Intensification of gas recovery from coal seams applying the method of hydrodynamic impact in horizontal boreholes

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Abstract. The techniques of hydrodynamic impact on the coal seam from horizontal boreholes drilled from mine workings with the aim of increased gas recovery are considered. A method for monitoring the parameters of a coal seam hydraulic fracturing and the actual results obtained in the conditions of Kuzbass coal mines are outlined.

1. Introduction
An important step in the development of coal deposits by the underground method is the on-time and effective degasification of coal seams which ensures the industrial safety of main technological processes of mining and affords the increased profitability for mining entities. At the same time, degasification, depending on methane emission sources, is subdivided into the degasification of the coal seam being mined (the barrier or preliminary one), the gob area degasification (employing surface or underground boreholes) and the preliminary degasification.

Degasification efficiency of coal seams being mined is primarily influenced by such parameters as permeability in the near borehole and remote zones and as well as the reservoir pressure. To improve filtration properties of a coal seam and, accordingly, the efficiency of degasification in Kuzbass coal mines, advance coal seams hydraulic fracturing (CSHF) is used in horizontal degasification boreholes drilled from mining workings [1-4].

2. Main part
To provide a borehole tightness when applying a coal seam hydraulic fracturing, a packer device or casing is installed to a predetermined depth, and a hole clearance over them is filled in with sealing components. For the casing, a column of 70 mm diameter steel pipes is used. The length of the uncased part of the well should be sufficient to maintain a hydraulic fracturing mode, which is characterized by a fluid injection rate multiple excess of the coal seam natural injectivity [5, 6].

To control CSHF parameters and to assess the quality of work performed in horizontal boreholes during underground mining with in seam degasification applied, a special chamber has been designed and manufactured in the form of a reinforced rubberized hydraulic hose rolled from one side and with a tight joint on the other side. A pre-programmed electronic self-contained pressure gauge is placed in this chamber, it is connected to a bore hole water supply system to record pressure fluctuations during hydrodynamic impacts. The pressure gauge is a deep-type electronic sensor of a stress type that allows to measure pressures up to 34.45 MPa with an accuracy of 0.05%.
Figure 1. Scheme of boreholes completion during CSHF application: (a) using a packer device; (b) using casing. 1 – coal seam; 2 – test well; 3 – packer device; 4 – casing pipe; 5 – possible zone of influence during CSHF application.

The fluid was supplied by a pumping station, designed to inject the working fluid into the hydraulic system of longwall shearsers and mechanized supports in underground mines of any category for gas and dust. During the injection period, the readings on a mechanical manometer installed at the wellhead and the fluid level variations in the measuring tank are continuously monitored. Upon the completion of fluid injection into the coal seam and pressure relief, the manometer is removed for obtained data analysis and interpretation.

Thus, the coal seam hydraulic fracturing (CSHF) in the borehole, with the packer device installed (figure 2, a), was performed at several intervals. In the interval No. 1, the impact on the coal seam was carried out for 11.8 minutes. In the process of forcing the working fluid at a 10.29 MPa pressure a control valve (CV) was opened to supply fluid into the inter packer space. After that, at the 38th second of the borehole stimulation when the pressure reached 9.87 MPa the coal seam was disintigrated (CSD) with a pressure drop down to 9.58 MPa. Further, at 10.17 MPa pressure, insignificant pressure drops were also recorded. After that, further work on hydrodynamic impacts was accompanied with coal seam saturation without any fluctuations of pressure.

When the working fluid was forced into the borehole with an installed casing (figure 2, b) the coal seam stimulation was carried out for 132 minutes at a maximum pressure of 14.18 MPa. In the process of fluid injection, a sequence of pressure drops was recorded, corresponding to the opening of natural (CSHF) and the formation of artificial fractures (CSD).

Figure 2. Pressure fluctuation (P) and temperature changes (t) during CSHF: (a) in the borehole with installed packer device; (b) in the cased borehole.
Thus, at a pressure of 10.24 MPa and 10.35 MPa, a coal seam breaking occurred with a pressure drop to 5.66 MPa and 6.24 MPa, respectively. Further, at a pressure of 13.36 MPa at the 30th minute of the impact, the coal seam was disintegrated, which was followed by a drop in pressure to 11.99 MPa and accompanied with thumps in the rock mass. With the continuation of liquid injection, as the coal seam had become more saturated, pressure fluctuations within 14.18 MPa - 13.00 MPa interval was observed, corresponding to its disintegration. At a pressure of 14.07 MPa at the 114th minute of the impact, a sharp drop in pressure to 12.61 MPa was recorded, which indicated a coal seam hydraulic fracturing.

3. Conclusion
Thus, the given technique for controlling the hydrodynamic impact on the coal seam allows us to perform an accurate efficiency assessment of gas recovery stimulation in the conditions of underground coal mines. In addition, if certain conditions are met and additional work is performed, it is possible to determine changes of coal seam filtration properties in the near borehole zone prior and after the hydrodynamic impact [9-11].

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