

## WAYS OF RECYCLING OF MINE METHANE

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Power coal alongside with natural gas and black oil is one of the basic energy carriers in power engineering, industrial production and household sector in the Russian Federation at the present time and in future. The characteristics feature of the fuel and energy complex of the Russian Federation is the prevalence in balance of natural gas whose share exceeds 53 % and tends to the growth. In the countries of the Western Europe and the North American continent, having as stocks of coal, and natural gas, the share of natural gas in the fuel and energy balance for maintenance of power safety of the country is substantially lower. In the balance of the Russian Federation the share of natural gas in immediate future will be reduced due to coal, atomic energy renewal and no conventional kinds of energy increase in the efficiency of using power resources. The coal mining is accompanied by allocation of methane adsorbed by the coal file deleted in an atmosphere. Collected in the atmosphere, methane just as CO<sub>2</sub>, H<sub>2</sub>O, and N<sub>2</sub>O create the hothouse effect. The factor of anthropogenesis issue of methane at a coal mining and natural gas is presented Table 1.

Table 1

To mine coal mining	23,19
To career coal mining	1,34
At extraction of natural gas	6,65

The parameter of global warming (Global Warning Potential) for methane is equal to 23, and for N<sub>2</sub>O – 296. CO<sub>2</sub> 65 % of the general negative anthropogenesis influence on the enhancement of the hotbed effect belong, to methane of 19 %, NO<sub>x</sub> of 6 %, etc, – 10 %.

Gasification of coal-mining regions is an urgent problem because of adverse ecological conditions, however cannot be carried out in the near future due to the natural gas acting from Northern areas of Russia because of its deficiency and necessity of significant capital expenses for maintenance of its transport.

Methane of coal layers on the structure practically differs nothing from the natural gas extracted from sandstones. Difference consists that coal possesses low gas permeability, in a free condition inside of times and cracks is from 2 up to 12 % of methane, in the adsorbed condition of 8-16 % and in the form of gas-coal a solution from 70 up to 80 % of methane. To take gas from coal layers it is possible only after change of its condition by active influence on a layer that translates it in a free condition and improves migration.

During tens years decontamination on collieries of Russia is carried out for increase of safety of conducting mountain works by development gas dangerous layers. There are various ways of decontamination to sate with gas corner pedigree files: preliminary for some years, preliminary for some month, ventilation. At preliminary decontamination from a day time surface drilling vertical or vertically-horizontal chinks before crossing with corner pedigree a file in which make hydro break for increase in permeability of a file and increase in inflow of methane to extract to a chink containing punching. The given technology is actively applied in a number of foreign countries (the USA, Australia, China, etc.) Also provides reception significant extraction the methane submitted in gas distributive networks. Development of domestic technology of extraction of coal methane by the chinks drilled from a surface in coal layers, not broken by mountain works, with 2002 is engaged in Promgaz under orders of Gazprom. The forecast resources of coal methane comparable to stocks of gas deposits, methane of coal deposits as allows to consider the no conventional energy carrier and to put problems of its industrial extraction. Now extraction gas of chinks of the experimental range which is settling down in territory of the Kemerovo area, makes 3500–4000 m<sup>3</sup>/day, concentration of methane is equal 96–98 %.

The widespread technology of extraction of methane of coal layers is the preliminary decontamination which is carried out by means of vacuum-pump station. In a lava prepared for

development from mine drilling chinks which are connected to underground decontamination to a gas main on which methane leaves on a day time surface. The design of chinks and a gas main is those, that in decontamination the gas main through cracks in corner pedigree a file and flange connections of a gas main acts air. On a surface the methane-air mix (MAM) acts, concentration of methane in which can vary over a wide range.

The third technology of extraction of methane from underground mountain developments is ventilation, concentration of methane in which should not exceed 0.75 %.

In a quantitative sense by means of preliminary decontamination it is possible to take from 10 up to 50 % of the methane originally containing in corner pedigree a file, by means of preliminary decontamination – 10–20 %, with ventilation 30–80 % of methane.

The first technology provides extraction of the most qualitative on structure of methane of coal layers, but is most expenses and can become profitable at sharp increase of the prices for natural gas that is real prospect the nearest years.

Methane of the fulfilled ventilating jet because of low concentration of methane can be utilized or at low-temperature catalyzes burning, or at its use as blasting in power and thermal installations (Australia). In Russia the fulfilled ventilating jet is not utilized.

Resources of coal methane, prisoners in layers of coal on operating mine fields are the most accessible to extraction. In industrial stocks of coals contains up to 160 billion m<sup>3</sup> methane from which means of preliminary decontamination it is possible to take 40–65 billion m<sup>3</sup> methane.

Use of mine methane is complicated by that it from mountain developments in the form of a methane-air mix (MAM) leaves, structure and extraction which vary over a wide range, and concentration of methane on a regular basis decreases to explosive sizes 5–15 % CH<sub>4</sub>, the mix contains a drop and steam moisture, a coal and mineral dust. Use MAM is authorized normative documents at the maintenance of methane less than 2.5 % or over 25 %. The condition MAM can be received due to reduction receipt air in the decontamination system which is being under pressure. Foreign experience, and also experience of Open Society Vorkutaugol shows, that maintenance in deleted MAM concentration above 25 % really achievable problem demanding for the realization acceptance of some measures:

- increases extraction decontamination chinks;
- reductions receipts air in decontamination system.

The increase extraction decontamination pipes can be reached by various sources of external influence: mechanical, chemical, thermal, etc.

Mechanical method of influence is drilling decontamination chinks; the various reactants cooperating with mineral substances concern to chemical methods of influence, containing in corner pedigree a file, thermal influence render the acoustic resonator, thermal pipes, etc. The Method of acoustic influence is approved on operating mines and has shown the efficiency. Use of thermal pipes with the purpose of decontamination corner pedigree a file now is proved only theoretically and has not passed experimental approbation.

Deduced on a day time surface condition the methane-air mix is used in power or thermal installations.

Greater dissociation the coal-mining enterprises causes a demand decentralized systems warmly and electro supply. In the specified systems there are no the main heating mains, being a source of losses of heat at its transportation to consumers. These systems differ the small inertia, the low cost price of received heat and are presented by several types heat-generators a water, air and radiating heat supply. In “Promgaz” the independent modular boiler-house mine with chemical water-preparation and boiler automatics capacity 1.0 MW full factory readiness is developed. The boiler-house contains a line of submission of a methane-air mix; the block of preparation of gas; boilers; block two-level torches with the terminators of fire, allowing to work on MAM at concentration of methane within the limits of 25–50 % at the set thermal capacity; a blowing-off line; the monitoring system of concentration of methane in MAM and a premise of a boiler-house; units of emergency overlapping of submission of a methane-air mix and its dump in a blowing-off line. The unit of the control of concentration of methane in MAM contains a gas analyzer and the latches connected with it cutting submission MAM in case of decrease of concentration of methane below the established limit. Excess of

temperature in a boiler-house is limited by the thermo sensitive valve. Unlike the modular boiler-houses working on natural gas, the mine modular boiler-house is equipped by the block of preparation of the gas, carrying out clearing and drying gas, system of automatics of safety and modernized block torches for work on MAM. The boiler-house has successfully passed acceptance tests on one of mines of Kuzbas (Fig. 1). Problems have arisen because of absence of normative base on mine methane. For maintenance modular boiler-house mine standard by mine methane on mine have been taken measures on increase in concentration of methane in deleted mixes in operating decontamination to system due to reduction receipts ventilating air.



Fig. 1. Appearance independent modular boiler-house mine with a bringing gas main

The sub-standard methane-air mix ( $CH_4 < 25\%$ ) which quantity on many mines of Kuzbas now makes 80–90 %, leaves in an atmosphere. To transform sub-standard MAM in standard it is possible due to addition of natural gas. At absence of natural gas the technology of enrichment MAM by means of membranes, with use shortly cyclist adsorptions or a gravitational division in a separator is demanded. However these technologies now economically are not justified.

In “Promgaz” the technology of use of sub-standard mine methane now is developed. Experimental researches addition of inert gases sub-standard MBC by products of combustion for maintenance of safe transport of an explosive mix from decontamination stations before power installation (Fig. 2, curve  $CH_{4f}$ ) and transformation into a gas mixture addition of additional air (Fig. 2,  $CH_{4b}$ ) have been lead. It has been shown, that the given procedure is competent at initial concentration of methane of 18.5 %  $CH_4$  of 25 %, that essentially expands a scope of mine methane.

Mine methane can be demanded as fuel in recuperative and mixing heaters of air, used for heating a ventilating jet, drying of coal, creation of air thermal veils. Systems of the decentralized heating of premises include also gas infra-red radiators of various temperature levels. In work calculations of efficiency for all types the heating engineering units of the decentralized heat supply (Table 2) are executed.

Table 2. Efficiency for various units of the decentralized heat supply

Types of units of the decentralized heat supply	Thermal efficiency, %
Mixing heaters of air	98 – 99
Recuperative heaters of air	75 – 85

Radiating dark radiators for the open premises	≈ 50
Radiating dark radiators for the closed premises	50 – 85
Gas boiler-houses	90 – 92

One of perspective directions of increase of efficiency of use of primary fuel is the combined manufacture electric and thermal energy with use of turbines of small and average capacity (mini thermal power station). Advantage of such way of development of energy is achievement of operating ratio of fuel up to 0.85.

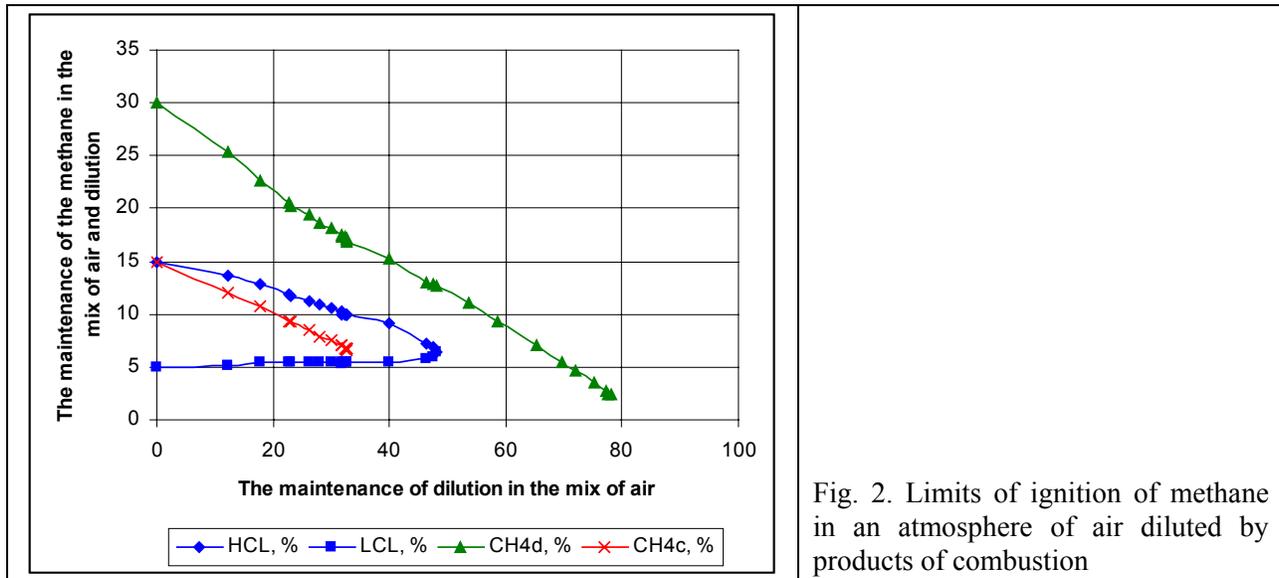


Fig. 2. Limits of ignition of methane in an atmosphere of air diluted by products of combustion

There are some technical decisions of development of electric energy directly at consumers. At presence condition mine methane, it is expedient to use gase-diesel installations. Expediently also application of turbines with against pressure on existing steam and pairs water-heating boiler-houses which can work on mine methane. The given technology consists in recycling potential energy pair at downturn of its pressure up to the demanded size not dump of pressure, and fulfillment of work.

## CONCLUSION

1. The share of coal and in passing taken coal methane which use will lower specific energy consumption will increase in the fuel and energy balance of Russia of immediate prospects, will raise profitability of coal-mining mines, will improve ecology.
2. At use of mine methane it is necessary to consider changeability of structure, expenditure, features of ignition and burning of methane-air mixes.
3. For development of thermal energy it is necessary to use modern independent modular boiler mine, recuperative and mixing heaters of air, radiating radiators which are demanded as in systems centralized, and the decentralized heat supply.
4. The pilot project on introduction by independent modular boiler mine capacity 1 MBt is realized in 2007 on one of mines of Kuzbas.
5. Wide introduction independent modular boiler mine in coal regions of Russia will solve a problem of their heat supply, together with will essentially improve an ecological situation.
6. For reception of electric energy it is necessary to use both gase-diesel installations, and mini-thermal Power Station under which, in particular, it is possible to convert existing steam boiler-houses.
7. Methane of ventilating air can be utilized at use of this air as blasting in power installations and at catalyst burning in recycling of heat installations.