Increase of power efficiency at coal mines on the basis of methane utilization

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During mining there is process of emitting methane which is a greenhouse gas and which is emitted to the air at the most of the mines. But coal mine methane fits for generating thermal and electric power which can promote increase of power efficiency at coal mining enterprises. The article contains the experience of realization of coal mine methane utilization projects in Kuzbass and estimation of its economic efficiency.

Key words: **utilization, coal, mine, methane, power efficiency.**

1. INTRODUCTION

During of the process of mining methane emits which can become dangerous for miners' health and lives, and also for equipment located in workings of coal mines. Degasification allows decreasing methane content in the workings and increasing safety level at operating coal mines and also productivity of coal faces because of reduction of downtime caused by high gas concentration in the workings. Coal mine methane recovered by degas systems is emitted to the air and not used at the most of the coal mining enterprises. Coal mine methane is a greenhouse gas emission of which assists global climate change. In accordance with Russian Law coal mines have to pay ecological payments for methane emissions. Nonetheless, methane is a valuable power generating source fitting generating thermal and electric power which can be used for mine's needs as well as for other consumers [1].

Realization of coal mine methane utilization projects will favor efficient use of natural power engineering resources.

2. SOURCES OF COAL MINE METHANE

In accordance with the Law «On electric power generating» coal mine methane is a renewable power source («gas generated at coal mining») [2]. Reduction of consumption of heat and electricity replaced by use of non-traditional power source – coal mine methane - allows reduction of coal consumption and also rational use of natural resources. Thus, realization of methane recovery at the claims of coal mines in Kemerovo region is an actual technical objective.

The methane sources with its concentration over 30% in air-methane mixture are:

- Surface degas boreholes;
- Underground degas boreholes;
- Boreholes in gob area and in collapsed areas;
- Methane recovery systems from insulated mined areas.

The methane source with methane concentration below 1% is ventilation systems. For stable operation of coal mine methane utilization systems, e.g., genset stations, modular boilers, it is necessary to provide methane concentration above 30% in air-methane mixture.

3. EXPERIENCE OF COAL MINE METHANE UTILIZATION IN KUZBASS

In Leninsk-Kuznetsky, with participation of the authors, the project of coal mine methane utilization in generator station (electric power production) was realized (Fig. 1). Coal mine methane recovered by degas system is supplied to the first water separator where moisture is removed. Then, by a pipe line air methane mixture is transported into an additional water separator where it is dried. After air methane mixture is supplied to a genset where the combustion takes place. The final product is a generated electric power which is supplied to the grid of Leninsk-Kuznetsky by a transformer.

Fig. 1. Genset station in a container mode

The technological scheme also stipulates control valve which regulates pressure in a pipeline and provides stable gas supply to a generator. Table 1 contains technical characteristics of a genset station.

TABLE 1 TECHNICAL CHARACTERISTICS OF A GENSET STATION

Parameters and indices	Data
Nominal electric power productivity, MW	0.9
Nominal thermal power productivity, MW	1.1
Methane concentration in air-methane mixture, % (above)	35
Fuel	Degas methane

In Prokopyevsk methane utilization system in a modular boiler for generating heat was implemented in the frames of the project UNDP/GEF 00014640 «Russian Federation – Eliminating Barriers to Coal Mine Methane Recovery and Utilization» (Fig. 2).

Fig. 2. Modular boiler

Besides the boiler, a heater facility was assembled at the site allowing controlling and monitoring at the initial stage of putting the equipment to necessary technological modes. Table 2 contains technical characteristics of a boiler.

TABLE 2 TECHNICAL CHARACTERISTICS OF A MODULAR BOILER

Parameters and indices	Data
Boiler KVE-0.7-115 GM	
Nominal power productivity, MW	0.7
Operating water pressure out of a boiler, MP	0.6
Temperature in a boiler, °C	40
Nominal temperature out of a boiler, °C	110
Fuel	Degas methane
Gas burner MDGG – 80 B	
Nominal thermal power productivity, MW	0.8
Range of heat control, %	10-100
Gas flow rate, m3/h, not more	90

For operating a modular boiler it is necessary to have minimal methane concentration of 25% in air methane mixture.

4. ESTIMATION OF ECONOMIC EFFICIENCY

For realization of coal mine methane utilization projects it is necessary to have capital costs including costs of developing project and technical documentation, receiving approvals in state and experts' control agencies, purchase of equipment, construction, assembly and commissioning works, putting into operation.

The estimation of economic efficiency of use of genset stations at coal mines in Kemerovo region was accomplished. Within the frames of the project it is suggested to drill degas boreholes from surface with depth of 400-600 m at claims of coal mines. For methane recovery vacuum pumps will be used supplying methane to a gas generator station consisting of 5 container-mode gas generators operating by air methane mixture with methane concentration of 40 – 99%. Capacity of each gas generator is 1.5 MW. Safety system includes sensors for emergency switch off for air methane mixture supply to a gas pipeline when methane concentration is below 30%. The project also stipulates assembly of transformers and electric power lines from gas generator station to the grid. Gener-

ated electricity will be used for mine's own needs as well as to be supplied to the grid to sell for other consumers.

In order to realize the project it is necessary to obtain investments in amount of 364.8 million Rubles. The income from the project includes sale of generated electric power. The payback term of the project is 4.4 years, IRR is 3.8%, net discounted income for 5 years' period will be 8.6 million Rubles (Table 3). In case of additional financing at cost of realization of Kyoto protocol mechanisms economic efficiency will increase (cost of 1 tCO_{2e}. is 240 RR (€6)).

TABLE 3 ESTIMATION OF ECONOMIC EFFICCIENCY OF COAL MINE METHANE UTILIZATION PROJECT IN GENSET STATIONS

Index	**Without ERU**	**With ERU**
Investments, million RR	364.8	364.8
Payback term, years	4.4	3
NPV for 5 years, mln RR	8.6	160.4
IRR, %	3.8	17.9

The payback term will reduce to 3 years, IRR will increase to 17.9%, NPV for 5 years will amount to 160.4 million Rubles.

5. CONCLUSION

Degas methane is a power source fitting for generation of thermal and electric power. Its use allows increasing of power efficiency of coal mines. Successful experience of coal mine methane utilization in Kuzbass lets replicating such projects. Application of Kyoto protocol mechanisms allows attracting additional financing and increasing economic efficiency of coal mine methane utilization projects.

6. LITERATURE

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[2] Federal Law of 26.03.2003 # 35-FZ «On electric power engineering».

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