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Carbon dioxide sorption on gas bearing shale and halloysite

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Sorption of CO_2 on organic rich shales and clay minerals is becoming the focus of many investigation in recent years due to two reasons. First, unconventional gas reservoirs, such as shales, after methane depletion can serve as a potential place for CO_2 storage. Secondly, some clay minerals have a high sorption capacity towards gases and therefore can be used in gas cleaning technologies (Air-pollution control) or CO_2 capture.

The aim of this study was to compare Silurian gas shale from Lublin basin (eastern Poland) with halloysite mineral from Dunino deposit in south-western part of Poland. The shale in this study represented typical mineralogical composition of gas bearing shales found in Baltic-Podlasie-Lublin Basin with high illite-smectite content and relatively low content of organic matter (1.1% TOC) [1]. Halloysite is a product of basalt weathering, a two-layer mineral belonging to the kaolinite subgroup and is represented by the same chemical formula $Al_2Si_2O_5(OH)_4 \cdot nH_2O$. Although the dominant minerals in the rocks are different and belong to different clay minerals group high pressure sorption of CO_2 was compared in order to verify to what extent clay minerals exhibit gas sorption properties.

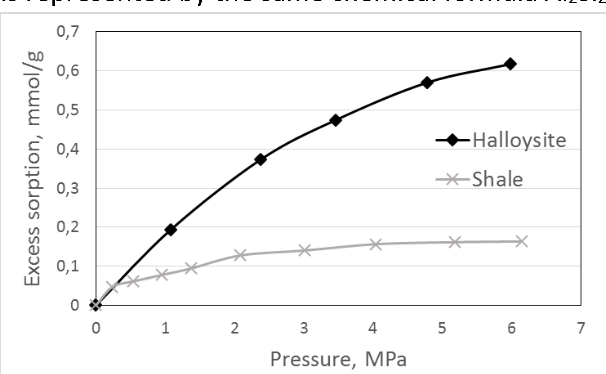

Figure 1: Example of CO_2 sorption on Polish gas bearing shale and halloysite at 45°C (halloysite) and 55°C (halloysite)

For the purpose of the study a high pressure manometric sorption setup was used. Experiments were carried out on powdered (particle size <0.1 mm) and dried rock samples up to the pressure of approximately 6 MPa and in temperature of 45°C (halloysite) and 55°C (shale). Obtained experimental results were recalculated into absolute adsorption curves and fitted with Langmuir and D-R models.

Although the halloysite does not have any organic matter, sorption capacity of halloysite was almost three times higher than shale (Fig. 1). These results can be explained by the fact that over 30% of shale rock was composed of non-sorptive minerals (quartz, plagioclase, feldspars and calcite) whereas halloysite was in its almost pure form. The sorption capacity of shale and halloysite is much lower than other organic sorbents such as coal.

References:

[1] Kuila U. et al. (2014) Fuel 359: 359-373