Gas Saturation In Coal—Uncertainties And Pitfalls

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A crucial part of working out the prospectivity of any CSG permit is the estimation of the gas saturation of the coals in the area. So, what is gas saturation, and how do we estimate it?

There are two factors to be quantified in order to estimate the gas saturation: gas content in the coal and the Langmuir isotherm of the coal. The gas saturation is generally estimated by desorbing the gas from the coal over several months in a canister into which the coal core has been placed. There are a number of issues concerning this which I will discuss in some detail. The Langmuir isotherm is constructed in the laboratory, and aspects of it will be discussed also. Gas saturation is calculated by dividing the gas content of the coal by the isotherm derived volume at reservoir pressure.

Gas content is the measure of the quantity of gas actually stored in the coal. The coal is collected by coring in the exploration well. The gas content estimation is made up of three parts, named Q1, Q2 and Q3. The coal sample is placed in a canister at the surface and the gas is desorbed over several months (Q2). Q1 is the estimation of the gas which is desorbed and thus lost while the core is being removed from the hole, and prior to it being placed into the canister. Q3 is the measure of the residual gas left in the core after the Q2 period.

One of the issues the industry has wrestled with is when the gas loss from the core commences. Does it start prior to actually cutting the core, on cutting the core, once it is lifted off the bottom or when the weight of mud equals the reservoir pressure? This is a discussion which can be had over a beer or three, but most companies start the measurement once the core is approximately halfway to the surface. The Q1 measurement is then based on the slope of the desorption curve from the initial measurements. It is very important that the canister is raised to reservoir temperature as soon as possible, as erroneous estimations will result if this is not done. This is demonstrated in Figure 1. This figure also shows the importance of taking measurements at close time intervals once the core has been emplaced in the canister and the temperature has stabilised.

Following these two procedures will minimise the error in the estimation of the lost gas, or Q1.

The other issue to be covered in the estimation of Q1 is the minimisation of the time taken for the core to be placed into the canister. There are a number of steps which need to be taken before the core can be safely ensconced in the canister. Once the core arrives at the surface it needs to be laid out, wiped down and described. A desorption sample is then selected, broken off and measured, and placed in the canister. The canister is then immediately sealed and purged of air. All this should occur within 15 minutes.

The measured desorbed gas is known as Q2. The canister allows the desorbed gas given off the coal to be measured in volume. Generally, this desorption is going to continue for several months. Gas volume readings should be taken at close intervals in the early stages of the desorption, with one minute intervals for the first 10 minutes, two minute intervals for the next 10 minutes, and at five minute intervals for the next 20 minutes. As the desorption continues, the readings can be taken at wider intervals (Figure 2). The resulting desorption curve should resemble that seen in Figure 2. If the curves are not regular, and instead look like those seen in Figure 3, it means that the temperature control is lacking.

The residual gas left in the coal after the desorption is completed is called Q3. This is measured by taking a small sample of the desorbed coal and crushing it to release the remaining gas. The main question here revolves around the size of the sample to be crushed. There are a number of possibilities here which include crushing the entire sample from the canister, half the (slabbed) core, composite random or selected thumb-sized samples or a single sample of about 200 g. If the sample size is less than the whole canister, then it will be necessary to upscale the measured gas from the crushed sample to the whole core. The sample size usually chosen is typically around 200 g from 4,000 g of core, or about 5%. Therefore Q3 is an indicative result, rather than a truly measured result.

Thus, the gas content estimation consists of an estimation of Q1, a measured Q2 and an indicative Q3. This implies that the result will contain errors, and it is important that we understand this and are aware of what was done on the core in the field and in the lab. Only by understanding the process used and problems encountered on each core sample can we have an understanding of the accuracy of the gas content estimation.

This brings us to the Langmuir isotherms. They are basically desorption tests in reverse.

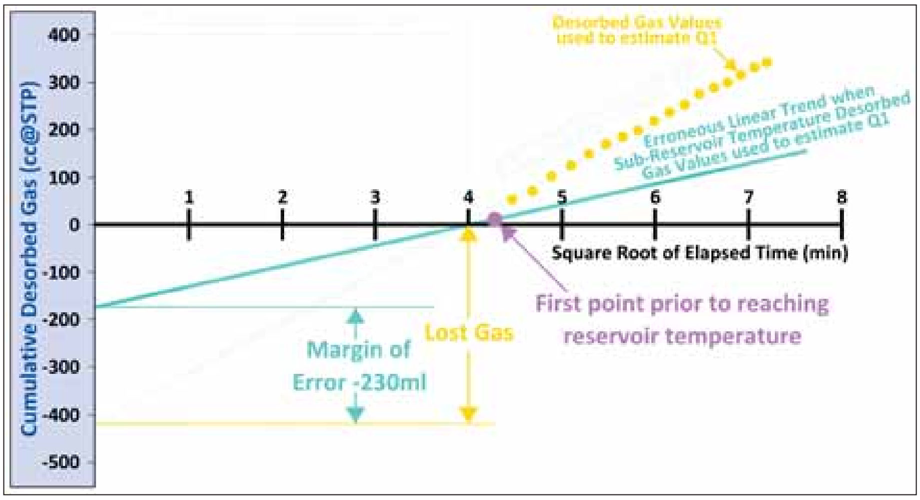

Fig. 1. Importance of temperature and frequent readings

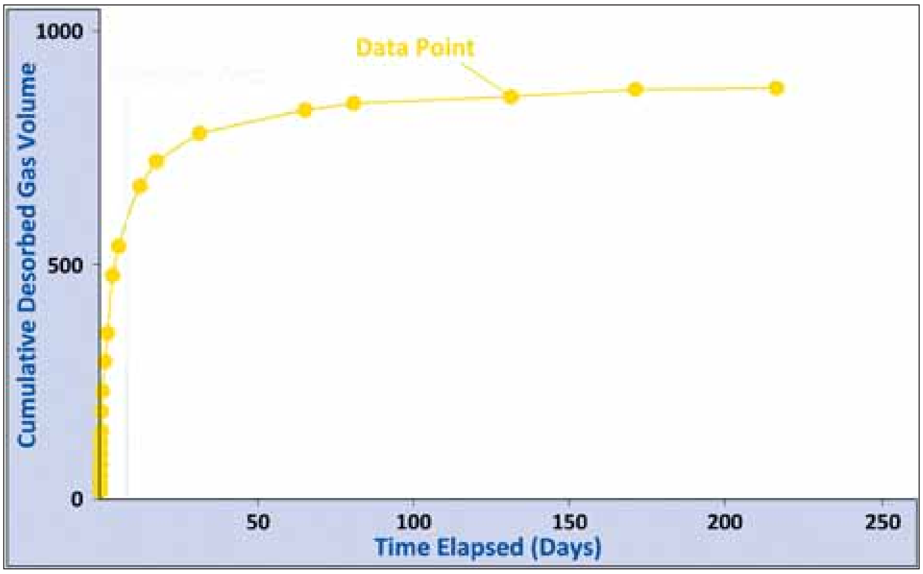

Fig. 2. Measuring the desorbed gas—Q2

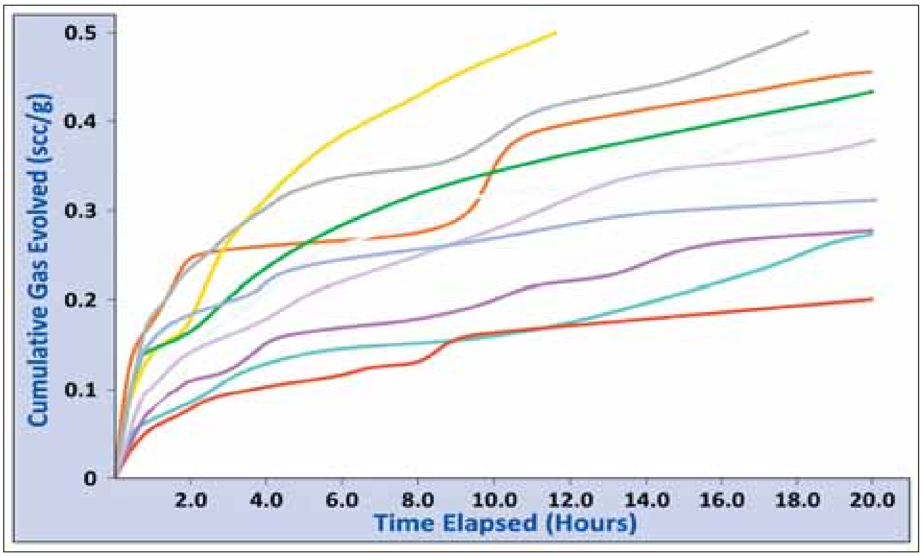

Fig. 3. No temperature control

Here, we are seeking to find out how much gas could have been held in the coal instead of how much was held in the coal. Adsorption isotherms start with ground coal so do not allow for free gas.

Langmuir isotherms are constructed using PVT lab principles and equipment to determine how much gas is adsorbed onto coal (ground to powder) over a range of pressures and at a constant temperature (Figure 3). After each pressure increment, the pressure is maintained to allow equilibrium to return to the system. The temperature and the upper end of the pressure range should reflect reservoir conditions.

Approximately 100 g of sample is used in the lab to construct each isotherm. Generally, a small number of tests are carried out. This means that the isotherm data is indicative, and not absolute.

Gas saturation is calculated by dividing the gas content by the isotherm-derived volume at reservoir pressure. Gas saturation is one of the most important measures which assists in defining the prospectivity of an area. So, how accurate is gas saturation? Given the description above, the accuracy of the gas content and issues with the calculation of the isotherm mean that saturation is often poorly defined. This underlies the importance of having a significant data-set to work with, a full understanding of and close control of the processes involved in the calculations.

In the next article, I will discuss the use of isotherms to assist in defining the prospectivity and other aspects of the CSG project.

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