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Impact of the rate of utilising the mine production capacity on the unit production costs

Introduction

The relation between prices and unit costs of production is of a crucial meaning for the economic position of a mining company. In each case a lowering the unit costs of production is very important, and especially in the case of longer times of low level prices. It is necessary to look intensively for possibilities of decreasing the unit costs of production to values not exceeding the prices (Magda 2016, 2017).

The specificity of the mining production in Polish underground hard coal mines is characterised by high fixed costs, high share of labour costs and usage of expensive technical means of production. The unit costs of the mining production depend on the level of production and the rate of utilising the production capacity. The higher production of the mining company the lower unit costs. The best situation is when the level of production equals to the production capacity (Turek 2013).

A relation between fixed and variable costs of production in the specific conditions of Polish coal mining industry was investigated by many authors, as among others (Klank 1998; Gawlik 2006, 2007, 2010; Jonek-Kowalska and Turek 2016).

The mining production in Polish underground hard coal mines is also characterised by a high degree of uncertainty and risks. In practice, certain disturbances affect the production process. They result from many reasons, such as e.g.: impossibility of full exploration of the

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deposit, limited possibilities of recognition of real natural conditions in the mining area, natural hazards, such as gaseous, dusts, fires, outbursts, water and others, which can cause risks for safe and rhythmical continuation of the mining operations.

The production capacity of the mining company and – in consequence – the level of saleable production should be adjusted to the market requirements, since only then these companies can function well under the market economy conditions. When the mining capacity is not adequate for the market demand, endeavours leading to its reduction (in consequence lowering fixed costs of production) should be undertaken.

The aim of this paper is to present the selected results of investigations concerning the possible directions of reducing the unit costs of an underground mine production together with some results of practical calculations. Theoretical considerations concerning the mathematical modelling of the unit production costs as the value depending on the rate of utilising the production capacity and the fixed costs coincided with the production capacity unit, are presented in the first part of this paper. The calculation example showing the impact of the rate of utilising the production capacity on the mine unit production costs with the use of practical input data, is shown in the second part of this paper.

1. Basic theoretical considerations

In the assumed time unit (e.g. one year), the production costs constitute the sum of the fixed costs, which are independent of the level of production, and variable costs, which are consumed directly in the production process and which are used roughly in direct proportion to the level of production (Gentry and O'Neil 1984). The concept of fixed versus variable costs is valid in the general sense and is very important in the process of decision making based on economic criteria.

If we assume one year as the time unit, the production costs can represented as (Czopek 2003):

$$K = K_s + K_z$$

- K – production costs, million PLN/year,
- K_s – fixed production costs, independent of the level of production, million PLN/year,
- K_z – variable production costs, dependent on the level of production, million PLN/year.

The variable production costs can be expressed as:

$$K_z = k_z \cdot P$$

- k_z – variable unit costs, PLN/Mg,
- P – level of production, million Mg/year.

Since the level of production cannot exceed the production capacity, it is limited by the following dependence:

$$P \leq Z$$

Z – production capacity, million Mg/year.

The production capacity of the underground mine results from the capacities of basic production and auxiliary operations, which influence its size: extraction operations, ventilation, haulage (horizontal transport), hoisting (vertical transport) and mineral processing. The resultant production capacity in the quantitative expression is the smallest of the values corresponding with these production and auxiliary operations:

$$Z = \min \{Z_f, Z_w, Z_o, Z_c, Z_p\}$$

Z_f – production capacity of the extraction operations, million Mg/year,
Z_w – production capacity of the ventilation system, million Mg/year,
Z_o – production capacity of the horizontal transport (haulage), million Mg/year,
Z_c – production capacity of the vertical transport (hoisting), million Mg/year,
Z_p – production capacity of the mineral processing, million Mg/year.

The production capacity of the underground mine, expressed in million Mg/year, depends on the assumed number of production days in a year scale.

In the general form, the unit production costs can be expressed as follows:

$$k = \frac{K_s}{P} + k_z$$

k – unit production costs, PLN/Mg.

In Polish hard coal mining industry relatively high level of fixed costs (about 60–80% of total costs) can be observed (Klank 1998; Gawlik 2006; Jonek-Kowalska and Turek 2016), therefore special attention must be paid to these costs. Less share of variable costs doesn't mean that they are less important, but it is considerably more difficult to reduce the variable unit costs (k_z) in a short term (e.g. during one year), so we can make out an assumption that:

$$k_z \approx \text{const}$$

For the determined levels of the fixed costs (K_s) and the variable unit costs (k_z), the reference (minimal) unit costs can be expressed by equation:

$$k_{\min} = \frac{K_s}{Z} + k_z$$

$k_{\min}$ – reference (minimal) unit production costs, PLN/Mg.

The minimal unit production costs constitutes the ideal aim to which the management of the mining company should be striving. Every other value (higher) of the unit production costs leads to these costs surplus in relation to the minimal unit costs, which can be determined from equation:

$$\Delta k = k - k_{\min}$$

Δk – surplus of the unit costs over the minimal costs, PLN/Mg.

Basing on the assumption that $k_z \approx$ const within certain time period the surplus of the unit costs in relation to the minimal costs can be expressed by a general equation (Magda 2016):

$$\Delta_k = \left(\frac{1}{w_1} - 1\right) \cdot w_2$$

The surplus of the unit costs is a function of two indices w_1 and w_2:

$$w_1 = \frac{P}{Z}$$

$$w_2 = \frac{K_s}{Z}$$

$$0 < w_1 \leq 1$$

w_1 – rate of utilising the production capacity,
w_2 – fixed costs coincided with the unit of the production capacity, PLN/Mg.

Since the variable unit costs does not significantly effect the increase of the unit production costs, special attention should be directed towards the fixed unit costs, which also can be expressed by means of indices w_1 and w_2, in the following way:

$$k_{js} = \frac{w_2}{w_1}$$

- k_{js} – fixed unit costs, PLN/Mg.

Thus, the fixed unit costs are inversely proportional to index w_1 and directly proportional to index w_2.

Difference between the value of surplus Δk for two different values of indices w_1 and w_1* can be determined from the formula (Magda 2017):

$$R = \left(\frac{1}{w_1} - \frac{1}{w_1 *} \right) \cdot w_2$$

- R – difference between two values of surplus Δk for the indices w_1 and w_1*, PLN/Mg.

In the case, when index w_1 is expressed in percent, therefore:

$$w_1 = \frac{100 \cdot P}{Z}$$

$$0 < w_1 \leq 100$$

$$\Delta k = \left(\frac{100}{w_1} - 1 \right) \cdot w_2$$

$$R = 100 \cdot \left(\frac{1}{w_1} - \frac{1}{w_1 *} \right) \cdot w_2$$

Thus, the rationalisation criteria for the mine unit production costs can be formulated in the following way:

$$w_1 \rightarrow 1 \text{ or } w_1 \rightarrow 100$$

$$w_2 \rightarrow \min$$

$$k_{jz} \rightarrow \min$$

Operations aimed at decreasing the unit production costs can be divided into operations leading to:

- harmonization of the capacity of production and auxiliary operations, to make them adjusted to each other as much as possible,

- improvements of the index w_1 value, i.e. increasing the rate of utilising the production capacity,
- improvements of the index w_2 value, i.e. minimising the fixed costs corresponding to the production capacity unit,
- minimising the variable unit cost.

In the first case (harmonization of the capacity of production and auxiliary operations) the excessive production capacities of particular production and auxiliary operations, higher than the production capacity of the operations of the lowest production capacity should be eliminated, since this limits the resultant mine production capacity. Usually this limiting element constitutes the ability of the extraction operations. However, it should be remembered that it is dependent on the assumed number of production days in the year. When a prolongation of the annual work time is expected, the capacity of the remaining operations should be adequately adjusted. Operations aimed at the reduction of useless production capacities improve also index w_2, since they are limiting the fixed costs corresponding to the production capacity unit.

In the second case (improvement of the index w_1 value), endeavours should be undertaken to increase the rate of utilising the mine production capacity by changes of the work organisation leading to a usage of the technological means of production and manpower as much as possible. This can be achieved either by a prolongation of the work time of the mine or by application of the continuous work system. It should be remembered that this also leads to increasing the extraction operations capacity, since the number of days with production – in a year scale – are increased and the remaining operations should not limit this capacity. The application of the continuous work system requires employing more workforce, which – in turn – increases the fixed production costs. If the fixed costs increase is lower than it results from the production capacity increase the lowering of index w_2 will be possible. The application of modern technologies of production engineering, especially Lean Management tools, can be an additional way of increasing the rate of utilising the mine production capacity. These tools help in wastefulness elimination, removing useless reserves, introduce Lean Management which eliminate the company from useless elements and processes. These tools – in effect – lead to a better utilising the production capacity and simultaneously to lowering the unit production costs.

In the third case (improvement of the index w_2 value) the basic operation leading to an improvement of the index w_2 value is the detailed analysis of the production costs in the system of operating cost items, separating fixed costs share in individual position of the system, followed by the assessment of possibilities of theirs lowering by undertaking proper restructuring operations.

In the fourth case (minimising the variable unit costs) the detailed analysis of the production costs in the system of operating costs items should be conducted, separating variable costs share, followed by the assessment of possibilities of their lowering.

Operations leading to decreasing the unit production costs can constitute an element of the restructuring program of the mining company. This program can be divided into the shown below stages.

- Identification of indices w_1 and w_2, recognition of eventual needs of their improvement – analysis and diagnosis.
- Development of the restructuring program leading to the rationalising of indices w_1 and w_2.
- Planning the operations for cutting unit variable cost.
- Scheduling the restructuring operations.
- Monitoring the implementation process of changes combined with the monitoring of indices w_1 and w_2 as well as unit variable cost.

2. Research results

An example of practical calculations refers to an underground hard coal mine. Basic input data are the next:

- Annual level of production: 4.8 million Mg/year.
- Annual production capacity: 6 million Mg/year.
- Manpower: 8000 employees.
- Production days: from Monday to Friday, excluding holidays.

Prolongation of the working time is considered, having on mind better utilising the technical means of production. Increasing the number of working days is taken into account – i.e. from Monday to Saturday, excluding holidays. It is assumed that none additional manpower will be employed, but management of the mining company is ready to propose employed miners to work voluntary on Saturdays for a double basic pay.

A question is arising – how such a solution would influence on the unit costs of production with comparison with alternative solution having on mind increasing the rate of utilising the mine production capacity in every possible means?

Two variants of production time organization are taken into account:

- Var. I – the continuation of actual duration of production time, i.e. five days a week (from Monday to Friday, excluding holidays) is assumed.
- Var. II – extending duration of production time from 5 to 6 days a week, without increasing manpower, with voluntary work on Saturdays for a double basic pay is assumed. In this case 2527 additional man-shifts in a week are needed.

Annual level of production in Var. II is higher than in Var. I, due to the longer production time. The difference results from the output obtained on Saturdays, so the annual production capacity is also different, in Var. I is equal to 6 million Mg/year, in Var. II is equal to 7.2 million Mg/year.

Var. II is characterised by the following basic data:

- Annual level of production: 5.76 million Mg/year.
- Annual production capacity: 7.2 million Mg/year.
- Manpower: 8000 employees.
- Production days: from Monday to Saturday, excluding holidays.

Particular cost items in the case of Var. II were calculated according to the next assumptions:

1. Amortization costs (fixed and variable) are proportional to the number of production days.
2. Costs of: equipment lease and rent, drilling and mining services, methane drainage services, training services, mining damage services, transport services and exploitation charge (fee) are proportional to the level of production.
3. Costs of: materials, energy, other mining services, repair services, other services, other taxes and charges are divided into fixed (constant) and variable (proportional to the level of production).
4. Labour costs, welfare securities and union benefits in the case of Var. II take into account consequences of payment increased due to extending the production time from 5 to 6 days per week.
5. Real property tax, exploitation, environmental and PFRON charges as well as insurances and other costs are fixed and the same in both two variants.
6. Variable unit costs are constant.

Characteristics of costs for Var. I are shown in Table 1.

Results of appropriate costs calculations for Var. II are shown in Table 2.

We obtain the next values of the indices w_1 and w_2 and the total unit production costs:

- for Var. I:

$$w_1 = 80\%$$

$$w_2 = 242.88 \text{ PLN/Mg}$$

$$k = 420.69 \text{ PLN/Mg}$$

- for Var. II:

$$w_1 = 80\%$$

$$w_2 = 227.01 \text{ PLN/Mg}$$

$$k = 400.85 \text{ PLN/Mg}$$

When we compare results of the unit production costs calculations we can notice, that these costs are lower for Var. II and the difference between two variants is equal to 19.84 PLN/Mg. We could state that extending the working time from 5 to 6 days a week results only slight decreasing the unit production cost (about 4.72%), but considerably increasing the level of production up to 5.76 million Mg/year (20%).

Table 1. Characteristics of the production costs – Var. I

Tabela 1. Charakterystyka kosztów produkcji – war. I

It	Cost specification	Fixed costs (PLN/year)	Variable costs (PLN/year)	Total costs (PLN/year)	Fixed unit costs (PLN/Mg)	Variable unit costs (PLN/Mg)	Total unit costs (PLN/Mg)
1.	Amortization	196 403 059	82 024 691	278 427 750	40.92	17.09	58.01
2.	Materials	72 045 625	122 543 082	194 588 707	15.01	25.53	40.54
3.	Energy	100 911 798	26 298 698	127 210 496	21.02	5.48	26.50
4.	Equipment lease and rental	0	37 172 869	37 172 869	0	7.74	7.74
5.	Drilling and mining services	0	64 630 286	64 630 286	0	13.46	13.46
6.	Methane drainage services	0	14 884 136	14 884 136	0	3.10	3.10
7.	Other mining services	25 705 151	29 726 695	55 431 846	5.36	6.19	11.55
8.	Training services	0	22 481 621	22 481 621	0	4.68	4.68
9.	Mining damage services	0	11 148 533	11 148 533	0	2.32	2.32
10.	Repair services	22 898	81 457 793	81 480 691	0.00	16.97	16.98
11.	Transport services	0	59 213 965	59 213 965	0	12.34	12.34
12.	Other services	45 604 059	163 200	45 767 259	9.50	0.03	9.53
13.	Labour costs brutto	761 976 416	0	761 976 416	158.75	0	158.75
14.	Welfare securities	162 791 059	0	162 791 059	33.91	0	33.91
15.	Union benefits	63 042 704	0	63 042 704	13.13	0	13.13
16.	Real property tax	8 686 215	0	8 686 215	1.81	0	1.81
17.	Royalties (exploitation charge)	0	10 240 008	10 240 008	0	2.13	2.13
18.	Environmental charge	283 381	0	283 381	0.06	0	0.06
19.	PFRON charge	9 218 204	0	9 218 204	1.92	0	1.92
20.	Other taxes and charges	1 413 213	42 098	1 455 311	0.29	0.01	0.30
21.	Insurances	8 466 831	0	8 466 831	1.76	0	1.76
22.	Other costs	714 555	0	714 555	0.15	0	0.15
	Total	1 457 285 169	562 027 674	2 019 312 843	303.60	117.09	420.69

Table 2. Results of the production costs calculations – Var. II

Tabela 2. Wyniki obliczeń kosztów produkcji – war. II

It	Cost specification	Fixed costs (PLN/year)	Variable costs (PLN/year)	Total costs (PLN/year)	Fixed unit costs (PLN/Mg)	Variable unit costs (PLN/Mg)	Total unit costs (PLN/Mg)
1.	Amortization	235 683 671	98 429 630	334 113 300	40.92	17.09	58.01
2.	Materials	72 045 625	147 051 698	219 097 324	12.51	25.53	38.04
3.	Energy	100 911 798	31 558 437	132 470 235	17.52	5.48	23.00
4.	Equipment lease and rental	0	44 607 442	44 607 442	0	7.74	7.74
5.	Drilling and mining services	0	77 556 343	77 556 343	0	13.46	13.46
6.	Methane drainage services	0	17 860 963	17 860 963	0	3.10	3.10
7.	Other mining services	25 705 151	35 672 034	61 377 185	4.46	6.19	10.66
8.	Training services	0	26 977 945	26 977 945	0	4.68	4.68
9.	Mining damage services	0	13 378 239	13 378 239	0	2.32	2.32
10.	Repair services	22 898	97 749 352	97 772 250	0.00	16.97	16.97
11.	Transport services	0	71 056 758	71 056 758	0	12.34	12.34
12.	Other services	45 604 059	195 840	45 799 899	7.92	0.03	7.95
13.	Labour costs brutto	868 333 084	0	868 333 084	150.75	0	150.75
14.	Welfare securities	185 513 435	0	185 513 435	32.21	0	32.21
15.	Union benefits	71 842 205	0	71 842 205	12.47	0	12.47
16.	Real property tax	8 686 215	0	8 686 215	1.51	0	1.51
17.	Royalties (exploitation charge)	0	12 288 010	12 288 010	0	2.13	2.13
18.	Environmental charge	283 381	0	283 381	0.05	0	0.05
19.	PFRON charge	9 218 204	0	9 218 204	1.60	0	1.60
20.	Other taxes and charges	1 413 213	50 518	1 463 731	0.25	0.01	0.25
21.	Insurances	8 466 831	0	8 466 831	1.47	0	1.47
22.	Other costs	714 555	0	714 555	0.12	0	0.12
	Total	1 634 444 326	674 433 210	2 308 877 535	283.76	117.09	400.85

If we want to answer the question about alternative solution having on mind increasing the rate of utilising the mine production capacity in Var. I we should previously convert the formula for R value to the next expression:

$$w_1^* = \frac{w_1 \cdot w_2}{w_2 - 0.01 \cdot w_1 \cdot R}$$

In this case: w_1 = 80%, w_2 = 242.88PLN/Mg, R = 19.84 PLN/Mg.
Therefore: w_1^* = 85.59%.

Increasing the rate of utilising the mine production capacity from 80% to 85.59% is equivalent to the solution proposed in Var. II from the point of view of the unit costs of production, but it results in increasing the level of production from 4.8 to 5.135 million Mg/year. Increasing the level of production can be obtained by better work organization together with better utilising the technical means of production.

Impact of increasing rate of utilising the production capacity on the mine unit production costs (increasing index w_1) for both variants is shown in Table 3. As we can see, increasing rate of utilising the production capacity results in reducing the unit production costs. For example, increase of index w_1 from 80 to 85% results in reducing the unit costs about 17.86 PLN/Mg (4.25%) in the case of Var. I or 16,69 PLN/Mg in the case of Var. II (4.16%).

Table 3. Reduction of the unit costs as a result of increasing rate of utilising the production capacity

Tabela 3. Redukcja kosztów jednostkowych jako rezultat wzrostu stopnia wykorzystania zdolności produkcyjnej

Increase of index w_1 (%)	Var. I		Var. II	
	(PLN/Mg)	(%)	(PLN/Mg)	(%)
80 → 85	17.86	4.25	16.69	4.16
80 → 90	33.73	8.02	31.53	7.87
80 → 95	47.94	11.40	44.80	11.18
80 → 100	60.72	14.43	56.75	14.16

Values of the unit production costs and the level of production for different values of index w_1 for both analysed variants are presented in Table 4. If it would be possible, full utilising of the production capacity results in reducing the unit production costs to 359.97 PLN/Mg in the case of Var. I or to 344.10 PLN/Mg in the case of Var. II.

The unit production costs in dependence of index w_1 for both analysed variants are shown in Figure 1.

Table 4. Values of the unit production costs and the level of mine production

Tabela 4. Wartości jednostkowych kosztów produkcji i poziom wydobycia kopalin

Index w_1 (%)	Var. I		Var. II	
	k (PLN/Mg)	P (Mg/year)	k (PLN/Mg)	P (Mg/year)
80	420.69	4 800 000	400.85	5 760 000
85	402.83	5 100 000	384.16	6 120 000
90	386.96	5 400 000	369.32	6 480 000
95	372.75	5 700 000	356.05	6 840 000
100	359.97	6 000 000	344.10	7 200 000

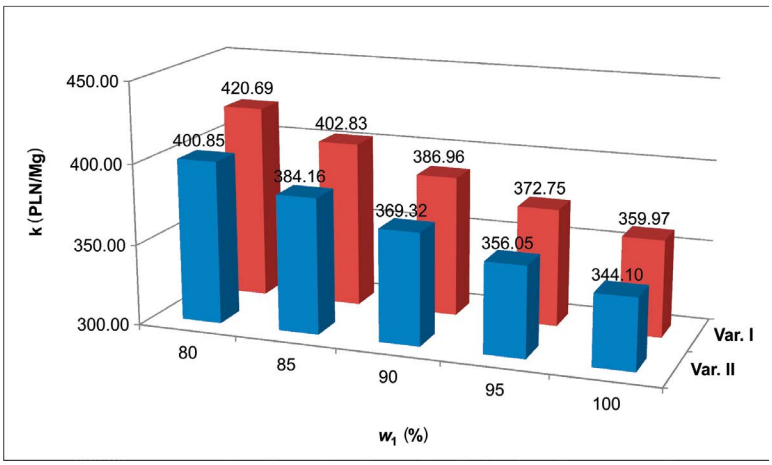

Fig. 1. The unit production costs in dependence of index w_1

Rys. 1. Jednostkowe koszty produkcji w zależności od indeksu w_1

The results of calculations refer to the case when additional investments are not needed to support increasing rate of production, when only more intensive utilising the production capacity is possible, e.g. by introducing better work organisation and/or better rate of utilising the technical means of production.

Conclusions

As the result of the carried out investigations several observations and conclusions can be formulated.

- As the result of the carried out analysis of the components of the unit production cost, two basic indices of a crucial meaning for searching for solutions leading to decreasing the unit production costs can be assumed. The index marked as w_1 is defined as the rate of utilising the production capacity, and the index marked w_2 is defined as the fixed costs coincided with the unit of the production capacity.
- The unit production costs – for the determined levels of fixed costs and variable unit costs are the lowest (minimal) when the level of production equals the production capacity.
- When the level of production is smaller than the production capacity the surplus of the fixed unit cost, in relation to the minimal cost, is formed. This surplus depends on the values of indices w_1 and w_2.
- On the basis of data concerning formations of indices w_1 and w_2, under real conditions of the mining company operations, the possibility of decreasing the unit production cost can be determined quantitatively, assuming as criteria: increasing the rate of utilising the production capacity and minimising the fixed costs corresponding to the unit of the production capacity, as well as minimising the variable unit costs.
- Indices w_1 and w_2 can be utilised for the development of the mining company restructuring program aimed at the reduction of the unit production cost, which can be obtained by increasing index w_1 to unity and by decreasing index w_2 and variable unit costs to the as small as possible values.
- Theoretical investigations concerning the impact of the rate of utilising the mine production capacity on the unit production costs were confirmed on the practical example of underground hard coal mine.

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IMPACT OF THE RATE OF UTILISING THE MINE PRODUCTION CAPACITY ON THE UNIT PRODUCTION COSTS

Abstract

The aim of the article is to present the selected results of analytical investigations concerning possible directions of reducing the unit production costs in the mining company together with some results of practical calculations. The investigations emphasize the role of the rate of utilising the production capacity leading to reducing the unit production costs. The main component having an essential influence on the unit production costs are the fixed unit costs. Two basic indices of a crucial meaning for searching for possibilities leading to decreasing the unit production costs are assumed. The first index (w_1) is a measure of the rate of utilising the production capacity, the second one (w_2) concerns the fixed costs coincided with the unit of the production capacity. Theoretical considerations concerning the mathematical modelling of the unit production costs as the values depending on the rate of utilising the production capacity and the fixed costs coincided with the production capacity unit, are presented in the first part of the paper. The rationalisation criteria of the mine unit production costs are formulated. These criteria can constitute the elements of restructuring program for the mining company. The calculation example with the use of the practical input data shows the impact of the rate of utilising the production capacity on the mine unit production costs. In the example two variants of annual working time are taken into account. Results of appropriate calculations are presented and analysed in an aspect of reducing unit costs of production as a result of increasing rate of utilising the mine production capacity.

Keywords: coal mining industry, cost management, unit production costs

WPŁYW STOPNIA WYKORZYSTANIA ZDOLNOŚCI PRODUKCYJNEJ KOPALNI NA JEDNOSTKOWE KOSZTY PRODUKCJI

Streszczenie

Celem artykułu jest przedstawienie wybranych rezultatów badań analitycznych dotyczących możliwych kierunków zmniejszania kosztów jednostkowych w przedsiębiorstwie górniczym wraz z prezentacją wyników praktycznych obliczeń. Badania podkreślają rolę stopnia wykorzystania zdolności produkcyjnej prowadzącego do zmniejszania jednostkowych kosztów produkcji. Głównym składnikiem mającym znaczący wpływ na jednostkowe koszty produkcji są jednostkowe koszty stałe. Przyjęto dwa podstawowe wskaźniki o istotnym znaczeniu dla poszukiwania możliwości zmniejszania jednostkowych kosztów produkcji. Pierwszy wskaźnik (w_1) jest miernikiem stopnia wykorzystania zdolności produkcyjnej, drugi (w_2) dotyczy kosztów stałych przypadających na jednostkę zdolności produkcyjnej. W pierwszej części pracy zawarto teoretyczne rozważania dotyczące matematycznego modelowania jednostkowych kosztów produkcji jako wielkości zależnych od stopnia wykorzystania zdolności produkcyjnej oraz wielkości kosztów stałych przypadających na jednostkę zdolności produkcyjnej. Sformułowano kryteria racjonalizacji kosztów jednostkowych. Kryteria te mogą wchodzić w skład programu restrukturyzacji przedsiębiorstwa górniczego. W drugiej części pracy przedstawiono przykład obliczeniowy opracowany na podstawie danych wejściowych zaczerpniętych z praktyki ilustrujący wpływ stopnia wykorzystania zdolności produkcyjnej na jednostkowe koszty produkcji. Przykład dotyczy dwóch wariantów organizacji rocznego czasu pracy załóg górniczych. Wyniki odpowiednich obliczeń przedstawiono i poddano analizie w aspekcie zmniejszania jednostkowych kosztów produkcji jako rezultatu wynikającego ze wzrostu stopnia wykorzystania zdolności produkcyjnej.

Słowa kluczowe: górnictwo węgla kamiennego, zarządzanie kosztami, jednostkowe koszty produkcji