

Determination of suitability of natural Polish resources for production of ceramic proppants applied in gas exploration from European shale formations

Joanna Szymanska (1) and Jaroslaw Mizera (2)

(1) Warsaw University of Technology, Faculty of Materials Science and Engineering; Warsaw, Poland (joanna.szymanska.pl@gmail.com), (2) Warsaw University of Technology, Faculty of Materials Science and Engineering; Warsaw, Poland (jmizera@inmat.pw.edu.pl)

Poland is one of few European countries undertaking innovative research towards effective exploration of hydrocarbons from shale deposits. With regard to strict geological conditions, which occur during hydraulic fracturing, it is required to apply ceramic proppants enhancing extraction of shale gas.

Ceramic proppants are granules (16/30 – 70/120 Mesh) classified as propping agents. These granules located in the newly created fissures (due to injected high pressure fluid) in the shale rock, act as a prop, what enables gas flow up the well. It occurs if the proppants can resist high stress of the closing fractures. Commonly applied proppants are quartz sands used only for shallow reservoirs and fissile shales (in the USA). Whereas, the ceramic granules are proper for extraction of gas on the high depths at hard geomechanical conditions (in Europe) to increase output even by 30 - 50%. In comparison to other propping materials, this kind of proppants predominate with mechanical strength, smoother surface, lower solubility in acids and also high stability in water. Such parameters can be available through proper raw materials selection to further proppants production. The Polish ceramic proppants are produced from natural resources as kaolin, bauxite and white clay mixed with water and binders. Afterwards, the slurries are subjected to granulation in a mechanical granulator and sintered at high temperatures (1200 - 1550°C).

Taking into consideration presence of geomechanical barriers, that prevent fracture propagation beyond shale formations, it is crucial to determine quality of applied natural deposits. Next step is to optimize the proppants production and select the best kind of granules, what was the aim of this research.

Utility of the raw materials was estimated on basis of their particle size distribution, bulk density, specific surface area (BET) and thermal analysis (thermogravimetry). Morphology and shape were determined by Scanning Electron Microscopy (SEM). Energy Dispersive Spectroscopy (EDS) enabled analysis of their chemical composition, what was compared with X-ray fluorescence (XRF) results. Crystallinity of the raw compounds was established by X-ray diffraction (XRD). Characterization of loamy materials enabled evaluation of their impact on ceramic slurries preparation for further granulation and sintering.

The proppants were analyzed with X-Ray Tomography to determine their shape and pore distribution. 3D models also enabled prediction of proppant settlement in the fracture. The crucial parameter as mechanical strength, that influences the integrity of created fractures (fines exceeding 1 % reduce fracture conductivity), was established during the crush tests. High roundness coefficient, uniformity and bulk density results informed about stability of the prop. Environmental proppants interaction was evaluated by turbidity and solubility in acid measurements, which reflect a threat of the proppants decay in the well.

The obtained outcomes prove the utility of applied natural resources in the granules production. In consequence, the obtained proppants can be used for hydraulic fracturing in high pressure, temperature and low permeable shale formations. The granules fulfil the norms thus are prospective on a global proppants market.