Improvement of intensive in-seam gas drainage technology at Kirova mine in Kuznetsk coal basin.

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Abstract: One of the ways to resolve the "green energy-economic development" dilemma, in which the coal industry is situated, is by the improvement of technologies and the integrated use of extracted resources, including methane gas as a clean energy source. Using the example of the Kirova mine, located in Kuznetsk coal basin—one of the ecologically unfavorable coal mining regions of Russia—this article discusses an integrated technology for the extraction of coalbed methane (ECBM), which makes it possible to reduce greenhouse gas (methane) emissions and improve the safety and intensity of coal mining. The Kirova mine, with its 3 Mt production in 2019, is one of the coal mining leaders in Russia. The available mining equipment has the potential to significantly increase the output; however, gas is a limiting factor to this. The customary approaches to coal seam degassing have already been petered out. The miners and mine science are facing a challenge to validate and test an alternative technology to ensure effective in-seam gas drainage prior to vigorous mining. This article gives an account of the improvement track record of the in-seam gas drainage technology used to pre-treat coal seams for intensive and safe extraction. This technology suggests, at the first stage, hydraulic loosening of the target coal seam through wells drilled from the surface (SSHL), then hydraulic fracturing (HF) of the coal seam through the boreholes drilled from underground development headings, followed by methane extraction from the high-permeability coal-gas reservoir created through standard in-seam gas drainage underground wells. Results are presented in this paper of field testing of the improved SSHL technique. Findings are presented on the effective parameters of the HF technology. Methodological recommendations are offered for selecting viable in-seam gas drainage technology.

Keywords: intensive coal mining; in-seam gas drainage; surface wells; hydraulic slotting; underground boreholes; hydraulic fracturing; in situ tests; improvement of technology

Supplementary information

Figure S1. Photos of the equipment for hydraulic slotting of the target coal seam through wells drilled from the surface (SHS), field of Kirova mine.

Рисунок 1- Обвязка скважин ГРП на экспериментальном участке шахты им. С.М. Кирова

Figure S2 The graph of water download volume (blue, m^3) and download rate (red, m^3/minute) during hydraulic slotting process. The well No 1 at the experimental area.

This graph shows the achievement of hydraulic slotting regime.

Рисунок 2 – Выход на режим гидрорасчленения на скважине 1 ГРП

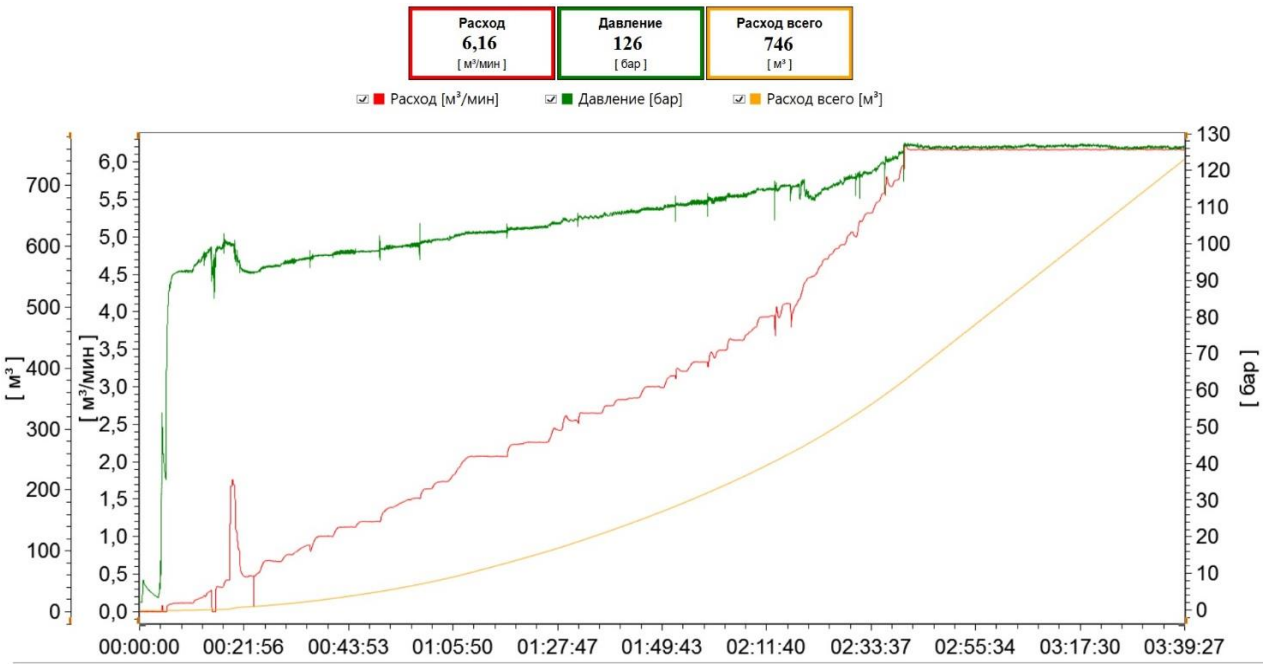

Figure S3 Graph of hydraulic slotting regime realization (the well No 1, experimental area).

Рисунок 3 - График реализации ГРП на скважине 1 ГРП

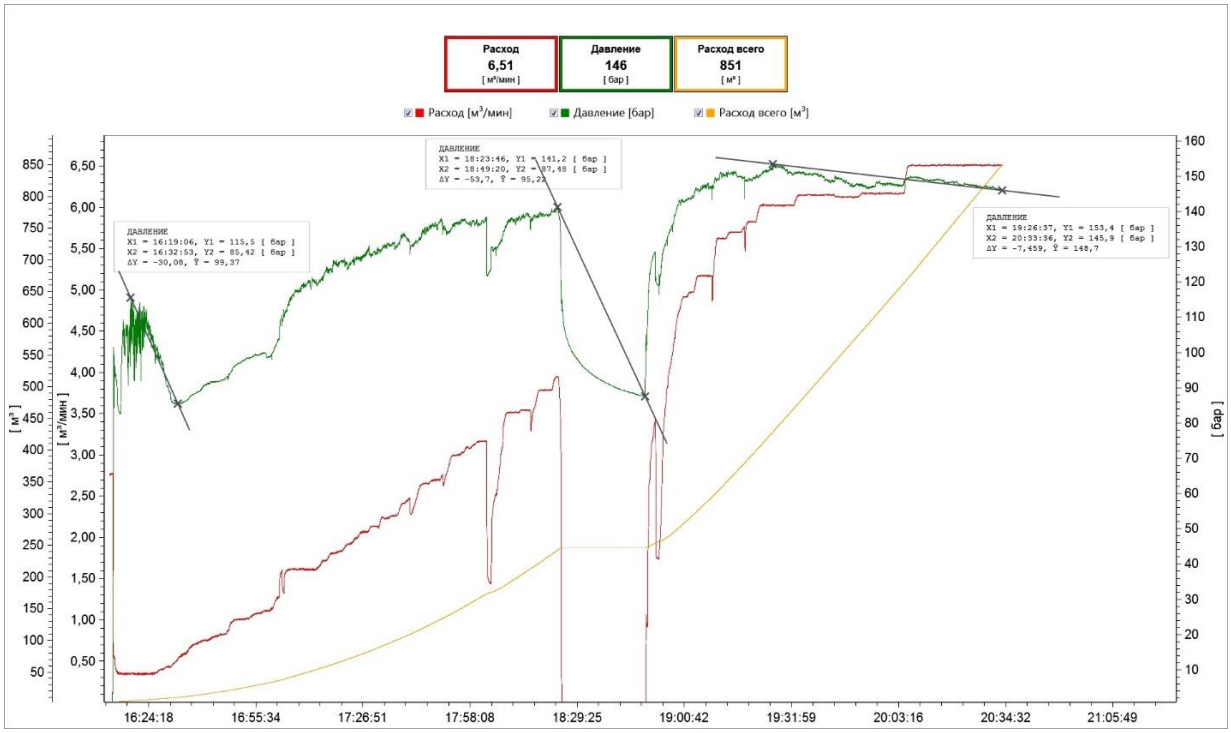

Figure S4 Graph of hydraulic slotting regime realization (the well No 3, experimental area).

Рисунок 4 - График реализации ГРП на скважине 3 ГРП

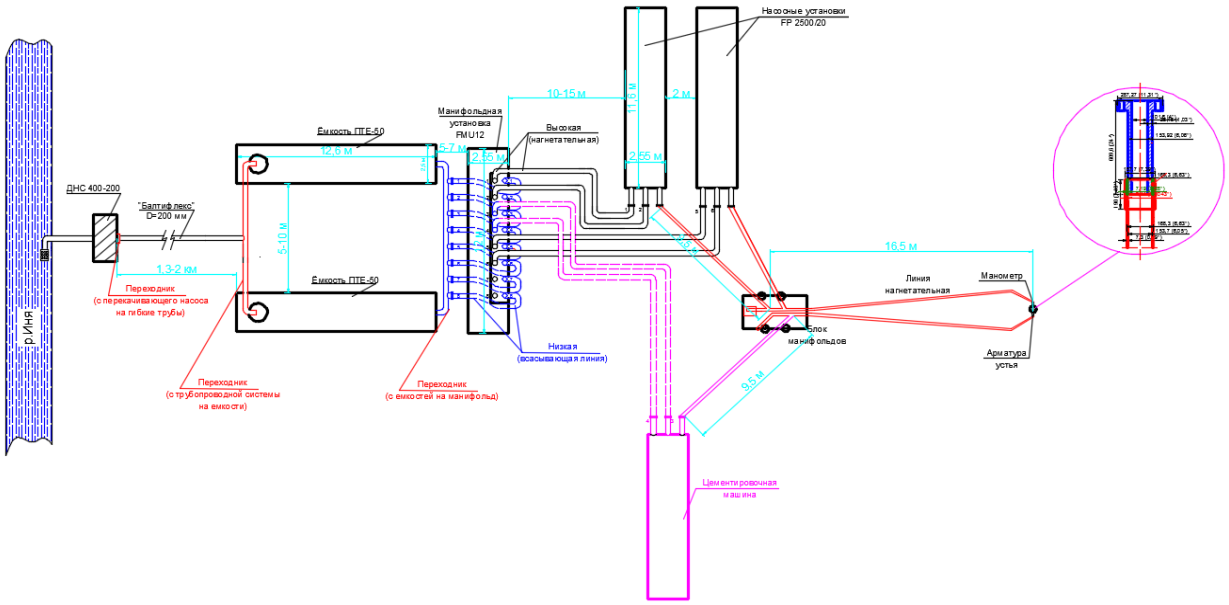

Figure S5 Connection equipment scheme for hydraulic slotting realization (Kiriva mine).

Рисунок 5 – Схема подключения оборудования для проведения ГРП на шахте им. С.М. Кирова

Figure S6 Spontaneous water degassing (The well No 1, experimental area)

Рисунок 6 – Выход газа из скважины 1 ГРП в режиме самоистечения

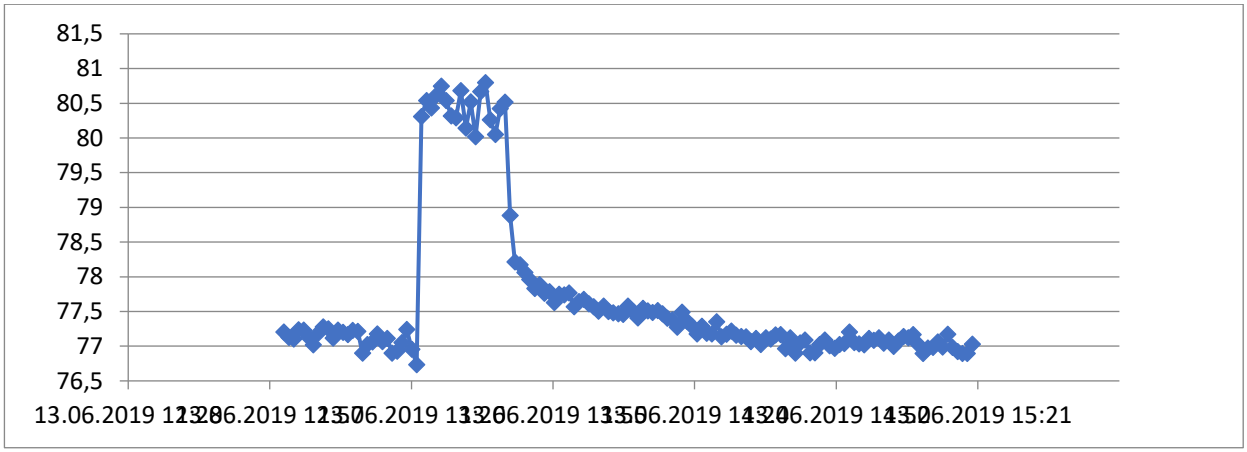

Figure S7 Change in pressure in the hydraulic slotting borehole (No 2, experimental area) when carrying out hydro fracturing in underground well No 63/5.

Рисунок 7 – Гидросвязь скважин подземного гидроразрыва и скважин ГРП с поверхности

Figure S8. Kirova mine. Block of the drainage station

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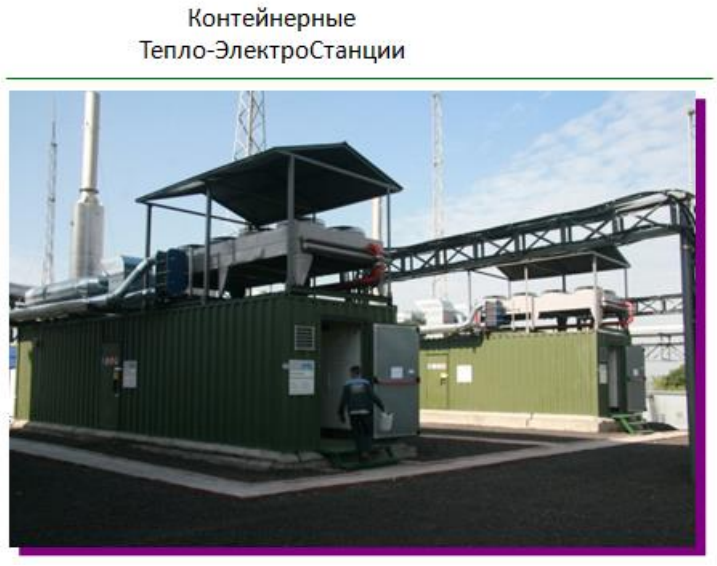

Figure S9. Kirova mine. Methane power station

Контейнерная теплоэлектростанция на ш. им. С.М. Кирова

Figure S10. Kirova mine. Converted Coal Mine Methane Boiler

Переоборудованный котел на шахтном метане