Retention of the Gas within the Source Rocks

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The fact that gas, especially methane is not easily transported through low permeability rock is known as the Klinkenberg effect. It has been historically measured in the laboratory and is utilized as a correction to the permeability measurements that are done on tight rock. However, up to now, within basin modeling, this phenomena was not taken into account since the effort was more focused on having good calibration on the HC in place in the reservoir than that of the HC remaining on the source rock. In case of source specific compositional modeling, the nonexpulsion of the dry gas was mathematically mimicked by increasing the viscosity of this phase at a clearly unrealistic level . Assuming that the Klinkenberg effect can be extrapolated to sedimentary basin time and space scales is not likely realistic. However this might be an alternative way to explain and model the significant mass of gas that remains trapped within shaly source rocks, which cannot be properly predicted by the conventional Darcy approach when unrealistic permeability and/or gas viscosity values are used.

In order to test this hypothesis and demonstrate its effectiveness, a Klinkenberg-like correction term was added to hydrocarbon species conservation laws in the Temis modeling simulator. In the new version of the software, the mobility of the hydrocarbon gases is now non-linearly pressure dependent, thus mimicking pressure-gas permeability correlations measured in the laboratory. As a result, the retention of methane and ethane is no longer limited by the average HC phase behavior and can be calibrated for each compound separately. As a result the retention of methane or ethane can have different efficiencies and can be calibrated separately; in previous versions of Temis, identical factors that were mainly dependent on the saturation-based, expulsion threshold (Lorant et al., 2010).

The case study to be presented shows that this phenomena has the expected effect on expulsion with the composition of the expelled HC varying. As a result the non-expelled HC, that is the target for the unconventional oil and gas shale exploration, vary in quantity and chemistry (C1 versus C2 fractionation for instance). In addition, since the Klinkenberg effect is valid not only in the source rock but also in any low permeability shale, the amount of gas trapped along the migration pathway within the shaly layers increases. The resulting HC quantities within conventional reservoirs where there are numerous shaly layers are therefore also affected.

Lorant F., D.M. Jarvie, I. Moretti, 2010, *Can conventional basin modelling predict gas shale occurrence? A case study from the Fort Worth Basin, TX (USA)*, Extended abstract EAGE Shale, Avril 2010, Nice, France.