Conception of fuel-energy system proposing underground burning of coal layers

INTRODUCTION

One of the basic features of mining industry is the fact, that re-excavated deposits of minerals resources appear, as a rule, more low-grade and (or) are less accessible, than excavated before. Therefore in coal mining industry is impossible not only improvement, but even keeping up modern level of technical and economic parameters if one is oriented to known technological, technical and organizational decisions. In this connection, special significance has the perspective basic researches of the fuel and energy systems supposing the underground burning (gasification) of coal in its bedding place.

To unsolved problems of underground thermo-chemical coal processing it is necessary to relate high losses of energy in bowels (from 30 up to 50 % of it is spent for useless warming up of rocks), difficulty of burning process control and distribution of deformations of land surface above the burnt out interior space, insufficient combustion heat of produced generating gas. In spite of a number of conclusive advantages of rock-hole geotechnologies, they can not provide (in authors' opinion) the effective solving of specified problem problems.

Increasing of economic and ecological actives of underground thermo-chemical coal processing can be achieved during production of the electric power directly in mine conditions. For this purpose special gaseous-electric complexes are developed, which use synthetic gas at coal processing for manufacture of the electric power in their bedding place. It is necessary to note, that necessary (profitable) increase of combustion heat of produced gas (up to 8 and more MJ/m^3) can be produced only in conditions of a high pressure and intensive oxygen supply in the center of burning (so-called technology of integrated gasification JGCC) and requires clear control for parameters of coal burning process. Besides it is necessary to provide recycling of heat used for warming up of surrounding rocks.

DESCRIPTION OF A NEW METHOD OF UNDERGROUND BURNING OF THIN COAL LAYERS

For solving the risen tasks in Donbass State Technical University the control method by burning process and heat exchange at coal processing in bedding place is developed, based on mine preparation of power blocks and using the trumpet collector in layer's ground for circulation of the heat-carrier. The general operation circuit of the block is given on fig. 1, longitudinal and a transverse section - on fig. 2.

This method is as follows. A site of coal layer 1 delineate by excavations 2, forming the given dimensions (a, b) of the power block. Excavations go by wide pit-face over coal, preparing the space for gasification channels 3 and packs 4. Along the zone planned fire pit-face the capped fuses are placed. Fire pit-face 5 goes in process of coal combustion with speed 0,5-1,5 m/days. Pack 4 is made by block up of rock received at making delineation excavation, with the further injection of a hardening solution. On interface with excavation a concrete support structure 6 is erected, which carries out the isolation functions as well preventing the distribution of high temperatures and gas streams out of the block. Fastening of delineation excavations 2 is advisable to do using splash-concrete method in combination with support structures.

From excavations 2 into rocks of the layer 7 holes 8 are drilled in which the steel pipes 9 connected to input and output highways 10 are placed. From a surface to the power block air-pumping (11) and gas-outlet (12) holes connected to channels of gasification 3 are drilled. In such a way, it is prepared several adjoining blocks placed near the underground power station. People in

mine site are present only during the construction of power blocks, and their fusion preparation is provided manless. At thermo-chemical coal processing to firing site 5 through air-pumping hole 11 and channel 3 the high-tension air jet is supplied the air jet, which provide the oxidizing processes. Outgoing gases move in a direction of the hole 12, where in a soaking up way they move into cogeneration systems on a surface.

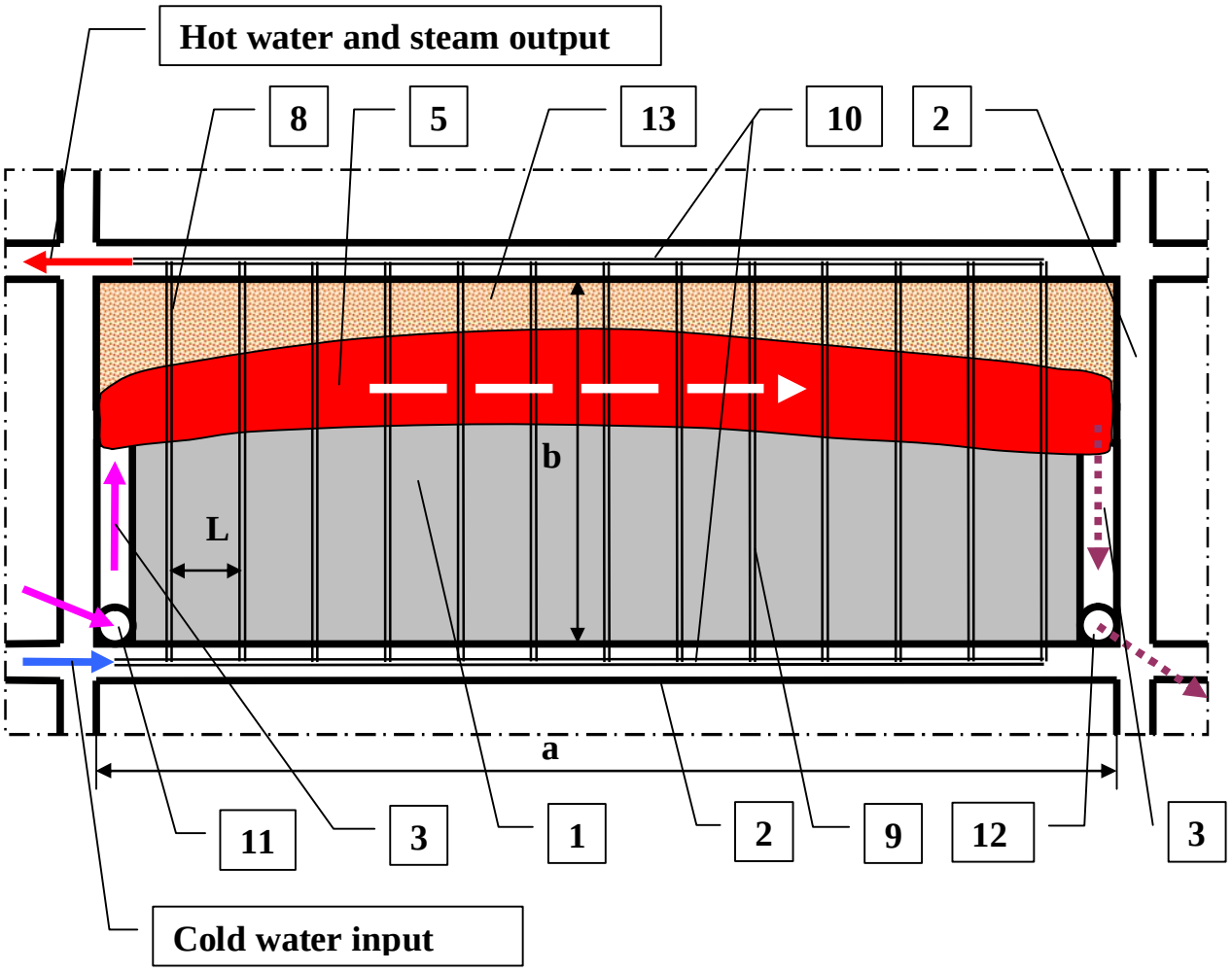
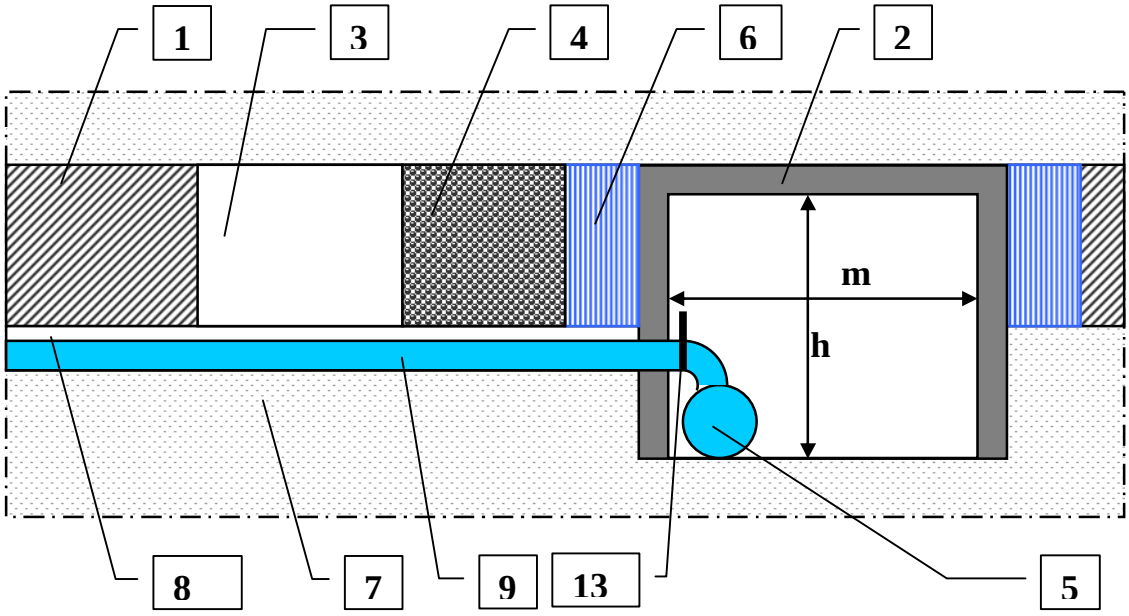


Figure 1 – Scheme of run of the power block

The temperature in a burning zone exceeds 1000°C, heating the ground rocks and a roof which keep their high-temperature potential for a long time. At that for heating the rocks it is used about 50% of energy produced during coal layer combustion.

During the period of firing preparation of the block in the generated trumpet collector the energy carrier (water) is brought up, which, being warmed up to the given temperature (that is adjusted by speed of water movement in pipes), ensures the operation of energy-generating devices. Taking into account, that speed of burning (gasification) of coal layer is 0,5 - 1,5 m/day, time of operation of each power block can be half a year and more (depending on the used dimensions of the block). It expedient to use as turbo generators the modular geothermal power units "Tuman 2", which use water with temperature about 200°C. Besides such power unit has rather small dimensions (10,5×3×3,5 v), that is essential advantage at its positioning in the underground chamber.



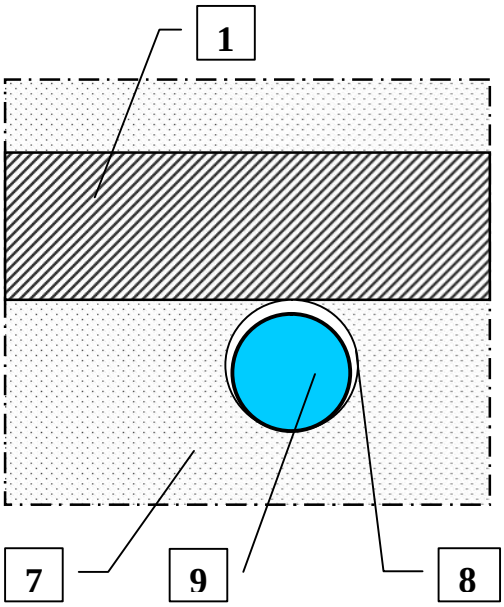


Figure 2 - Longitudinal and cross sections of the power block

The important technological parameter of the system determining the charge of pipes of a collector and the cost price of produced electric power is the distance between pipes L which should be maximum possible (taking into account the most full heat extraction from the zone of burning and the heated rocks). For definition the expedient intertube distance L we shall consider a problem of heat exchange.

INVESTIGATION RESULTS FOR PARAMETERS OF METHOD

Theoretically for extraction of all thermal energy produced as a result of coal layer combustion and having distributed into rock massifs, it is necessary to isolate a burning place (from below and above the layer) by the cavities filled with the circulating heat-carrier. As to place the

heat-carrier in roof is not possible technically (in connection with rock crushing of the roof at fire wear of a layer), we shall operate only with a cavity 1 in ground (fig. 3). As, the heated rocks of a roof 2 collapse during the burning process of a layer, and the breaks of continuity of roof rocks 3 create thermal resistance and prevent the heat distribution, than its major part (not less than 80 %) can be taken by the heat-carrier of one bottom cavity. For manufacture power production it is necessary to make a selection of heat of rocks using the metal pipes collector, so in our case the preventing cavity 1 is replaced by the discrete sites 4 simulating pipes of a collector.

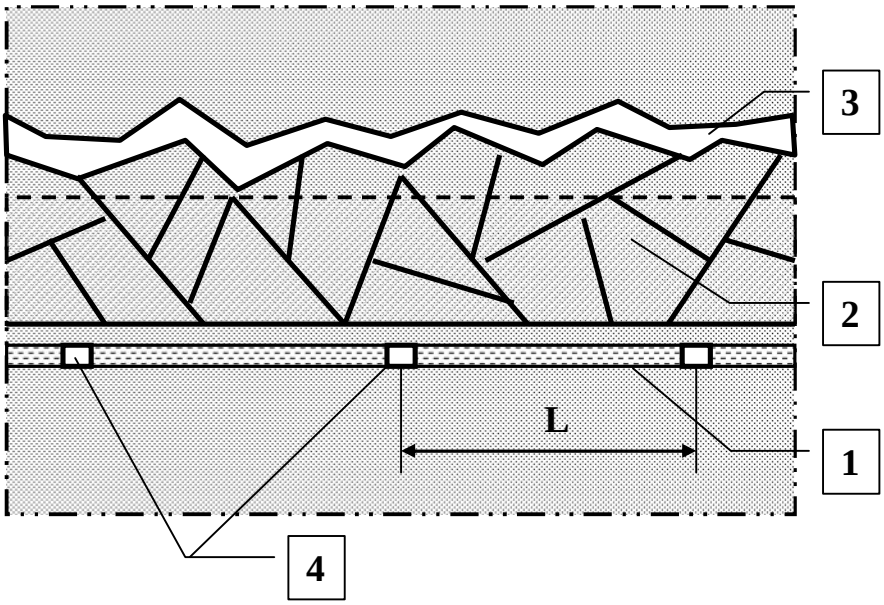


Figure 3 - Model of heat extraction from a burning zone

As the calculations have shown, movement of the heat-carrier (water) in a pipe allows practically nongradely take heat from environmental rocks in a burning zone of a layer over the distance equal to four radiuses of a pipe. The significant part of heat will be selected in the next period of time, which can be up to 5 days (depending on capacity of a layer and moving speed of the heat-carrier). The distances from which the extraction of heat by one pipe of a collector is possible is determined by a temperature gradient of rocks around of burning zone, speed of layer burning and its capacity. Proceeding from the data of practical experience used in theoretical researches, the distance between pipes can be within the limits of 5 - 20 m that provides economic feasibility of use of trumpet collector for extraction of heat power potential of adjoining rocks.

So, if sizes of the coal block are 300×100 m and capacities of 1 m layer in addition to gasification products it can be produced about $23 \cdot 10^6$ kWt hours of power. As calculations have shown, it is 1,5-1,8 times exceeds the expenses for preparation of the power block, including its equipping with a tube collector.

The effect of a new method is provided also due to essential increase of combustion heat of the obtained products of gasification as in the closed block it is possible to provide the automatic control of key parameters of gasification (temperature, pressure, speed of air supply and gases "removal"). Besides as the layer is divided into blocks by mining excavations with heat-isolated support, the borders of distribution of coal burning process are provided that excludes the undermining of objects on a surface.

In comparison with traditional preparation of minefield the construction of underground mine-power station considerably will simplify the scheme and will decrease the extent of mine excavations. Maximum efficiency of application of the developed technology can be received on the working mines, requiring their reconstruction or experiencing the liquidation process because of low efficiency of run of thin coal layers.