TECHNICAL-ECONOMIC INDICATORS FOR THE ASSESSMENT OF TECHNOLOGICAL SCHEMES OF MINES

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ABSTRACT:*In order to assess mining technological systems, the following three operational indicators are suggested: level of mining technology, level of concentration of workings and level of mine workings intensity. These technical-economic indicators allow both to evaluate the scheme and the technical solutions chosen for the exploitation. The main characteristics of a mine are the production capacity and the duration of service of a mine. In order to determine the production capacity, an algorithm is proposed that allows different technological variants and solutions to be analyzed, based on recommended technical –economic indicators.*

1. MAIN CHARACTERISTICS OF A MINE

The main characteristics of a mine are production capacity and duration of service. Production capacity of a mine is called characteristic, showing the quantity of useful mineral substance extracted in a time unit(24 hours, year).

Production capacity determines the quantity parameters of the entire complex and the main technical-economic indicators of mine functioning.

The service duration of a mine is equal to the period in which the industrial reserves of a seam within the mining field are exploited.

There is a correlation between the annual production capacity of a mine A_a , its duration of service T_s and the magnitude of the mining fields' industrial reserves Z_{ind} :

$$T_s = \frac{Z_{ind}}{A_a} \tag{1}$$

The total duration of service of a mine T_t will be a little larger than T_s, since the time required to achieve the mine production capacity and restriction of activity towards the end of the reserve exploitation is added to the calculated duration:

$$T_t = T_s + t_1 + t_2 \tag{2}$$

Where:

t_1 - time the mine's designed production capacity is reached;

t_2 - time the activity is restricted towards the end of the reserves exploitation.

When the mine's annual production capacity and the existence are established, there usually are two cases: seam reserves are limited; seam reserves are unlimited.

In the second case, to reach the mine's probable production capacity, statistic method or the variant of placing workers in technological processes and operations are recommended.

Determination of production capacity of a functioning mine. As basic methodical document to determine the production capacity of a functioning mine, "Calculation instructions for bituminous coal mines production capacity" should be developed, which should provide the following assertion: "The production capacity of a functioning mine is determined as being the smallest resulted from the transfer capacities of the leading technological processes(links), namely: mine working faces, underground transport, extraction(hoist), technological complex at the surface and ventilation."

Calculation of the mine production capacity is a laborious problem requiring algorithms and programs to be developed, allowing determination of mine production capacity for any conditions(with various face equipments, with any underground transportation scheme etc.).

Unit 3 determines the transfer capacity of the transportation with conveyers along the passage "face – loading point on the principal transportation gallery", which is determined by the minimal transfer capacity of the transportation means, along each route.

Unit 4 determines the transfer capacity of the principal transportation gallery along the route "loading point in the sector – shaft ramp". The calculation can be made both when engines are used in the principal gallery and in case of conveyers.

Units 5 determines the transfer capacity of the shaft ramp as being the smalles of the transfer capacity of the shaft ramp as being the smallest of the transfer capacities of the workings of the shaft ramp(in case of engine transportation).

Unit 7 determines the transfer capacity of the extraction(hoist).

Unit 8 makes calculations for the technical possibilities for ventilation conditions for which the air flow required to be brought to the mine is determined. Afterwards, the production determined from the mine

workings faces being known, the air flow passing through the fan determines the technical possibility of the mine according to ventilation conditions.

Unit 9 determines transfer capacity of the surface technological complex for which the transfer capacities of the "collecting silos - loading in railway cars" and "collecting silos – emergency deposit" are assessed.

Unit 10 determines the mine production capacity as the smallest of the leading technological processes (links) transfer capacity.

Unit 11 prints the calculations. Besides the mine's production capacity, the transfer capacities of the leading technological processes, and the nominalization of the least productive equipment("narrow spaces") in each leading technological process are pointed out.

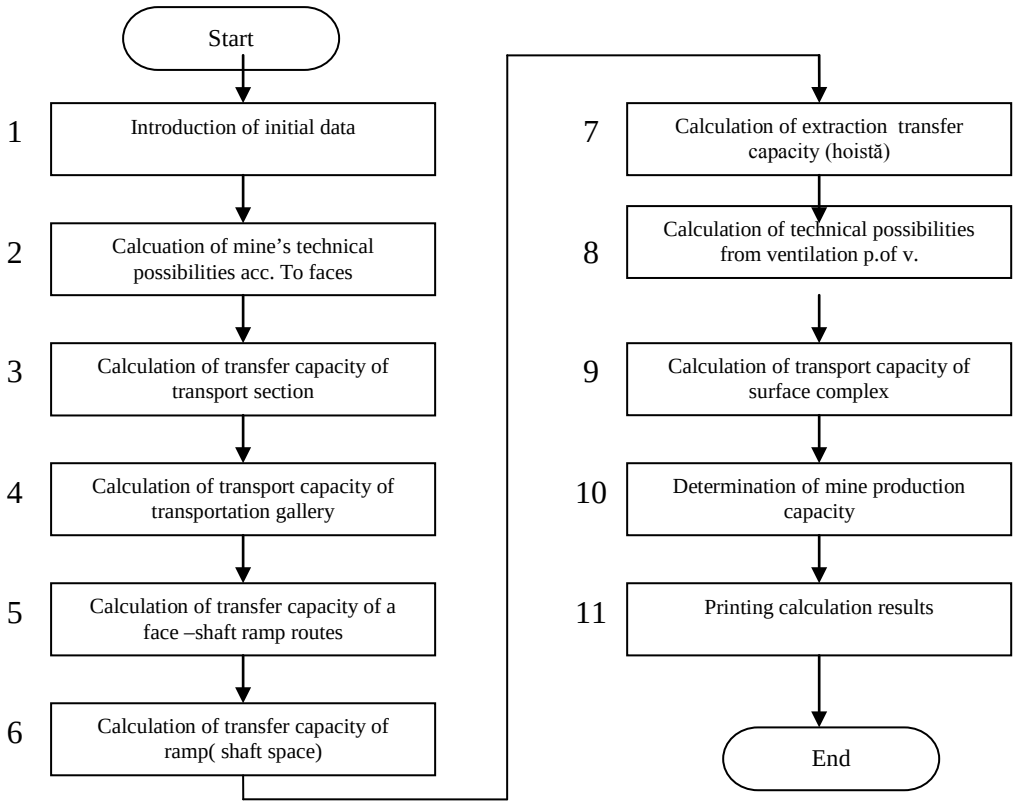

Fig. 1. Algorithm diagram of determination of production capacity of an active mine

In the design of coal mines, the parameters and characteristics of the enterprise are also founded, therefore with the passage of time makes it more progressive and efficient.

In order to carry out completely and objectively the adopted technological solutions and the chosen technological schemes of the mine, technical-economic indicators should be used, which could be structured in 3 groups: technical-productive indicators, economic indicators and geological-mining characteristics.

2. ELEMENTS FOR THE ASSESSMENT OF THE MINE'S TECHNOLOGICAL SCHEME

To assess the technological scheme of a mine, with a sufficient depth of prognosis and truthfulness of technical solutions chosen, it is considered that the following indicators and parameters should be adopted:

- Work productivity of the worker in the mine production, t/shift(t/month);
- Work consumption for 1000 t average production of the mine, year-shift/1000 t;
- Indicator of the mine technological level, expressed by the number of jobs of workers in production, for 1000 m^2 exploited area of seams in 24 hours, jobs/1000 m^2;
- Mine production capacity, t/shift(mil. t/year) determining the concentration level of production;
- Face capacity, t/day;
- Indicator of the mining working concentration levels, expressed by the magnitude of the exploited area of the seams an average per hour, for an active face m^2/h;
- Parameters of the opening, preparation, and exploitation system of the mining field;
- Indicator of the mining workings level of intensity, calculated in m^2/day or m^2/hour exploited seam area, for an active face:
  a) Length and volume of opening and preparation workings, which is done during the entire service duration of a mine for 1000 exploited strata area in the mining field,

actually determining the technical level of the opening and preparation systems of the mining field;

b) Length and volume of mining workings for the opening and preparation of the mining field;

c) Length and volume of opening and preparation workings for the mining field, done for the entire service duration of a mine, for 1000 t industrial reserve of the mining field, on which the work volume and the time of mine construction, the investment costs and amortization costs depend.

d) Length and volume of mining workings for 1000 t annual production capacity of a mine, which are adopted in the designing stage of a mine and determining the work consumption, construction or reconstruction time and the specific capital expenses.;

e) Length of mine workings to be maintained for the average daily mine production(km/1000 t), determining the number of workers for mine workings maintenance and in some degree for transportation and therefore the work consumption and the cost of those workings during exploitation;

- Indicators for preparation and exploitation systems of production sectors, namely:

a) Length and volume of preparation workings for 1000 t industrial reserve of production sector on which the expenses for their execution within the coal price depend;

b) Number of preparation workings simultaneously executed in a production sector;

c) Length and volume of preparation workings and faces executed in a mine in 24 hours for 1000 t capacity of daily production of a mine, on which the work consumption and the execution cost for 1 m working, and therefore the share of expenses for this kind of consumptions in the coal price depend(along with the previous indicator);

d) Number of workings that should be maintained before the faces, for 1000 t of the daily production capacity of a mine;

e) Number of workings that should be maintained from the side of the exploited space of the faces, for 1000 t of the mine's daily production capacity;

f) Length and volume of preparation workings of production sectors that should be maintained, for 1000 t of the mine's daily production capacity, on which the work consumption and the cost of maintenance for these workings and in some degree for transportation within the production sector entirely depend, along with the two precious indicators.

3. INDICATORS FOR THE TECHNICAL-ECONOMIC ASSESSMENT OF THE COAL MINES' TECHNOLOGICAL SCHEMES

To assess the mining technological systems, the following three operational indicators are considered the most important: indicator of the mine's technological level, indicator of the workings concentration and indicator of the mine workings intensity.

3.1. Indicator of the mine's technological level

The technical level indicator is meant to assess the share of each technological process of a mine, in the general level of technology in the mine.

From this point of view, the most preferable indicator of the technological level of a mine is work consumption for 1000 t of the daily production of a mine.

The expression to determine the technological level of a mine N_m has the following form:

$$N_m = \frac{1000P_m}{S_m} = \frac{1000P_m m\gamma}{A} \qquad (3)$$

Where :

P_m – number of jobs in extraction in 24 hours;
S_m – area of exploited strata in 24 hours, m^2;
A – daily production capacity of a mine, t;
m – stratum's average thickness, m;
γ – volumetric mass of coal, t/m^3.

3.2. Indicator of the concentration level of the workings

The notion of concentration of working in mining industry is made up of two principal elements: production concentration and mining working concentration.

The main indicator, with the help of which the production concentration level is determined, is the production capacity of a mine. If the production concentration level is expressed by the size of the mine's production capacity, then as its main indicator, the total level of faces for 1000 t of daily average production of a mine is considered.

The indicator of the concentration level of the mining workings $K_{c.l.}$ is determined with the formula:

$$K_{c.l.} = \frac{1000n_{t.a.}}{A} \qquad (4)$$

Where :

n_{ta} – total number of mine faces;
A – daily average production of a mine, t.

Thus, the adopted indicator of the working concentration K_{cl} is expressed by the relationship of the

total number of faces related to 100 t daily production of a mine.

The concentration of the workings in a mine is a notion determining the degree of concentration workings in the mining field. Its level depends on several factors: total number of faces and preparation faces in a mine, number of panels, blocks, strata and levels that are simultaneously exploited in the mining field, the length of the mining workings.

The principal factor determining the concentration level of the mining workings is the total number of the faces in a mine, ensuring its production. The fewer the faces or their specific indicator (total number of faces rot 100 t daily production of a mine), the fewer the panels, blocks, strata and levels that are exploited simultaneously. This, in its turn leads to lessening of the specific extent of the mining workings in a mine.

With the increase of the concentration level of the mining workings, the specific capital costs and basic funds for mining workings are reduced, the costs with work consumption and means for mining working maintenance and in some degree for transportation are reduced, leading to a cut down of the final balance of work expenses and expenses for this kind of workings(in the cost of coal, etc.) .

The increase of the concentration level of the mining workings leads to the decrease of the basic funds, of the exploitation consumption and increase of work productivity, therefore leading to a cut down of the coal price and related costs, increase of economic efficiency and production.

The considerable reduction of the number of faces providing a mine's production capacity, that is increasing the concentration of mining workings, is only possible based on the increase of production at the face.

Therefore, the face production is the principal determining factor, ensuring production increase in panels, blocks, strata, levels, improving thus a mine's technical-economic indicators.

The achievements in the field of underground exploitation technology and method opened ways to considerable increase the face's production capacity, which in its turn contributed to the subsequent increase of both the concentration level of the workings, and the production capacity of a mine – the main indicator of production concentration.

3.3. Indicator of the mining working intensity

As indicator of the mining working intensity $I_{l.m.}$, the size of the strata exploited in average per hour (day) for an active face is adopted.

The formula to determine $I_{l.m.}$ has the following form:

$$I_{l.m.} = \frac{A}{24 n_{a.a.} m \gamma} \qquad (5.)$$

Where:

$n_{a.a.}$ - number of active stopes;
m - the average thickness of the strata, m;
γ - volumetric mass of coal, t/m^3.

When comparing the versions of technological schemes or the technologies of performing stope works, for the same intensity geological and mining conditions of mining works it can assess the speed of advancement of the workings or or the average amount of coal extracted from the stope in 24 hours.

In order to lay a foundation for the technical level indicator of the opening and preparation workings, the mining field is analyzed, its dimensions by direction are noted with $S_{c.m.}$, by inclination with H, and the total extent and volume of the opening and preparation workings of the mining field, effected during the entire period of mine service, by L and V. Thus, the specific length and volume (V_s)of these workings for 1000 t industrial reserves can be determined with the formulae:

$$L_s = \frac{1000L}{HS_{cm} m \gamma c} \qquad (6)$$

$$V_s = \frac{1000V}{HS_{cm} m \gamma c} \qquad (7)$$

Where:

c – extraction coefficient of the reserve.

If in the formulae (3.4.) and (3.5.) L, V, H, $S_{c.m.}$ – are constant, then the magnitudes L_s and V_s will depend on the values of m and γ, that is for the same dimension of the mining field, strata depth, technical solutions and parameters of the opening and preparation system, specific values of the extent and volume of the mining workings for 1000 t industrial reserves will depend on the thickness and volumetric mass of coal strata.

Thus, as indicator of the technical level of the opening and preparation of the mining field, the specific length and volume of opening and preparation workings of mining fields for 1000 m^2exploited area of the strata are considered.

The adopted indicators allow both the mine's technological scheme, and the technical solutions selected for exploitation to be assessed.

The mine's technological schemes applied in determined geological-mining conditions with optimum values of the above mentioned indicators, provide not only minimal work consumption, but also minimal costs.

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4.CONCLUSIONS

Restructuring coal industry, its being made efficient require a systemic combination between technological, economic, environmental and social aspects

The technological scheme of a mine can be considered a system including basic and auxiliary technological schemes, and the totality of mining workings of opening, preparation and extraction, as well as mechanisation and automation means of the basic and auxiliary processes, allowing the extraction of useful mineral substances by a determined work organization.

The objective function of a mining system is assessed by efficiency; therefore the technical and economic indicators should be analyzed.

The main characteristics of a mine are its production capacity and its duration of service.

In order to determine the production capacity, an algorithm is proposed allowing the analysis of various variants and technological solutions based on technical –economic indicators.

A mine's efficient operation requires a rational structure for the technological scheme of the mine to be established, where conditions are created for a quasi-continuous activity of the faces.

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