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NEW TECHNOLOGY OF GAS EXTRACTION ON THE BASE OF A COAL TO A HYDROGEN TRANSFER

In modern period the useful extraction of energy from coal seams does not achieve 7–9% of calorific capacity of the coal. These data are calculated at the expense energy expenditures in mining and transportation and conversion of the one into power generation. The labor-intensive of coal mining is fluctuated as 0.02–0.5 man-shift per tone and 10–12 tones of the fresh air are sent per one tone of the extracted coal. Coal mining is accompanied by 25–28% empty rock. In coal mines 1–2 men are killed during one million tones extraction of the coal. Industrial procedures of coal extraction break the environments very much. Extracted mine's gases and mineral particles contribute to total warming of the Earth climate very much. The shortages require from mining science the insistent efforts for quests of new unconventional technologies of coal extraction and conversion of the one.

Moscow State Mining University has proposed unconventional technology for introduction in the methane content coal fields (Vasyuchkov & Vorobjev, 1996, 1997) [1–3]. The proposals include three stages of unconventional coal mining: drilling of boreholes from the surface to extracted coal seams, underground gasification of the coal seam and extraction of coalbed methane mixing with gas of underground combustion of the coal. An essence of the technology consists in transfer of the hard coal in the combustible gas mixture and transport of the one along tube line the gas mixtures. The scheme is differed by third blocks. The first block presents boreholes group which services for methane extraction from surrounding rocks and coals spaces (see 9–11 of Fig. 1). The boreholes may be drilled individual or group methods and cased with metal tubes and connected to vacuum pumps. The vacuum of the wells may be equal as 300–400 mm Hg and the diameter of the ones as 80–125 mm. the group may be located near the gas wells or far from it. But the distance mustn't more several (3–4) kilometers. Cleaned mixed gases must be moved into the unit of combined cycle turbine for further power generation.

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The conceptual scheme of the unconventional technology is shown in the Figure 1. Integrated unconventional technological scheme consist of several panels which are in technology too. Concentrated and cleaned gas mixer moves in combine cycle turbine where simultaneous extraction. The first panel is under gasification process of a coal seam and second panel services for coalbed methane extraction to the surface pipeline system of coal-gas-energy complex [4].

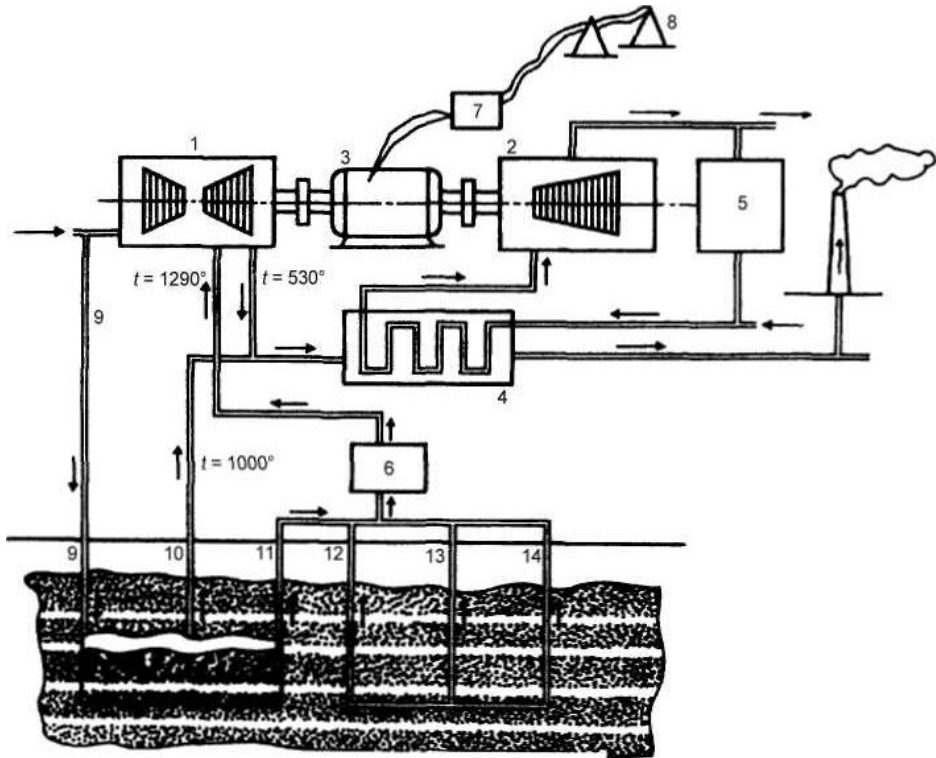


Fig. 1. Integrated borehole's coal-gas-electricity scheme: 1 – gas turbine; 2 – steam turbine; 3 – generator of electricity; 4 – heat exchanger; 5 – condenser; 6 – gas cleaning; 7 – transformer; 8 – high volt line; 9 – borehole for clean air (oxidizer); 10 – heat excluded borehole; 11 – gas excluded borehole; 12, 13, 14 – coalbed methane boreholes

Coal of the first panel is extracted through boreholes by means of gasification process. Hot gases picking out from the production boreholes are collected and mixed with coalbed methane extracted from second panel. The cleaning and concentration processes are included into this power generation. In the Figure 1 three main blocks of this integrated coal-gas-electricity technology are shown: block of transformation of coal in hot combustible gasses (hydrogen, methane and oxide of carbon) and block of coalbed methane extraction and block of power generation into combine cycle turbine.

Next technology scheme consists of the block of hydraulic extraction of a coal seam with flexible monitor through a borehole and the block of coalbed methane extraction and the block of power generation in the combine cycle turbine. The scheme is demonstrated in the Figure 2.

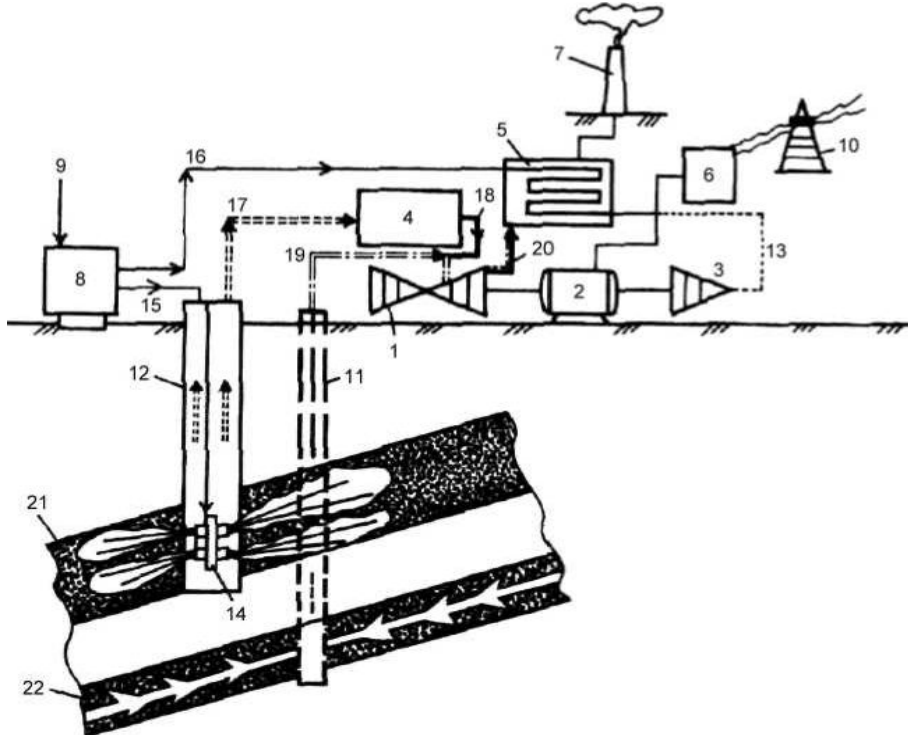


Fig. 2. Principal scheme of hydraulic mining and gasification processes for power generation:
 1 – gas turbine; 2 – generator; 3 – steam turbine; 4 – gasification unit; 5 – heat-exchanger;
 6 – transformer; 7 – smoky tube; 8, 9 – water supply; 10 – electric power line; 11 – borehole for
 coalbed methane extraction; 12 – borehole for water-coal pulp; 13 – steam; 14 – hydraulic monitor;
 15 – pipe line with high pressure water; 16 – water in heat-exchanger; 17 – water-coal pulp for
 gasification; 18 – combustible gases into turbine; 19 – coalbed methane into gas turbine;
 20 – exhaust fumes in heat exchanger; 21 – upper coal seam for hydraulic mining;
 22 – lower coal seam for coalbed methane extraction

The difference of the scheme from the previous scheme consists in hydraulic process of coal mining. This process provides the water – coal pulp which may be moved into the turbine. For sustainable work of the turbine the cleaning and preparation processes in this scheme must be used. On the modern stage of borehole’s technologies development the innovative equipment, of course, must be produced. The unconventional systems of supporting of the coal seam roof must be created. This is enough difficult but may be come true. The systems of hydraulic extraction of coal with hydro-monitors and chambers and

supporting of the roof with pillars are more progressive. This technology is based on the reliable calculations which must be done for the dimensions of pillars. And designs of the hydro-monitor and unit as feeder for it are important problems. This is all for mining science. And once more one problem is. In the technology the water – coal pulp is directed in the gasification unit for transformation in gas fuel. Nevertheless known nature of this process the accurate calculations must be confirmed in the practice for the specific kind of coal.

Above mentioned schemes are characterized underground conditions for industrial use. Moscow State mining university has proposed the unconventional technology of mining on the base of elements open hit method of mining.

The scheme of unconventional technology for coal processing to the gas fuel is depicted in the Figure 3. In last scheme the new element is appeared. This is recovery of hydrogen. The technology has proposed by Moscow state mining university (Puchkov *et al.*, 2005). According to the technology hydrogen will be produced from hot combustible gases of gasification process.

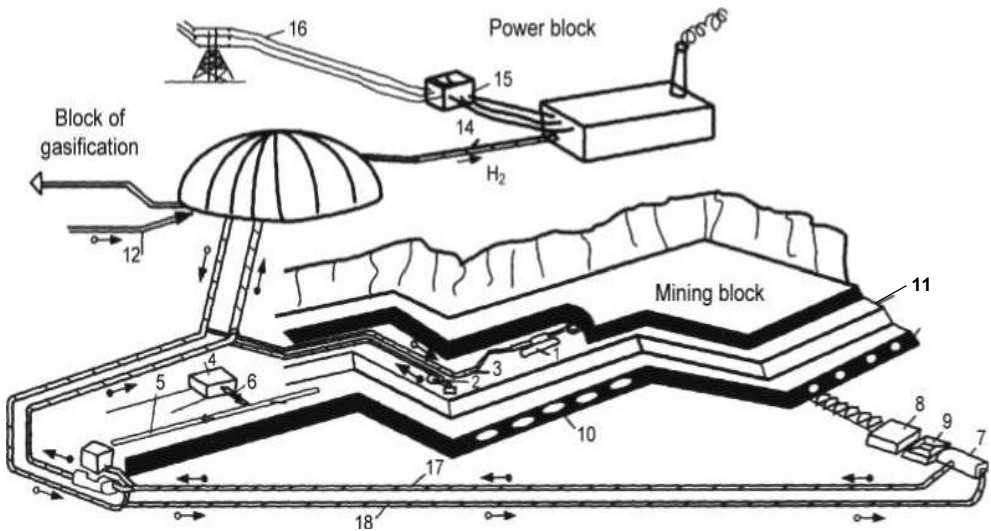


Fig. 3. Scheme of open pit mining and coal gasification and power generation in combine cycle unit: 1 – hydraulic monitor; 2 – exhaust coal hump; 3 – pipe line of high pressure; 4 – milling combine; 5 – belt conveyer; 6, 9 – bunker; 7 – supplier; 8 – screw-boring combine; 10 – chambers; 11 – upper coal seam; 12, 18 – water pipe line; 13 – lower coal seam; 14 – hydrogen pipe line; 15 – transformer; 16 – high volt line from combine cycle unit; 17 – pulp pipe line; 19 – waste of gasification and cleaning processes

The essence of the hydrogen production in a structure of the CGE Technology consists in gas-generator mixture cleaning and enriching of the one by coalbed methane and chemical reaction of carbon oxide (CO) with a water (H₂O) in the alkali solution including metal carbonil [Me(CO)_n] in low temperature (30–40 °C) reactor. Further, the mixture of residual combustible gases is undergone the removal of sulphur and nitrogen and ammonia and

carbon dioxide. The Figure 4 demonstrates the principle scheme of local CGE complex with hydrogen production.

The technology is realized next way. The extraction of the coal bed methane is executed in one site of a coal field but in other site the underground gasification and combustion (UGC) of a coal seam is produced. The process of the UGC is realized through two gases and feeding (supply) wells and three outgoing wells. Raw gas from underground generator is cooled and directed to cleaning from mechanic admixtures in a cyclone 5.

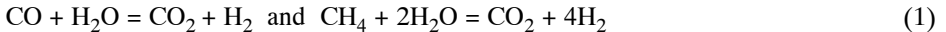
Further the chemical cleaning from the sulphur is realized in two stages. The first stage is characterized receiving of hydrogen sulphide 6 and the second stage by means of receiving clean sulphur from hydrogen sulphide into an absorber Figure 4. Schem of Hydrogen Production in Local Coal-Gas-Electricity Complex (LCGEC)

Conventional meanings in Figure 4: 1 – coal seam; 2 – input flow well; 3 – output (production) gas flow well; 4 – heat -changer; 5 – cyclone; 6 – reactor; 7 – heat- changer with absorber 8, 9 – low temperature hydrogen reactor (LTHR); 10 – high temperature hydrogen reactor (HTHR); 11 – heat-changer; 12 – filter; 13 – chemical reactor; 14 – utilization cooler; 15 – hydrogen generator; 16 – methane recovery well; 18 – area of methane extraction; 19 – fire zone (channel).

Further generator gas is directed into low temperature hydrogen reactor 9 where the chemical reaction of hydrogen receiving from oxide oxygen takes place. Remain gas mixture is mixed with a coalbed methane from neighboring extraction wells. After the process the mixture contains next components: N_2 and H_2 and CH_4 and CO_2 .

For removal of the methane and transfer of the one in the hydrogen the mixture is treated with water steam in presence of catalyst and high temperature hydrogen reactor 10.

Further dioxide oxygen is removed by means of chemical reaction with calcium oxide and receiving of calcium carbonate which is directed in the utilization. The basic chemical reactions of hydrogen production are:



In both formulas the carbon dioxide is created. The gas isn't desirable in the hydrogen receiving process and must be subject to removal. This process is provided by means of the connection of the carbon dioxide with the calcium oxide and receiving of the calcium carbonate:



The reaction allows do removal that admixture as carbonic oxide. The other admixture N_2 is removed by means of the chemical reactions:



These reaction allow creation of an ammonia and liquid ammonia.

All above mentioned reactions requires strong conditions observance but the way for hydrogen production on the coal fields sites is possible.

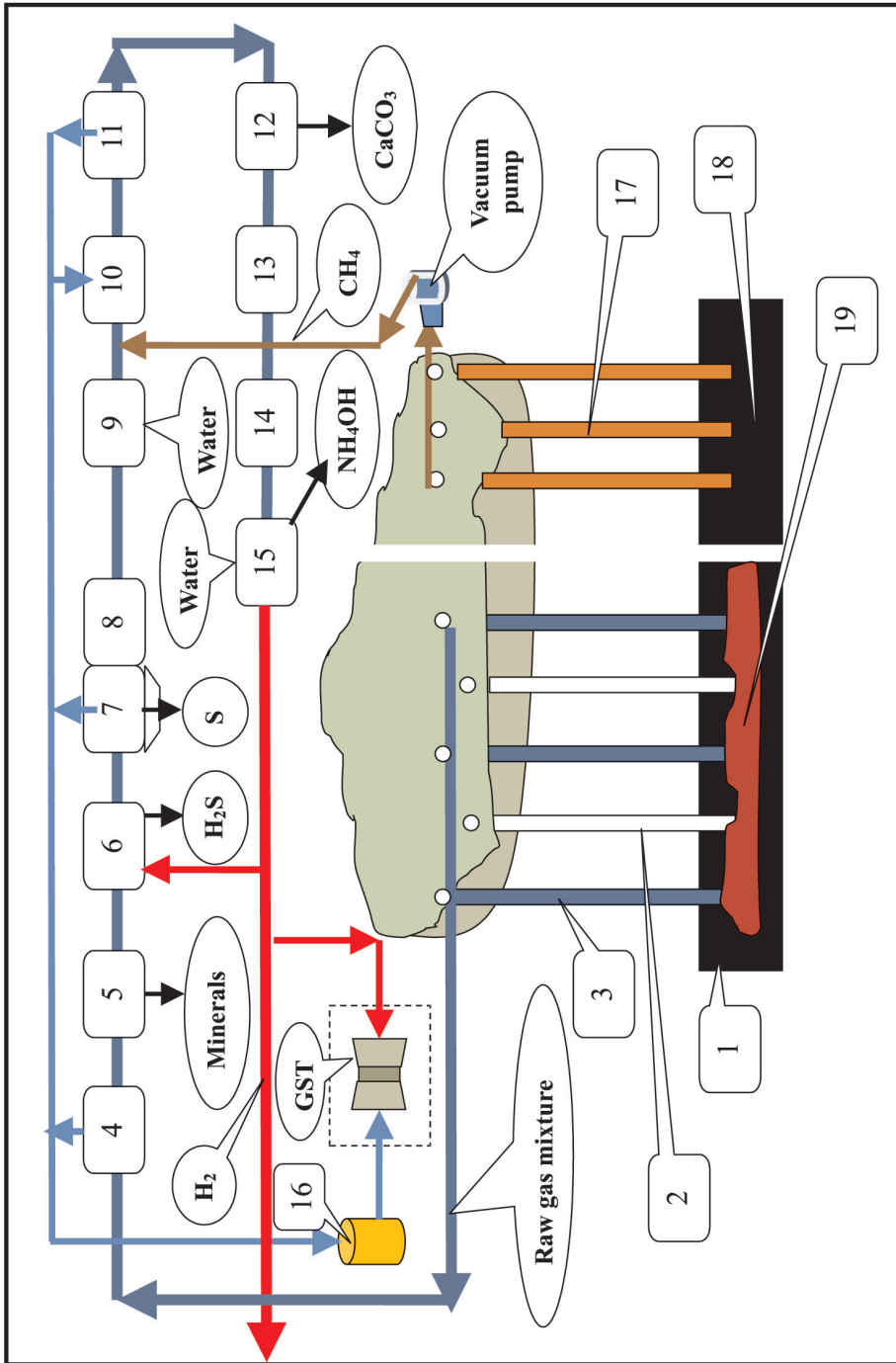


Fig. 4. Scheme of Hydrogen Production in Local Coal-Gas-Electricity Complex (LCGEC)

CONCLUSIONS

1. The conventional technologies of coal mining are characterized economical and ecological and social shortages which don't allow making quick progress in these areas.
2. Reality does challenge for mining science to develop principle new (novel) technologies on the well base use.
3. These technologies are: coal – gas-electricity (CGE) with underground gasification process and power generation in the combine cycle unit on the coal field and complexes of power generation and processes of hydrogen production (LCGEC).
4. The well hydrogen technology can make the competition for conventional technologies of coal extraction.

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