УСТАНОВКА ДЛЯ ФИЗИЧЕСКОГО МОДЕЛИРОВАНИЯ ПОДЗЕМНОЙ ПИРОЛИТИЧЕСКОЙ КОНВЕРСИИ ГОРЮЧИХ СЛАНЦЕВ

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SETUP FOR THE PHYSICAL MODELING OF UNDERGROUND PYROLYTIC CONVERSION OF OIL SHALE

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The article describes the setup for studying underground pyrolytic conversion of low-grade solid fuels electrophysical method under simulated pressure and heat sink underground conditions. A brief description of electric phenomena in the oil shale through which the rocks are heated. The main characteristics of key plant components. The features work with different combinations of adjusting and enhancing modules.

The traditional methods of oil shale extraction bear considerable drawbacks like environmental pollution and low cost-efficiency due to its low calorific value. Effective in-situ processing can be based on electrophysical phenomena. For investigating possibility and characteristics of this type of processing the further described setup was established. This setup is required for modeling underground pyrolytic conversion of oil shale via electrophysical heating, which depends on pressure, oil shale heat- and electrical conduction and electromagnetic field distribution.

As specimen, oil shale probes with different origin were taken. The oil shale consists of various organic and inorganic substances in different ratios. The structure is stratified and heterogenic, with randomly distributed inclusions and gas pores. The pyrolytic conversion of oil shale occurs at temperatures in the region of 400°C up to 800°C. This temperature is reached by Joule heat phenomenon, which is induced due to the current flowing between the electrodes through the oil shale. Shale has a high electrical resistance, hence the current cannot flow. To change this property a voltage of up to 10 kV is applied to the specimen with the objective to reduce the electrical resistance of the oil shale. Electrical discharge phenomena like it is described in [1, 2] are occurred after voltage application. This phenomenon contributes to the growth of treelike discharge channels described in [3, 4] as electrothermal treeing. Electrical discharges evolve high temperature that causes thermal destruction of oil shale organic compound. Some carbon part is not involved in thermochemical reactions, so it concentration increases locally. Discharge plasma forms a trace of carbonized volume with an electrical resistance of 10÷100 Ω/m. Treeing leads to a completed breakdown and short circuit current starts to flow through the oil shale. This current is causing Joule heat, which is sufficient for pyrolytic conversion inside the specimen.

The physical modeling of underground conditions can be performed in two different hermetic chambers.

Both chambers are made out of stainless steel. One with an approximate volume of 1 m^3 and a maximal allowable pressure of 1 MPa and the other with an approximate volume of 0.06 m^3 and a maximal allowable pressure of 0.3 MPa. The chambers have a plug for the nitrogen inlet, a forevacuum pump, a valve for sampling, isolated plugs for electromagnetic field input, a manometer and a protecting relief valve. As a backup feature a safety flap is installed on top of the bigger chamber, in case of an explosion inside this flap acts as predetermined breaking point. The bigger chamber has also five portholes that allow a view onto the oil shale inside the chamber. In the used chamber creates a forevacuum, then it is filled with nitrogen up to operating pressure. This inert atmosphere imitates the conditions in some hundred meters below the ground. Gas probe can be extracted out of the chamber with help of sampling valve.

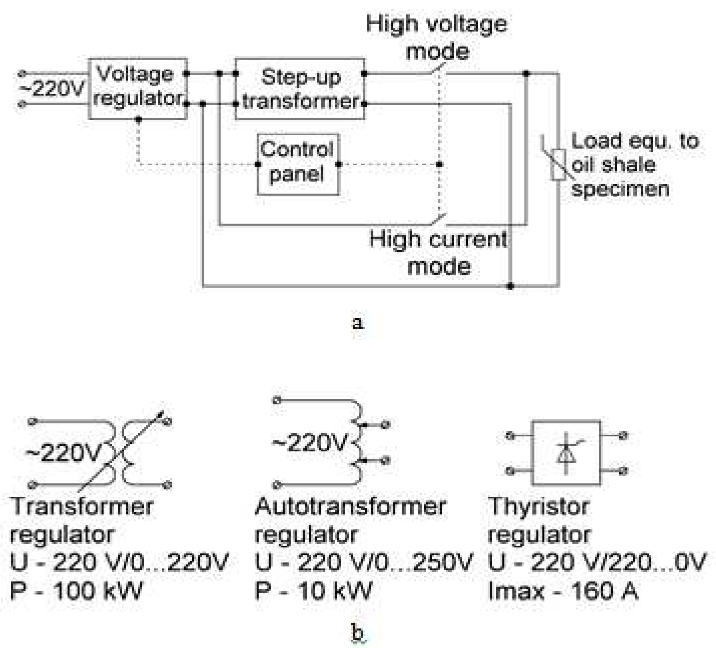

Fig. 1. a – Connection scheme, b – Voltage regulators

The electromagnetic field input part of the experimental setup consists of electrodes, isolated plugs which can isolate up to 10 kV, a commutation system, a voltage regulator and a power supply. The experiment is remote controlled from a console. Figure 1a shows the connection scheme of the setup.


Fig. 2. – Small chamber, power supply with regulators and commutation system (left photo), control panel and big chamber (right photo)

Two rod electrodes are inserted into the oil shale for the electromagnetic field input. The electricity transition trough the chamber side is carried out with leak tight isolators allocated at different spots of the chamber. Voltage regulation (fig. 1b) is realized by voltage transformer with variable magnetic coupling, autotransformer or thyristor regulator. During high voltage mode voltage up to 10 kV can be applied on the specimen to achieve the oil shale breakdown. After that high currents are flowing. At that moment the commutation system with short reaction time has to be switched to high current mode. During high current mode voltage is adjusted up to 220 V, so that the power input maintains high enough to continue the heating. Specimens properties are differ from bed to bed. Therefore the modular design of the setup allows more flexibility to customize the setup parts according to different specimen.

The power supply can be changed to transformer that provides voltages of up to 100 kV. As the isolation of the chamber is not designed for such high voltages experiments with more than 10 kV has to be made outside of the chamber. The room conditions are not equivalent to underground conditions. Thus this variation of setup is used for oil shale breakdown voltage testing if the shale does not breakdown at 10 kV. The type of transformer used for voltage regulation has energy loss caused by coils magnetic leakage. The coils are moved relative to each other and at low voltages the magnetic field mostly scattered during operation. This loss can be minimized by changing the transformer type to autotransformer or thyristor regulator.

Described setup allows investigate electrophysical phenomena under electromagnetic affect with large range currents and voltages in modeled underground conditions. These phenomena could be used for in-situ oil shale pyrolytic processing due to electromagnetic affect.

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ИССЛЕДОВАНИЕ СВОЙСТВ ПОКРЫТИЯ TIAL НА ЦИРКОНИЕВОМ СПЛАВЕ

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RESEARCHING OF PROPERTIES OF TiAl COATING ON A ZIRCONIUM ALLOY

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Coatings based on titanium aluminide alloy deposited on the Zr1% Nb obtained by vacuum arc plasma-assisted method. The coating thickness was 3 microns. Investigated the structure of the surface by scanning electron microscopy. The results of the study of mechanical properties of zirconia samples before and after coating. It has been established that the TiAl has good coating adhesion strength, and increases durability.