


# GAS STORAGE

## Gas Types

A vertical, close-up photograph of a coal seam, showing its dark, layered, and somewhat jagged texture. The coal appears to be part of a larger rock formation, with some lighter-colored material visible between the layers.

Gas is stored in coals by a mixture of means and this storage is somewhat related to the method by which the gas reached the coal. Gas in lower rank coals is generally biogenic, meaning that it is derived organically by bacteria during the breakdown process. The gas in higher rank coals is of thermogenic origin, meaning that it is derived from the process of being heated in the ground. Coals are formed in a water saturated environment and are usually wet though in some cases a gas cap may exist. Coals will have generated a lot of gas as part of their formation and only a fraction of that gas remains in the coal. Coals are a source rock for many petroleum reservoirs. The main gas generated in coals is methane although coals may hold trace elements of other gases that have been generated. In addition to the gases that are generated in the coals, other gases may have been introduced, usually from igneous sources. These introduced gases are, most commonly, carbon dioxide then nitrogen but may at times include some noble gases, notably argon.

## Gas Storage

The storage of gas in coal is in the micropores and in multilayer adsorption with possibly some chemisorption into the coal structure itself. Each gas type and the water in the coal compete for storage sites within the coal. This is most noted where hydrothermal sweeps of carbon dioxide rich fluids have affected the coal.

Where the methane has not been totally replaced and there is a mixture of carbon dioxide and methane in the coal, common theory would suggest that methane would be evolved first as it is not as well bonded to the coal as carbon dioxide. In fact this is frequently not the case and carbon dioxide is preferentially released. The explanation for this is that the carbon dioxide has replaced the methane on less favourable sites where it is not bonded so tightly to the coal.

Water should also be considered as a competitor with gases for storage sites in the coal. This is quite clear when sorption isotherms are measured in dry and wet coals. Wet coals adsorb less gas.

The sorption isotherm is by definition the relationship describing the volume of gas stored in coal versus the pressure of that gas at a fixed temperature. This is usually measured at the seam temperature as the value varies with temperature. Sorption isotherms may be measured by forcing gas back into powdered coal and then releasing the gas in pressure steps, while measuring the coal weight or the volume of gas released.

This is, however, not a simple process as the result depends on a choice of the moisture content of the coal for re-adsorption. In real coals, the water was present initially, then methane was generated. It is therefore reasonable to argue that the methane displaced water from potential surface sites. In the case of mixed gas isotherms it is not sensible to simply expose the coal to a mixture of gases and to let it adsorb, rather the complex process of adsorbing one gas and then another needs to be adopted.

Figure 1. Langmuir Equation

$$V = \frac{V_L \times P}{P_L + P}$$

Where:

$V$  is the gas storage capacity at a particular temperature and absolute pressure;

$P$  is the absolute pressure;

$V_L$  is the Langmuir volume coefficient;

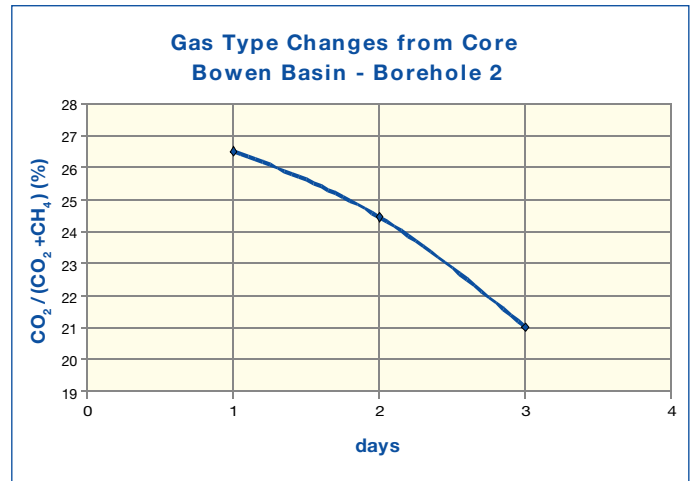
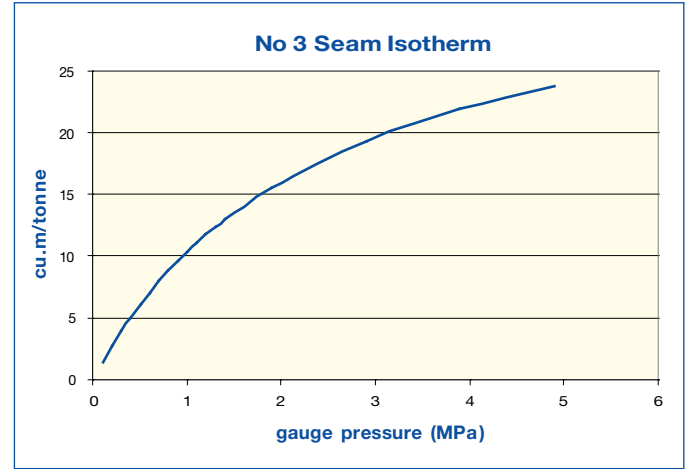
$P_L$  is the Langmuir pressure coefficient.

Sorption isotherms are conventionally described by the Langmuir equation, which suffices in most cases, but has no sound theoretical basis as it is written for monolayer adsorption.

In the field, Sigra samples and measures the gas release from core or cuttings to get gas volume. The gas types are sampled and are analysed for gas type. Varying gas types with production are a signature of the gas generation and sorption history of the seam.

In some cases in a mixed CO<sub>2</sub>/CH<sub>4</sub> seam gas environment the CO<sub>2</sub> is initially released at a higher rate than its overall gas composition. This is seen as being indicative of the manner by which the CO<sub>2</sub> was introduced to the seam.

Anthracite Sorption Isotherm



Sorption test apparatus at Sigra

