

## **PRINCIPAL DIRECTIONS FOR THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY IN THE COAL INDUSTRY OF RUSSIA**

Yu.N. Malyshev

Russian Union of Coal Producers, Moscow, Russia

**ABSTRACT:** Russia possesses high-grade fuel and energy resources, which include high-quality hard coals for power generation, iron-and-steel and by-product coke industry. For the nearest future, radical restructuring of the coal sector on the basis of the latest R&D findings rather than quantitative expansion of coal production will be the key direction for the improvement of the Russian coal competitiveness. Therefore, radical improvement of the R&D system structure in coal industry of Russia was effected in 1997. It was aimed at the settlement of the most acute problems:

- re-assessment and reasonable utilization of coal reserves and resources;
- forecast of geological conditions and preparation of coal-winning sections for eventual efficient operation, with advance comprehensive treatment of the rock mass including coal-bed methane drainage, extraction and utilization;
- development of novel coal-winning technologies and equipment, such as wide-web layer-by-layer cutting machinery (KSM-type) for surface coal winning, overburden removal and underground mechanized coal-winning systems;
  - development of the basics for the technologies of comprehensive preparation and high-temperature chemical coal conversion, coal briquetting, synthesis of coal-derived liquid hydrocarbons and other ecologically clean fuels;
  - introduction of improved pilot technologies for coal slurry preparation, handling and combustion;
- maintaining the acceptable ecological situation in coal-mining regions on the basis of the comprehensive approach to ecological problems in mining and due account for a wide-scale international co-operation.

Over 6 recent years the comprehensive restructuring of coal industry has been carried out. It envisages the technological refurbishing of coal mines and construction of underground and surface mines of a new engineering level with a parallel closure of loss-making mines and implementation of measures aimed at the social welfare of miners made redundant in the pit closure process. Coal output per man in the sector has grown by 30%, and it is forecasted that by 2005 it will have become comparable to that of the leading coal-producing countries of the Western Europe. The restructuring programme of the coal industry of Russia can be successfully realized only with an adequate scientific support. Therefore, the structure of the R&D system of coal industry has been radically reformed. Twenty-four research and development establishments, which had possessed a rather narrow specialization and traditionally served the interests of coal industry before the restructuring, were replaced by five large research centers. Their research areas are shown in Fig.1. Main directions of their research are described below:

### **1. Reassessment, Improvement and Reasonable Employment of the Coal Sector Reserves and Resources in Close Correlation with the Latest Findings and Developments in Coal Mining and Processing Technologies,**

The research programme envisages radically new approach to the assessment of coal reserves and resources with a special emphasis on those reserves, which can be reasonably extracted, and rejection of unfavourable reserves. It will give an opportunity of concentrating coal production in the areas, where coal reserves, which are available for technologically feasible extraction are located, and where geological conditions are most favourable. The following preliminary results have been achieved already:

- Analysis of the market value of coals with due account for geological, mining, ecological and geographic factors, identification of coal reserves available for feasible extraction with an application of modern technologies, analysis of favourable and unfavourable coal deposits and mine takes from the viewpoint of their

development, issue of recommendations on the rejection of unfavourable coal reserves, which are estimated at nearly 60 bin. t;

- Identification of the available resources for non-conventional application of coals including the synthesis of liquid fuels, beneficiation of solid fuel, production of a broad range of chemical agents, as well as recovery of rare metals and trace elements from coal matter;
- Assessment of the resources from the viewpoint of coal-bed methane utilization ;

## 2. Forecast of Geological and Mining Conditions of a Coal-Winning Section Being Prepared for Highly Efficient Operation and Advance Comprehensive Treatment of the Virgin Strata with the Provision of the Following:

- Continuous monitoring of geodynamic processes for safe development of coal deposits on the basis of geophysical monitoring, with the expansion of the application of roof bolting, improvement of the strata stability in the zones of tectonic faults, etc;
- Gas drainage of the virgin strata with coal-bed methane extraction and utilization. The resources of coal-bed methane in Russia are comparable to those of natural gas, however its utilization is not a common practice in fact, (while underground mines annually emit over 1.5 bin. m<sup>3</sup> of methane to the air basin). Two directions of methane utilization are considered: preliminary methane drainage of coal seams before the extraction and methane drainage in the process of mining. The first direction has not been introduced on a commercial scale in Russia, since a major share of coal-bed methane resources is not suitable for commercial extraction. The second direction is now mature enough for the commercial-scale application. Over recent years, work has been undertaken for its further improvement and creation of gas-diesel plants suitable for the efficient combustion of methane-air mixtures with a varying methane concentration.

## 3. Development of Novel Coal Winning Technologies and Equipment

3.1. In surface coal mining, among other progressive directions of continuous and cyclic-continuous technologies, the one envisaging the application of wide-web excavating machinery for layer-by-layer cutting, which completely eliminates blasting

operations, is most promising. A pilot KSM-2000P surface miner, which is known as the Russian KSM Project, has been developed in co-operation with the Krupp Fördertechnik (Germany). At present it successfully operates at the Taldinsky Open Cast Mine in the Kuznetsk Basin. A two-year operation has proved the feasibility of the co-manufacture of such machinery, which will be able to cut the strata of up to 100 - 120 MPa compression strength. For the conditions of the Taldinsky Open Cast Mine a nearly 1,000 t monthly coal output per man is guaranteed with this machinery, i.e., a 4-fold growth of the level attained there earlier, while coal production costs are reduced by at least 30%. Moreover, metal consumption of the whole machinery complex for overburden removal and coal excavation at an open cast mine is lower than in the cases of conventional surface mining machinery application.

In the nearest future a wide-scale work will be undertaken with an aim of the technological refurbishing of surface coal mining on the basis of the above technology for open cast mines of the Central Kuznetsk Basin, Transbaikal Region, South Yakutia and a number of other main coal-mining regions of Russia.

The programme of novel machinery development is oriented towards the expected expansion of the share of surface mining to 70% - 75% in the total coal output of Russia in the next decade.

3.2. In underground coal mining a special Programme for the development of modern mining machinery and equipment competitive with the best analogs of foreign manufacturers has been elaborated in our country. With its implementation, the establishment of underground mines of a new engineering level will become a corner-stone R&D challenge. A synthesis of advanced findings and developments of the domestic and foreign mining science in all technological processes of an underground coal mine is aimed at the exclusively efficient extraction of the most favourable coal reserves. It serves the basis for the above mentioned problem solution. Findings and developments in this area will provide for the following:

- Formation of the reasonable topology of a mine of a new engineering level, such as a "mine-coal face" (a "mine-coal seam");
- Extremely high concentration of mining operations providing for a nearly 10,000 t daily coal output per face, and even higher in some cases;
- Tangible reliability of all technological processes of a coal mine and a new system of

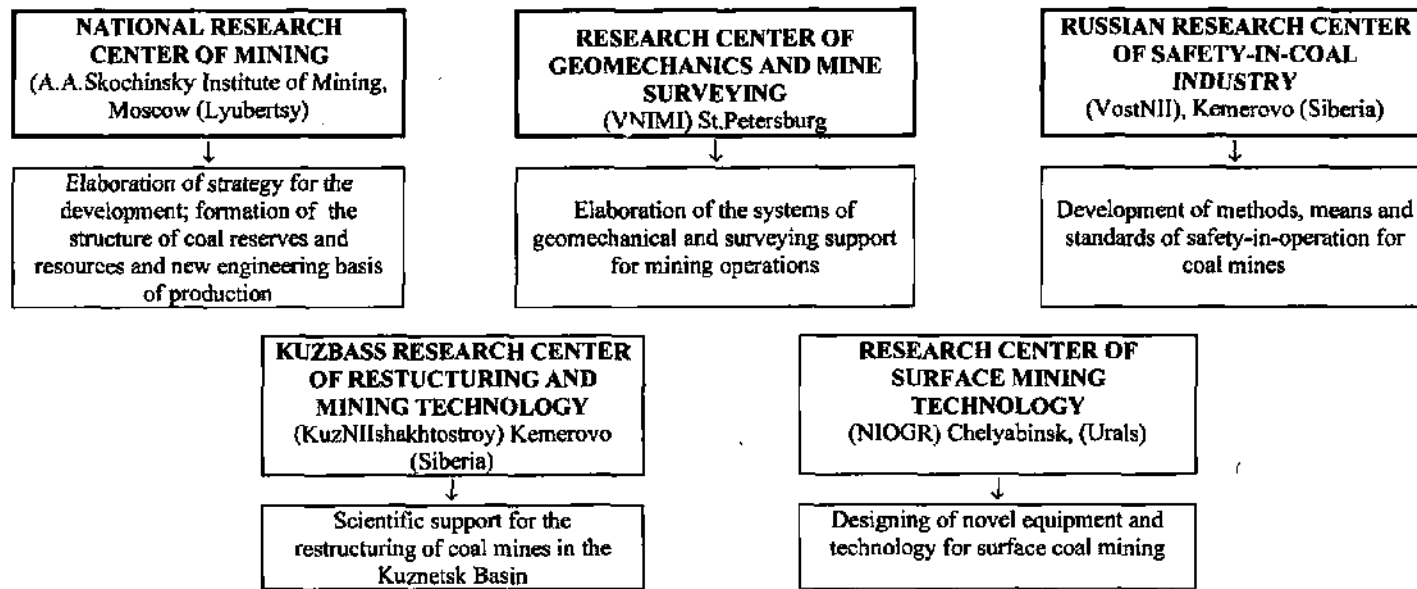


Fig. 1. COAL SECTOR RESEARCH AND DEVELOPMENT ESTABLISHMENTS, STRUCTURE

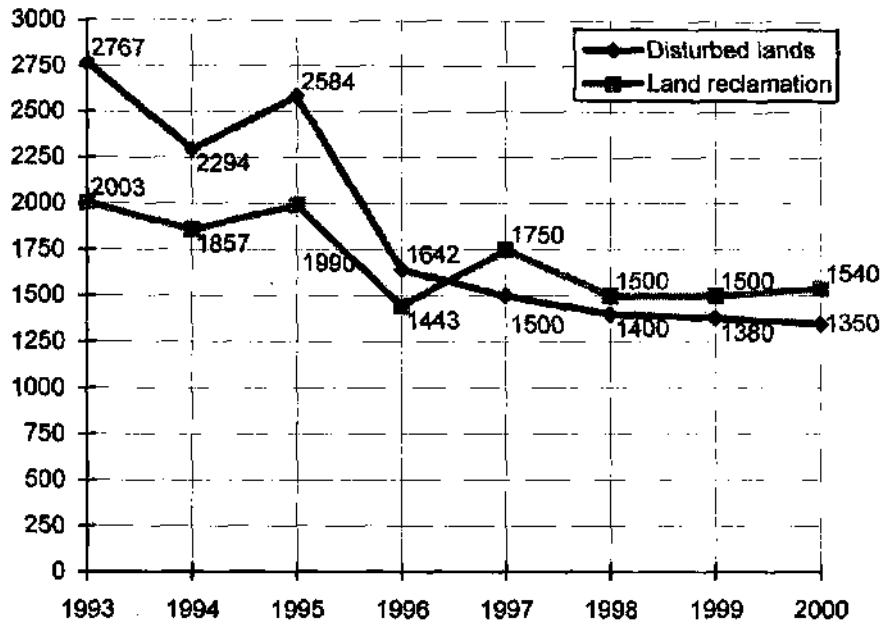


Fig. 2 DISTURBED AND RECLAIMED LANDS, ha

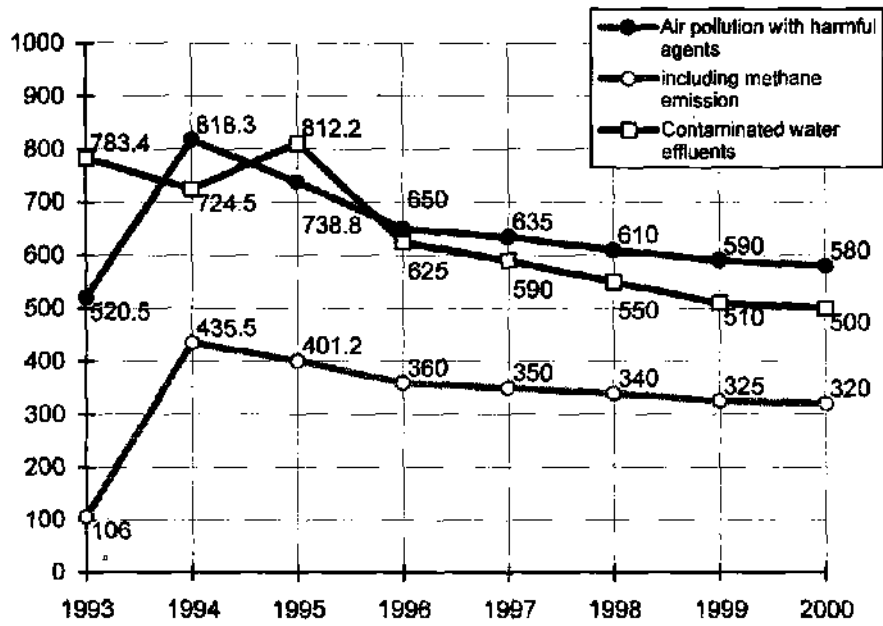


Fig 3. AIR POLLUTION WITH HARMFUL AGENTS, '000 t

- production management with the highest concentration of operations.

#### 4. Development of Novel Technologies for Coal Processing and Hot-Cure Chemical Coal Conversion Systems.

4.1. In coal preparation the creation of the efficient methods for the processing of coals, particularly those with high sulphur content, for the maximum possible desulphurization is the most acute and complicated research problem. This problem is rather pressing for many coal-producing countries, and, to the authors' view, it is a promising area for the international collaboration.

4.2. In coal conversion, new research directions are being developed in Russia with an aim of more complete utilization of the energy and chemical potential of various coal grades, from brown coals to anthracites. Namely, pilot technologies have been developed for hot-cure chemical systems for the briquetting of brown coals from the Kansk-Achinsk Basin, as well as hard coal (anthracite) slurries and fines. Opportunities for the implementation of the Russian-American Project based on the so-called "soft pyrolysis" (LFC) technology for the synthesis of coal-derived liquid hydrocarbons and relatively clean solid fuels are being investigated. Besides, research is in progress into the alternative methods for the production of coal non-fuel derivatives.

#### 5. Improvement of the Technologies for the Preparation, Conveyance and Combustion of Coal-Water Slurries

In this area Russia has accumulated a substantially high research and production potential. It has served a basis for the practical realization of the project of a pilot coal-water slurry pipeline connecting the town of Belovo with the Heat and Power Plant in Novosibirsk (Western Siberia). The 264-km pipeline annual capacity is estimated at 3 mln. t on a dry coal basis.

#### 6. Improvement of the Ecological Situation

This problem has acquired an ever-growing importance for the Russian coal industry. Forecast

on the development of the ecological situation in coal-mining regions for the nearest years reflects some opportunities for its rehabilitation (Fig.2 and Fig 3). The research is in progress into critical CO<sup>2</sup> and CH<sup>4</sup> concentrations, behaviour of coal-bed methane in the so-called "mine-gas pockets" of closed underground mines. Hydrogeological scientific grounds are being elaborated for safe closure of underground mines and reclamation of the disturbed lands, as well as démineralization of waste waters.

Paramount importance will be attached to the solution of the ecological problems. Comprehensive approaches will be used for the purpose, and top-priority will be given to the issue, with an emphasis on a broad-scale international collaboration.

#### CONCLUSIONS

1. Main directions for the development of science and technology in the coal industry of Russia are aimed at the realization of the sector comprehensive restructuring. Therefore the entire R&D system has been reformed and improved.

2. Reassessment of coal reserves and resources with the rejection of unfavourable coal reserves has been effected on a new methodological basis. In combination with an advance treatment of the rock mass it provides for highly efficient coal mining.

3. Novel high-performance machinery and technologies have been developed: wide-web excavating machinery for layer-by-layer cutting, which completely eliminates blasting operations in surface mining; mechanized coal-winning systems of a new generation and some other high-performance equipment for underground mining.

4. Research and field test work is in progress. It is aimed at the development of novel technologies for coal processing and comprehensive high-temperature chemical coal conversion, coal briquetting, synthesis, handling and combustion of ecologically clean water-coal fuels;

5. Paramount importance must be attached to the comprehensive solution of the ecological problems. In mining for the complete rehabilitation of the ecological situation in coal mining regions.

