PRACTICAL, FREE, ECOLOGICAL, AND SAFE METHOD FOR PRODUCING ELECTRICAL ENERGY AND A SUBSTITUTE FOR NATURAL GAS FROM COAL DEPOSITS

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The author gives a new, nontraditional understanding of coal as a solid solution. This solution does not contain methane as gas. Methane gas is a product of the solid solution disintegration. This reaction is a result of the mining operations. Outburst of the gas and coal into the mine is presented as an "autowave" process ("soliton") and gas generation as a product of a pseudoreaction of the coal system's gaseous and solid ingredients. Keeping in mind these and other theoretical considerations, the author proposes the concept of automated ("manless") simultaneous mining of ecologically harmful methane as the main component and the coal as an auxiliary component. The composite coal-hydrogen fuel is extracted and transported to the surface exclusively through the energy of the coal itself - the energy of the manned gas-dynamic process or "sudden" outburst of gas and coal. The fuel for a thermoelectric power station (water-coal mixture and methane) is the intermediate product of the georeactor. Electrical energy is the ultimate product of this georeactor.

The present state of knowledge in the proposed research field. Scientific investigation of gas-coal deposits with sudden outbursts has been limited because of a lack of adequate research tools and procedures. Models of mechanisms are not right. We do not have instruments of research for great depths; for example, mining experiments are in error by 300% and more. Laboratory experimentation is not possible because it is not possible to reproduce conditions similar to those occurring in nature.

Actually, in the New Independent States (NIS), all the methane from gas-containing coal deposits releases into the atmosphere in the course of mining. These gas emissions lead, on one hand, to irreversible losses of valuable chemical and energy sources; on the other hand, they negatively affect the environment and lead to overheating of the atmosphere. More than 200 billion m^3 of methane from underground mines have polluted the atmosphere during the last five decades. This amount of gas is comparable to the scale of a large gas field.

Objectives of the proposed research (objectives)

- Clean use of fossil fuels in industry.
- Rational use of energy in industry.
- Reduce the impact of the production and use of energy.
- Strengthen the technological basis of the energy industry with benefits for the economy and export potential, while improving social and economic conditions.
- Develop control of spontaneous gas and coal outbursts aimed at environmentally safe and manless extraction of coal and gas due to the energy of gas dynamic phenomena - This is the principal objective of the project.

There are many methods of research, such as associative (abstract thought experiments), laboratory methods, and natural methods (semi-industrial and field tests of new technology). Using these methods in the period 1993-1997, we developed more precise conclusions regarding a working hypothesis of the gas-dynamic phenomena (GDPh). For example, we studied the interrelation between all dynamic phenomena (DPh) and GDPh of self-destruction, i.e., the wearing and destruction evolution of a firm body.

The results of these tests were the source of new ideas. The main points of the hypothesis pioneered are the following.

The mechanism of sudden coal and gas outburst (the process of coal destruction at great depth to gas and dust, caused by mechanical energy) is similar to the following physical processes.

- the process of solid-liquid-gas transformation caused by thermal energy (Fig. 1, 2);
- the autogenous chemical reaction caused by chemical energy;
- changing of electronic conductors electrical resistance caused by electrical energy;
- other autogenous and autowave processes ("order-disorder" transformations).

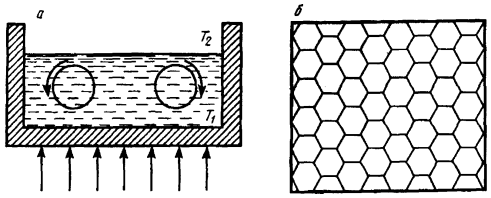

Figure 1

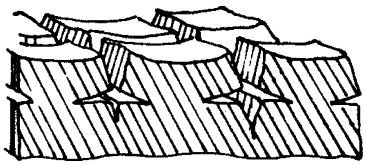

Figure 2

Coal is a typical active medium, which can possess all basic properties typical for active media known in synergetics and in the theory of autowave processes. Its main feature is self-organization, i.e., the development of spontaneous organized structures. At macro- and megalevels, three quasi-aggregate states of the coal substance are recognized (Fig. 3, 4):

1) "virgin rock" (without induced cracks);
2) "weakened" (from one induced crack to completely crushed state); and
3) "gas and coal-bearing flow" (solid phase in suspended state).

There is no gas in the free state in coal; it is generated by the mining-induced process of cracks origination.

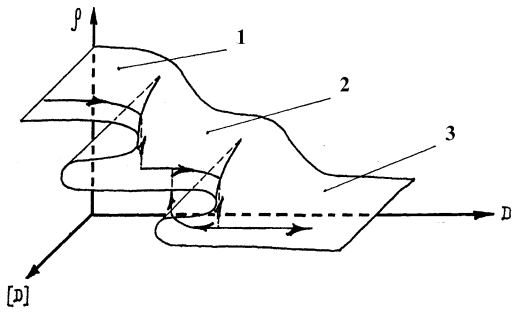

Figure 3

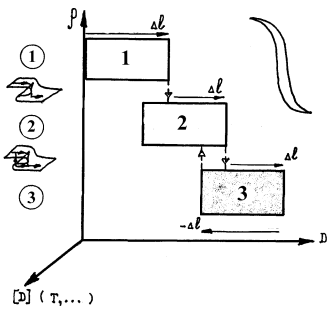

Figure 4

The generation of the gaseous component can occur depending on the intensity of disturbing effect either in the quasi-steady mode (i.e., gas release from the open face) (Figure 5) or in the dynamic mode, i.e. with autowaves (solitone) generation known as gas and coal (rock) outburst (Figure 6).

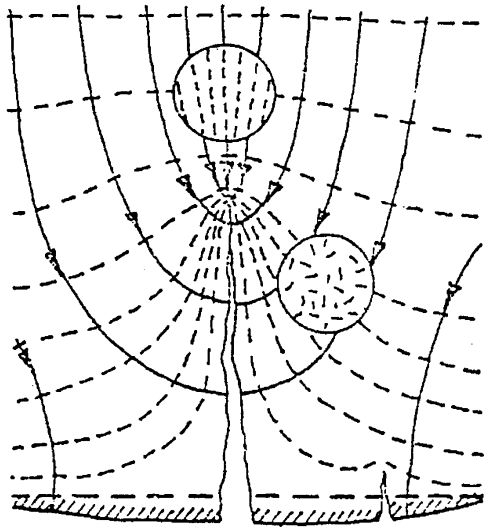

Figure 5

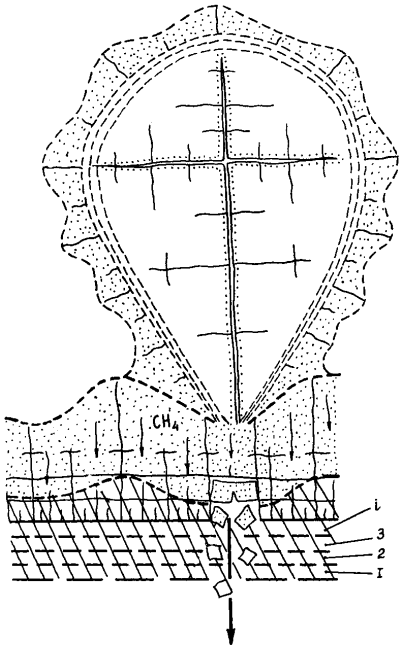

Figure 6

The author presents the new, nontraditional understanding of coal as a solid solution. This solution does not contain methane as a gas. Methane gas is product of the solid solution disintegration. This reaction is a result of the mining operations. Outburst of the gas and coal into the mine is presented as autowave process ("soliton") and gas generation as pseudoreaction of the solution of the coal system's gaseous and solid ingredients.

Based on the results of laboratory and in-situ experiments, we have come to the conclusion that we are dealing with a new (never studied before) type of pseudoreaction of nonchemical decomposition of the solid mass at macro- and megalevels under rock pressure [2]. Further investigations of structural phase transitions (such as "order-disorder") in an unbalanced "rock mass working" system have revealed the controlling parameters of the gas generation process and have resulted in a principally new "Vulkan" technology.

Keeping in mind these and other theoretical considerations, the authors present the concept of the "georeactor" for the manless simultaneous mining of ecologically harmful methane as the main component and the coal as an auxiliary component. The composition of coal-hydrogen fuel is extracted and transported to the surface exclusively through the energy of the coal itself - the energy of the manned gas-dynamic process or "sudden outburst of gas and coal".

The technology is valid for all outburst-prone rock masses. The authors assume that "Vulkan" coal mining will be managed by one or two operators from the georeactor, with no men underground. Coal breaking and transportation from the coal face to loading stations will only be performed using the energy of the controlled GDPh ("spontaneous" gas and coal outburst). The surface complex must be isolated from the atmosphere by a lock (sluice) chamber, which will result in complete utilisation of released gas.

The fuel for the thermoelectric power station (water-coal mixture and methane) is the intermediate product of the georeactor. Electrical energy is the ultimate product of this georeactor.

For the secure exploitation of the georeactor there is a simultaneous imitation complex that can automatically rule the regime of the mining of the coal-hydrogen fuel, and in the case of danger, the complex can give the variants of the next engineering actions. The imitation twin-model of an outburst-prone rock mass including a georeactor is an essential part of this technology. Otherwise, the enterprise (georeactor) cannot be safe.

Control of coal destruction related to gas and dust at great depth. The method of control is based on the hypothesis of "autogenous structural transformation of an outburst-prone rock mass". According to the hypothesis, the process of sudden coal and gas outburst caused by mechanical energy is similar to the changing of electronic conductors electrical resistance caused by electrical energy (Figure 7).

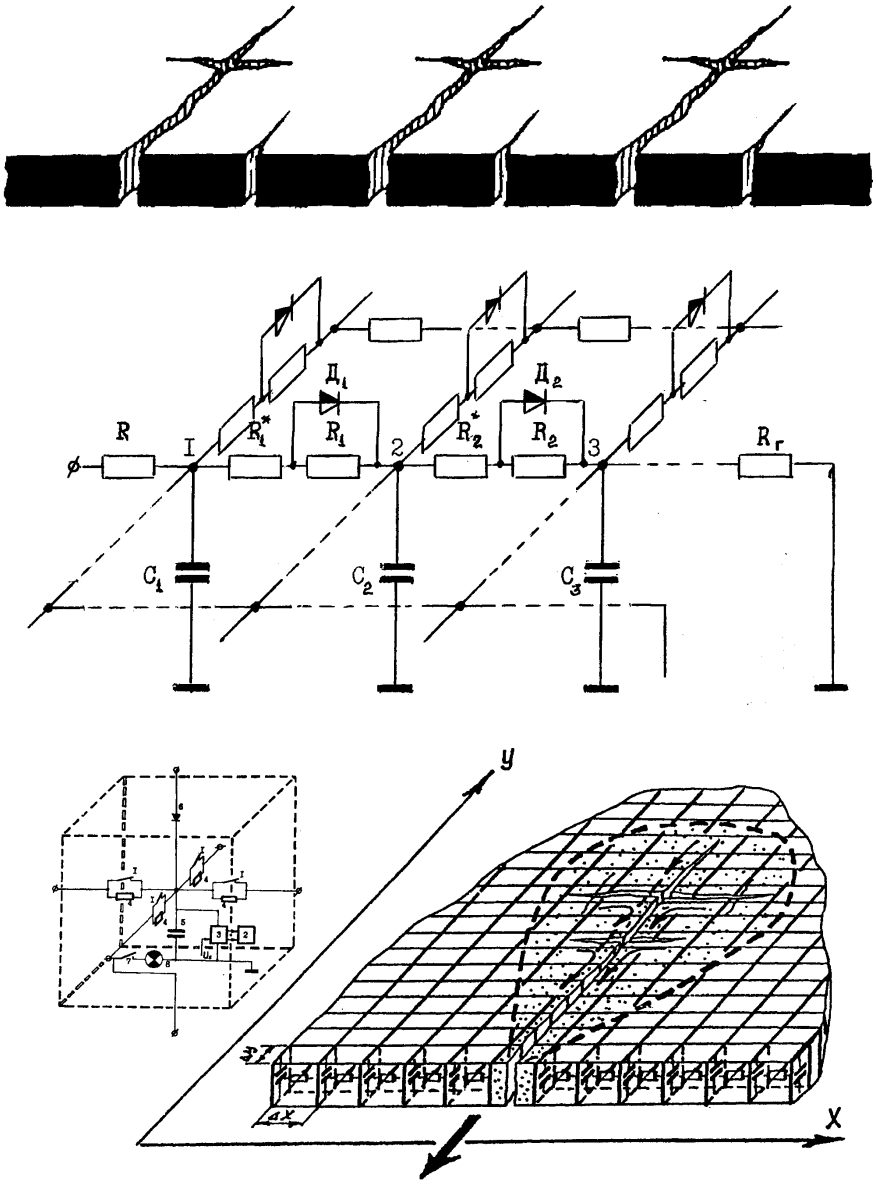

Figure 7

To generate the analogue-digital simulation complex called “Massiv”, it is necessary to solve the following problems:

- Numerical simulation of the processes in the course of breaking gas-containing rocks, i.e., the solution of filtration, elasticity and fracture problems;
- Computer circuit design of the electro-analog active medium with distributed local nonlinearity;
- Numerical experiments aimed at development of an algorithm of evolution of the active medium (models organizing media) using cell automaton analogue-machine;
- Visualization of the evolution of solutions of mathematical models in real-time scale and analogue-digital simulation complex.

For the purpose of further improvement of the electro-analog network models, investigations were executed for searching of an appropriate element base. These elements have to be more adequate to real object - outburst coal seam. Development and manufacturing of new electronic devices and maintenance service of an automated working place on the basis of the IBM PC Intel-486 and experimental analog-digital simulating device were continued in cooperation with companies “Active Nonlinear Network Analogs” (ANNA), “Self-organizing Autowave Nonprogramable Interactive Controling Systems” (SANICS) and “Elektronic Optical Systems” (ELOS). The experimental model of the device for optical representation of the simulated process was developed and manufactured. All results of investigations have a level of the inventions.

Further development of the thesis that simulating the electro-conductive medium is an analog of the cellular automatic machine was continued. Moreover, preconditions of creation of in essence new simulating medium were received [3].

Expected results. Based on results obtained, e.g. the phenomenological theory (hypothesis) of GDPh control and the concept of a future coal mining enterprise (the concept is based on so called “Vulkan” technology), we have come to following conclusions:

- It is necessary to change the existing priorities in the process of solid and gas phase extraction, i.e. to extract the gas, the coal being the additional component.
- It is expedient to initiate spontaneous gas and coal (rock) outbursts, control the process and use the GDPh energy for coal (or other mineral) excavation and transportation up to the surface rather then to forecast and prevent GDPh.

This can lead to the improvement of environmental conditions both in the NIS and all over the world owing to:

- Elimination of annual 2 to 4 billion m^3 outbursts of methane and other pollutants into the atmosphere, and
- 2- to 3-fold reduction of toxic pollution from heat and power stations due to the use of highly beneficated coal.

This can also help the Russian economy to become able to compete in the world market, i.e.:

- To reduce the cost of the mining process due to a 5 to 10 times increase in productivity, and
- To provide comfortable and safe working conditions for the miners in gas-containing underground mines.

The basis will be created for growth of export:

- Of methane, because its cost will be reduced to the cost of natural gas;
- Of coal, owing to its 780-800 million tons additional excavation per year;
- Of electric power, owing to utilization of cheap fuel; and

- Of scientific products in the result of creation of the theory of GDPhs control and a novel (having no analogies in the world) “Vulkan” technology for hydrocarbon fuel extraction.

Our potential customers are the energy-producing complex and the coal-mining industry who will see a fundamental solution to their problems through reducing the excessively high prices of mineral resources and coal. The traditional power engineering taken as a whole is still preferable in comparison to solar energy, wind energy, bioenergy and small hydropower engineering. Owing to the imperfections of traditional mining technology, the coal-mining industry is supported by the state all round the world except USA, South Africa and Australia. The subsidies reach about 20-30 percent of the excavated coal price in different countries, while they reach even 85-90 percent in Russia today. Modern technologies are very unsafe for miners because of the gas factor, methane explosions, instantaneous coal and gas outbursts and other gas-dynamic phenomena (GDPh).

The demand for the solutions greatly exceeds the supply because of poor knowledge of the nature of GDPh. Presently, the problem of instantaneous outbursts has become one of the most urgent for the coal industry of Australia, China, Poland, France, the Republic of South Africa, and other countries. During the last 10-15 years, instantaneous outbursts occurred in coal mines of the USA, Spain, and Turkey as well as in salt and ore mines of Germany, Canada, the Republic of South Africa and Brazil. Some catastrophic gas and rock outbursts are known.

Our product is knowledge (fundamental laws, scientific solutions of different problems of comprehensive mineral resources exploitation, patents, know-how, etc.) The significance of this collaboration lies in the fact that the authors of the project haven't monetary means for scientific research and were unable to make themselves heard to public opinion. The idea of this project is absolutely unique and has no analogies, either in Russia or abroad. The authors want to continue scientific research but they haven't monetary means. Now all people of Europe live in conditions of impending total exhaustion of sources of hydrocarbon fuel and global ecological catastrophe. The project can resolve many ecological problems, but it must be financed. Otherwise people of Europe will be unaware of this means of solving ecological problems.

Therefore, the main constituents of our solutions are novel and nontraditional:

- The “Vulkan” technology;
- The algorithm for simulation of self-organizing (“rock mass - working”) system and solutions of other synergetic problems (Figure 8);
- The theory of control of dynamic and gas-dynamic phenomena for deep mining.

These problems and ideas were preliminarily tested using Russian mini- (micro) computers “SM-4”, "DVK3-M2" and partly on IBM PC. Software for electronic circuit design from “ANNA” and cell automates designed of the authors were used for "soft" simulation. Further research requires modern improved computing equipment. Based on the results of industrial experiments in the face zone of coal seams and experience in coal mining, the main thrust in research during this year was made on processing of early experimental results and realization of new mine experiments. Special devices for borehole experiments in mines were designed and made in cooperation with the firm “Såròåê-2”. Processing of available experimental results shows complete reliability of the theory.

Expected income due to application of the “Vulkan” technology can reach hundreds of millions dollars at one face per year. Moreover, many experts in different fields of knowledge can be interested in numerous sets of applied programs for simulation of self-organizing media - a fundamental feature of all nature. The profits can start in 3 or 4 years, because of the necessity of the product perfection to a commercial level, legal and patent preparation, and marketing studies as well as other problems connected with pilot industrial tests.

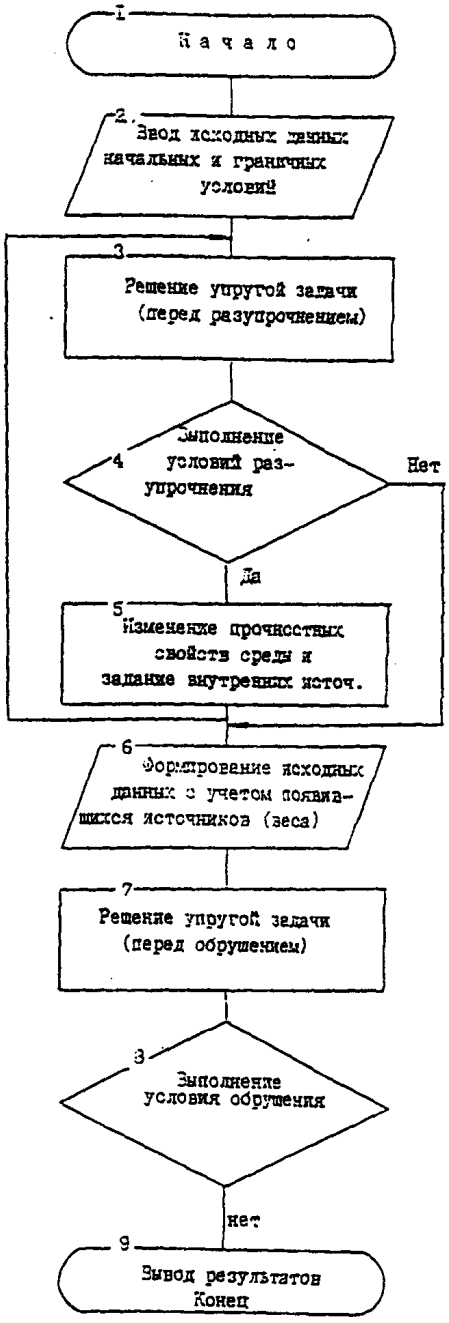

Figure 8

There is no need for any additional investment to introduce the concept to a coal enterprise of the future, the phenomenological theory of GDPh control and the patent for “Vulkan” technology into the marke can be done with domestic resources.

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