The Economic Feasibility and Efficiency of Complex Stock Development in Coal Deposits Operation

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Abstract. The article deals with the problem of efficiency gains in subsoil use and reducing natural resources waste in coal deposits operation. A technique to estimate the feasibility of developing coal deposits with complex bedding is proposed. An algorithm to estimate the effect of factors complicating deposits development and affecting resources extraction capacity is recommended. Provisions to improve the taxation system for coal mining under complex mining and geological conditions are considered.

1. Introduction

The return on investment in coal deposits operation in Russia, particularly deposits with complex bedding environment, is determined by its main factor - that is resource yield. The two interacting parties, the subsoil user and the investor, are interested in the independent estimation of the feasibility of coal deposits development. Moreover, there is also a third party, the state, which must defend the social interests in terms of the rational use of mineral resources and gain benefits in the form of tax revenues. From this perspective, the interests of all the three parties should be considered when estimating the feasibility of maximum involvement in coal deposits development.

The problem is urgent nowadays because under the growth of coal consumption in the world and complex mining and geological conditions for extraction, the economic efficiency of coal deposits development should be estimated in terms of the current pattern and prospects for the progress in science and technology, as well as the investment market expectations.

The development of deposits with complex bedding involves deterioration in quality of coal recovered. Fair payment for minerals use, which would both provide and encourage their maximum extraction, will be based on applying a methodological approach to the economic resources estimation that considers the interests of both society and business.

The goal of the research is to implement a systematic approach to estimate the efficiency of involvement in development of deposits with complex bedding as well as to justify the economic feasibility of their operation with maximum respect for the society and business interests.

2. The performance review and the problems of the coal-mining complex in Russia

Within the energy strategy of Russia for the period until 2035 [1], starting from 2021, the increase in the domestic primary energy consumption is expected to exceed the fuel and energy resources export. This is due to the growth of production volumes, transportation costs (by 20%), as well as in the public utilities sector (by 12%).
The main objective of the society is to preserve the country's geo-resource potential for future generations. Investors pursue the goal of maximizing returns on invested capital and heating their return. For subsoil users, the main thing is to maintain or improve their market positions by providing a competitive edge of their products.

The revision of estimation approaches is determined by the transition of the country's economy to market relations. The national economic effect can be defined as the total revenue of the budget from the deposits development. Therefore, the state's promotion of the maximum involvement in the resource development should appear as reasonable payments for the mineral resources use, the amount of which shows the geological conditions of their bedding.

The energy strategy involved a higher growth in coal consumption [1]. However, the world’s economic climate and the recession trends within the country caused a slowdown in production growth, which could not but affect the development of the industry and investment climate.

Modern mining production is characterized by an increase in coal waste in the subsoil due to the neglecting of the so-called unpromising sites. As a result, losses in the subsoil reach about half of the balance reserves per each ton of coal recovered. These losses are caused not only by the requirement to provide stability of the main opening outputs, but also by inefficient design solutions for the opening and layout of minefields. Significant deposits losses take place in the fields of recovered mines. This is due both to the imperfect equipment and technology of coal mining in the past and to the sharp decline in production in the country in the 1990s, which resulted in closing down a number of mines. Pre-analysis of Kuznetsk Basin mines says, about 31% of all abandoned coal deposits are found in the pillars of lateral openings and about 8.5% are at the slope openings. 57% of losses are localized in other parts. The closing period of most of these mines is 15-20 years, that is, these deposits are currently found in the zone of long-settled mining pressure, and mining and geological characteristics of these mines are accurate enough. Their development in the future will significantly extend the service time of the basin. However, this requires an effective mechanism to estimate the advantages of mining these minerals.

Guided by coal deposits distribution of productive minefields which are defined by their bedding, production density through the use of high-performance foreign equipment will be confined by 25-30% limits due to significant differentiation of deposits bedding even within one mine. As a result, it’s vital to design a tool for reasoning the high-performance equipment operation on deposits with complex bedding conditions.

Higher reliability and productivity of foreign mining equipment is one of the reasons for its design change. So, currently, the share of imported shearer-loaders in mines comes to about 75%. This leads to an increase in wearing-out costs. However, their technical performance proves to be no more than 50%. This is due to the fact that the high gas content of coal deposits in Russia limits the speed of clearing face movement. Production costs growth was also fuelled by a change in mining indicators.

3. The study of the impact of geological factors of coal deposits on economic indicators of coal-mining companies

The shortage of open deposits and the need to optimize their opening costs under the market conditions require an increase in their recoverability. So, in recent years in the CIS countries, about 29 million tons of deposits have been extracted, formerly identified as off-balance reserves, including about 10 million tons of resources which are sub-standard in capacity, about 13 million tons of resources that are sub-standard in ash content, and about 6 million tons of resources that are sub-standard in mining conditions. Involvement of these deposits into development is one of the most important factors of cost price growth in coal mining. Earlier studies have proved that the return on investment depends largely on recoverability rate of coal field deposits. In addition, the company prolongs effective economic life, reduces unit capital expenditure on mining, which results in gaining additional revenues, and, therefore, in making tax payments. All this shows that maximum involvement of deposits into accessed reserves development is beneficial both for investors and for society. However, companies incur additional operational expenses in deposits with complex bedding.
Therefore, it is vital to find a compromise between these parties, which can be achieved by improving the taxation system for coal mining companies, which will encourage subsoil users to increase the coal extraction factor in the developed coal deposits.

The analysis has indicated, in minefield development the basic capital investments are connected with the minefield opening and layout. Amortization deductions for opening and layout refer only to the share of extracted resources and form the mine depreciation fund, which deals only with equity capital or share capital. However, given the time to new mines construction to replace the decommissioned ones, and even taking into account the annual assets revaluation, there is investment depreciation by the time of its return, and the construction of a new mine requires additional capital investment. Through a formalized presentation of the return-on-investment period and the estimation of financial losses due to neglected reserves, it has been proved that even insignificant coal losses in deposits development multiply the capital investment losses. They result in a continuous coal mining price rise due to the growth in development-to-production factor per 1 ton of coal recovered. The company is forced to perform additional geological exploration at various stages of field operation.

The costs of these activities are included in intangible non-current assets and affect operational costs. When obtaining a license for the right to subsoil exploration and presenting data on geological surveys within the area of subsoil operation, the company makes one-time payments, the amount of which is also reported in non-current assets.

In this perspective, an algorithm and an economic and mathematical model are offered for reasoning the efficiency of deposits development within a specific complexity group, based on the feasibility of the maximum amount of additional benefits of the full development of industrial resources. Deposits with complex bedding as well as the deterioration in the quality of coal recovered do not provide the balance between the amount of industrial resources and deposits suitable for excavation. This is due to the fact that deposits with complex bedding lead to direct costs growth and profit reduction. On the part of investors and subsoil users, deposits development is profitable, provided a direct financial benefit. The study [3] presents an economical and mathematical model for reasoning the efficiency of the development of coal deposits, which makes it possible to establish the main indicators of return on investment for specific mining and geological conditions. The amount of additional investment in capital construction (deposit opening and layout) for the similar facility reconstruction has been estimated. The amount of reimbursement is established for specific conditions as part of the investment capital, which will be required in addition to replenishing the reserves in the amount equal to the spent ones. This will lead to a longer payback period. The formalized presentation of the investment payback period allows us to conclude that even insignificant coal losses in deposits development multiply the investments costs losses. Ignoring other factors that may lead to an increase in production costs, an estimation rate of extracting 1 ton of coal is established. Specific financial losses due to neglected resource losses have been determined. The maximum amount of additional benefits through the full development of industrial reserves is reasoned. The country is interested in the maximum extraction of the explored resources. To encourage subsoil users to maximize stock extraction, it is offered to change the way of MET (Mineral Extraction Tax) calculation. In deposits development, a tax is paid on mineral resources extraction. It is calculated on the basis of the annual production amount, the tax rate and the deflator ratios, whereas the amount of deduction from the calculated value depends on two factors: the deposit methane content and the possibility of spontaneous combustion. The research performed by the author [2, 3] shows that the bed gas content, on the basis of which the gas content in a coal mine is determined, has its profound effect on the parameters of the majority of technological processes in the mine. In MET calculations, it would be sensible to consider the mine gas content by calculating the efficiency factor of gas recovery. The research results are shown in table1.
Table 1. MET calculation for specific mining environments.

| The name of factors                          | Calculation formula                                                                 | Remarks                                                                 |
|---------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Gas recovery factor                         | $k_1 = 0.904 + 0.96xk_{deg}$                                                       | $x, x'$ - mine gas content, respectively natural and residual, m³/t.    |
| Residual gas content factor                 | $k_2 = 0.392 + 3.014/x'$                                                          | $x'$ - bed residual gas content                                        |
| Bed height effect factor                    | $k_3 = 0.997 + 0.624$                                                             | $m_b$ - working-bed height                                             |
| Variation effect factor of bed height       | $k_4 = (1.74 - 0.817x) \times m_b$                                                | $m_a$ - total bed height                                               |
| Bed inclination angle and its variation factor | $k_5 = (1.014 - 0.0092x\alpha)x$ $\times (0.955 - 27.19\Delta\alpha)$          | $\alpha$ - bed inclination, degrees, $\Delta\alpha$ - variation ratio of bed inclination angle |
| Bed faulting factor                         | $k_6 = 0.571 + 0.053x(h/m)$                                                       | $h/m$ - tectonic deformation range and working bed height factor       |
| Overall estimation                          | $S_4 = \prod_{i} k_i$                                                            | $D$ - annual recovery, t, $Norm$ - base tax rate, rub/Â, $F$ - coal quality deflator, 1.059 - for coking coal, 1.024 - for power station coal |

MET base rate depends only on the coal type (anthracite, stone, brown) and does not show the conditions under which the deposit is developed. It is advisable to introduce a differentiated base tax rate depending on the level of resources depletion, which is defined as the ratio of accumulated production to the total reserves of all categories and accumulated production. From the perspective of stock classification into simple, complex and very complex ones, in terms of their bedding, it is recommended to grant mining companies with a remission of MET when working under very difficult conditions, at the same time to revise upwards the mineral extraction tax, while developing deposits with favorable bedding.

4. Conclusion

Coal deposits are considered to be non-renewable resources. Nowadays, companies are interested in the development of deposits with complex bedding, which is due to the goal to save on exploration costs and on capital investments in new construction. However, this results in the increase in operating costs. It is necessary to make a compromise between the interests of subsoil users and society, which can be achieved by optimizing the taxation system. At present, the potential of mines in resources extension due to reserve fields is almost exhausted. To carry out further activities, it is necessary not only to search for technical, technological and organizational solutions aimed at the rational use of accessed reserves, but also to extract them in the most complete way, which will ensure more efficient investments use into company development.

The base rate of mineral extraction tax depends only on the coal type (anthracite, stone, brown) and does not show the conditions under which the deposit is developed. Reducing the basic rate can result in the shortage of financial resources channeled by the state to geological exploration of new deposits. It is advisable to introduce a differentiated base tax rate depending on the level of reserves depletion which is defined as the ratio of accumulated production to the sum of all categories of reserves as well as accumulated production.
From the perspective of reserves classification into simple, complex and very complex due to their bedding, it is recommended to grant mining companies with a remission of MET when working under very difficult conditions, at the same time to revise upwards the mineral extraction tax, while working out reserves with favorable positioning.

5. References
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