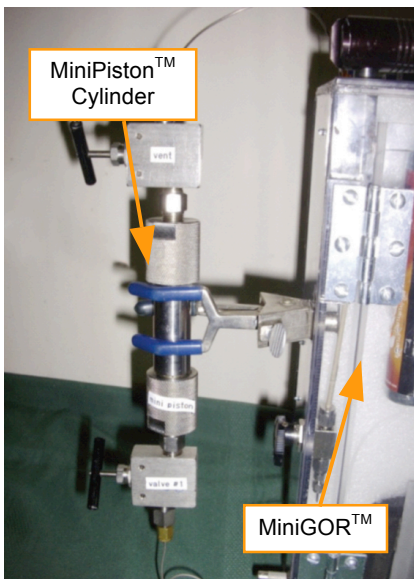
SGS Upstream Services provides real-time data analysis of the OBM contamination during well clean up. The analysis is capable of measuring OBM contamination below 1.0 wt% with a relative error of $\pm 0.1\text{wt}\%$. These measurements are made using SGS's proprietary MiniGOR™ flash apparatus and GC System. We install these at the site of your well or reservoir to provide you with immediate and accurate on-site data. Shortly after our installation we start making regular hourly fixed lab quality data analyses of OBM contamination. Our on-site service means you have this information immediately.



The MiniGOR™

The MiniGOR™ system is a single stage flash apparatus that allows for pressurized samples to be flashed to atmospheric conditions and permits isolation and collection of the separated phases (i.e. gas, oil, and water). The collection vessels for the gas and liquid fractions are temperature controlled, allowing for an accurate determination of the Gas to Oil Ratio (GOR) as well as retaining elevated temperatures for gas samples to avoid condensation of heavy

components. This instrument allows for onsite GOR and shrinkage measurements of live oil samples and gas condensates. The liberated phases can be easily stored or immediately analysed using a Gas Chromatograph. Oil samples are collected at the separator or directly from the well head using SGS's MiniPiston™ Cylinder, which is then used to flash directly into the MiniGOR™ system.



MiniPiston™ mounted to MiniGOR™

The method for flashing a sample through the MiniGOR™ results in Gas Oil Ratio (GOR) measurements with $\pm 1\%$ relative error and an overall repeatability of under 2%, giving you real-time GOR and shrinkage values that you can trust. The compositional data is collected using Gas Processors Association (GPA) methods, which are industrial standards for the measurement of natural hydrocarbons. These standards are used for extended gas analysis up to C_{14+} and liquid analysis up to C_{36+} .

BENEFITS OF THE SGS SOLUTION

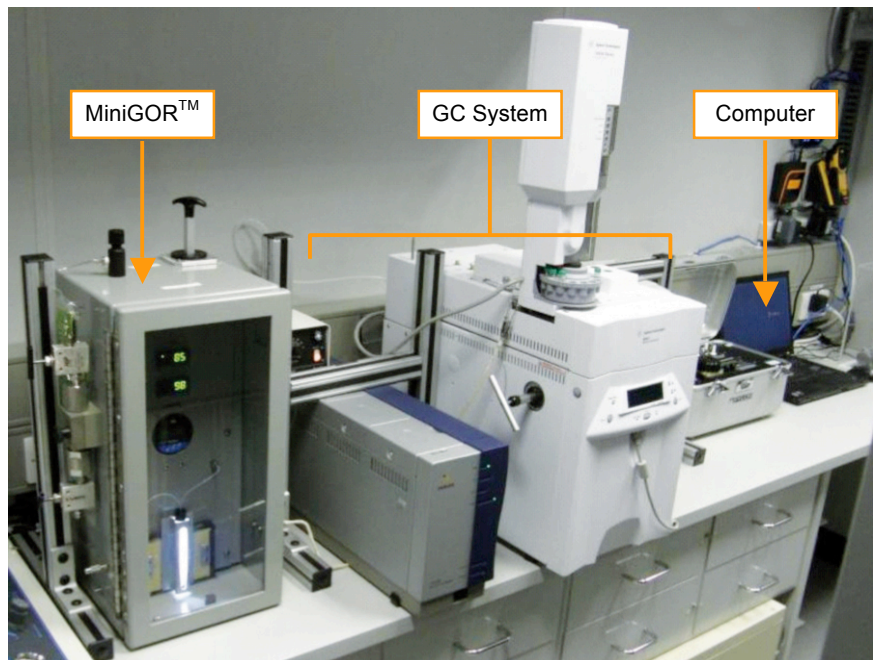
As an independent third party, SGS brings you fast, data analyses onsite. Our service has numerous benefits, not least of which is providing you with immediate results, saving you both time and money.

SGS's MiniGOR™ and GC System are practical for onsite analysis due to their value, size, reliability, and accuracy. When a well is sampled for the first time or after a shut in, it is common practice to allow the well to flow for an extended amount of time to ensure clean samples are obtained. However, we can provide reliable and detailed hourly analysis of produced fluids onsite. This means you know precisely when a well is no longer contaminated and can be sampled or switched on for production, dramatically reducing the time your well is off line.

Our analytical equipment can be readily packaged and transported by commercial shipping companies, which means that shipment can be arranged at short notice ensuring arrival of the equipment as quickly as possible.

A further benefit is the foot print the equipment requires onsite to perform an analysis. Conventional flash systems are large and including space for a GC unit and computer require the space of a small office. SGS's MiniGOR™ and GC unit can operate atop a small table in that same office. Our system takes only a couple of hours to set up and can be running immediately afterwards.

The rugged design of the MiniGOR™ makes it suitable for travel, meaning that it can be transported to and used in some of the hardest to reach and most extreme environments. It is designed to handle the rough conditions of shipping and operates well in hot, cold, dry, or humid regions due to its temperature controlled, isolated collection vessels making our service possible in whatever the location of your well or reservoir, be it desert, deep water or frozen conditions.



Analytical Apparatus Set-up

OFFERING OUR CUSTOMERS THE BEST SOLUTION

Here is an example of a situation where our MiniGOR™ and GC System was recently used to help one of our customers evaluate when an efficient analysis of their newly drilled well could be performed. The customer drilled an appraisal well using oil-based mud and needed bottom hole samples for analysis. The cased hole, extended reach, horizontal well was to be sampled once the produced oil was free of contaminants. A competitor oil service company and SGS were hired to perform onsite contamination measurements so that the customer would be able to compare the results. SGS was contracted to collect wellhead and separator samples during the initial flow of the well to measure composition with a particular focus on the degree of OBM contamination. The data collected was relayed to the customer's engineers so they could follow the progressive improvement of effluent quality.

Our procedure

The SGS MiniGOR™ system, proprietary GC, air compressor, hydrogen generator, and other peripherals were shipped to the drill site location and were fully operational three hours after unloading. Sample analysis followed a few hours later. Samples were collected at the wellhead and test separators during the initial flow of the well. Well test separator liquid and gas samples were collected and analysed every hour over a three day period. Immediate results were given to onsite engineers and electronic copies were sent to company headquarters. Samples of the drilling mud collected during drilling were analysed to determine the contaminant fingerprint. Samples were centrifuged to separate mud liquid from the mud solids and the liquid filtrate was then analysed

via temperature programmed, extended gas chromatography along with density measurements. A sample of virgin mud was also analysed for composition and density. The information from these analyses was used to identify the contaminated regions and allowed for OBM contamination calculations.

At specific times, crude oil was flashed from the wellhead sampling valve and collected in a small vial. These samples were centrifuged to separate any solids and water phases prior to further analysis. The crudes were then analysed for composition and density. From this data the corrected Oil Gravity (API) and OBM Contamination (wt%) were determined. The OBM contamination at the initial flow of the well was measured at 41.2 wt% with a corrected API gravity of 26.3°API. After the well was allowed to flow for 63.4 hours, the OBM contamination was measured at 0.4 wt% with a corrected API gravity of 19.3 °API.

Accuracy of the information

A number of independent studies have been performed to determine the minimum amount of OBM contamination for representative formation samples. The results of these studies describe the acceptable range from 20 to 1 wt% depending on the fluid in question. In this case study, SGS successfully measured OBM contamination below 1.0 wt% with a relative error of ± 0.1 wt%. A summary of this data can be seen in Figure 1. The OBM Contamination and Corrected Oil Gravity were also plotted as a function of time to show the cleanup of the produced oil. (Figure 2)

In this situation, SGS provided the customer with analyses that allowed them to successfully determine well cleanup in regard to subsequent bottom hole sampling. Our services saved this

customer over \$1 million USD/day in rig costs by defining when the well was ready for subsurface without the need for additional production.

WHY SGS?

SGS is the world's leading inspection, verification, testing and certification company. Recognized as the global benchmark for quality and integrity, we employ over 64 000 people and operate a network of more than 1 250 offices and laboratories around the world. We are constantly looking beyond customers' and society's expectations in order to deliver market leading services wherever they are needed.

Partnering with SGS opens the door to better performing processes, increasingly skilful talent, consistent and compliant supply chains and more sustainable customer relationships delivering profitable competitive advantage. Work with the global leader and take your commitment to the next level.

We have a history of undertaking and successfully executing large-scale, complex international projects. With a presence in every single region around the globe, our people speak the language and understand the culture of the local market and operate globally in a consistent, reliable and effective manner.

TO LEARN HOW SGS CAN HELP YOU ANALYSE THE OIL-BASED MUD CONTAMINATION OF WELL OR RESERVOIR VISIT WWW.SGS.COM OR CONTACT OGC@SGS.COM FOR MORE INFORMATION.

SAMPLE (TIME, HRS)	WELLHEAD PRESSURE, PSIG	WELLHEAD TEMPERATURE °F	CENTRIFUGE ANALYSIS, VOL%		OIL GRAVITY, °API		OBM CONTAMINATION WT%
			OIL	BS&W	MEASURED	CORRECTED*	
0.0					28.0	26.3	41.2
5.7	165	80.8	80.8	19.2	20.9	20.0	8.3
7.3	140	82.6	83.7	16.3	20.5	19.8	6.7
10.0	130	82.6	86.7	13.3	20.3	19.7	5.2
12.0	140	82.6	92.9	7.1	19.9	19.4	5.1
14.0	130	82.6	94.6	5.4	19.4	19.0	3.7
16.0	130	80.8	95.0	5.0	19.8	19.4	3.3
18.0	135	82.6	95.0	5.0	19.4	19.3	1.8
27.7	155	82.6	94.8	5.2	19.2	19.1	1.0
33.3	165	98.8	95.3	4.7	19.0	18.9	0.5
51.3	157	94	99.8	0.2	19.3	19.3	0.4
61.0	170	92	99.9	0.1	19.3	19.3	0.3
63.4	150	92	99.9	0.1	19.3	19.3	0.4

Figure 1: Table of well-head collection and analysis

* Oil gravity corrected for calculated OBM contamination

Note: Readings after 10 hours identified "solids" as mud/water emulsion & separated phases as predominately water.

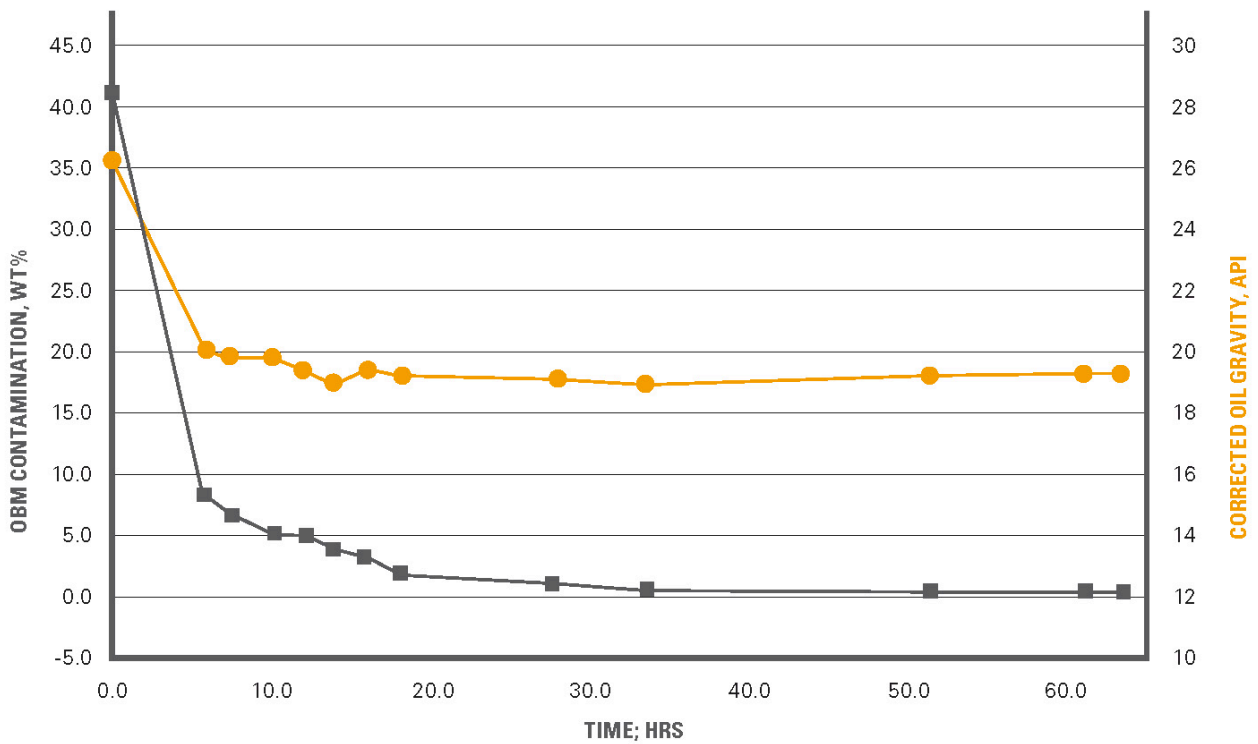


Figure 2: Clean up as a function of time