The compilation of material consumption quota of coal enterprises based on operation

Shun Jia, Haiyang Wang, Cheng Cao

School of Energy and Mining Engineering, Shandong University of Science and Technology, Qingdao, Shandong, 266590, China

Corresponding author’s e-mail: sdkjdxnyxy@126.com

Abstract: In the entire production and processing process of coal products, material consumption accounts for the largest part of the cost. For the management of material cost, the process of preparing the cost budget based on the job is the process of setting the rated price. The preparation of job-based material consumption quotas is to reflect the occupation and consumption of materials in the job process to the amount and value of the job. Traditional coal enterprise material consumption budgeting is based on material consumption in the production process as the starting point for budgeting, without considering the real motivation of material consumption. This paper studies the distribution of the number of picks consumed by the two fully mechanized mining teams under the same working face to form an operation quota.

1. Introduction

The definition of quota is the quantity standard for the reasonable consumption of materials under certain production, technology and management conditions to produce a unit product or complete a unit task (workload) [1]. The material consumption quota of a coal enterprise refers to the quantity standard of materials that a coal enterprise must consume for mining unit coal products or completing unit tasks under certain production technology, management level and natural geological conditions.

The preparation of material consumption quotas for coal enterprises based on operations uses the concept of "operations" in activity-based costing. The so-called "work" refers to the work that consumes resources in order to achieve a certain purpose in an organization. It is the basic unit of an organization's internal work or a collection of internal actions within an organization [2]. Operation is the basis for enterprises to consume resources such as raw materials, manpower, and electricity, runs through the entire process of product production and operation, and is an intermediary connecting resources and products. According to the different operating cost drivers, the material consumption is allocated to each operation, and the material consumption of each operation is allocated to each operation center, and finally the consumption quota of the operation center is worked out.

This paper selects the coal cutting operation of the shearer in the X coal mine's comprehensive mining operation center as the object, and analyzes the problem of the pick consumption quota of different comprehensive mining teams under the same production conditions from a horizontal perspective.

2. The work content and process of the comprehensive mining operation center

According to the mining production process of the fully mechanized coal mining operation center, it can be divided into the following operations: shearer cutting coal, moving frame, moving front conveyor, rear conveyor, top coal caving, cleaning floating coal, maintenance, etc. The specific...
content of each job is shown in Table 1 below.

Table 1. Process and operation content of comprehensive mining operation center

| Serial number | Job name contents of homework |
|---------------|-------------------------------|
| 1             | Shearer cutting coal          |
|               | The double-drum shearer is used, and the oblique cutting method is used at both ends of the fully mechanized mining face. |
| 2             | Move frame                    |
|               | Generally 4-6 frames away from the bottom drum of the shearer start to move the frame, and the frame moving step is 0.6m. |
| 3             | Move the front conveyor       |
|               | Begin to move the front conveyor at a position 5m behind the shearer to ensure that the distance of each move is less than 30cm as much as possible. |
| 4             | Push the rear conveyor        |
|               | After finishing moving the front conveyor, move the jack on the conveyor through a reasonable operation method, and move the rear conveyor to the specified range. |
| 5             | Top coal caving               |
|               | The top coal caving adopts the operation of this frame, which is caving coal by comprehensive methods such as roof pressure, repeated support of the support, tail beam swing up and down. |
| 6             | Clean up floating coal        |
|               | Clean up floating coal between racks, front racks, four connecting rods, base surfaces, and moving beam surfaces. |
| 7             | Overhaul                      |
|               | Check the condition of the equipment every day to ensure the normal operation of the equipment and deal with any problems in time. |

3. Direct materials involved in coal cutting operations of shearer

The consumption quota of fully mechanized mining materials mainly includes wood, supporting materials, Grease emulsion, accessories and other materials consumption quota [3].

The main material consumed by the shearer coal cutting operation is the pick. Collect relevant statistical data for September 2020, including material receipts, etc. Table 2 lists relevant data on pick consumption.

Table 2. Summary Table of Direct Material Consumption for Coal Cutting Operation of Coal Shearer-Picks (September 2020)

| name  | model | unit | date | Quantity | name  | model | unit | date | Quantity |
|-------|-------|------|------|----------|-------|-------|------|------|----------|
| picks | U47   | piece | 9.1  | 51       | picks | U47   | piece | 9.16 | 105      |
| picks | U47   | piece | 9.2  | 72       | picks | U47   | piece | 9.17 | 76       |
| picks | U47   | piece | 9.3  | 75       | picks | U47   | piece | 9.18 | 62       |
| picks | U47   | piece | 9.4  | 86       | picks | U47   | piece | 9.19 | 46       |
| picks | U47   | piece | 9.5  | 93       | picks | U47   | piece | 9.20 | 60       |
| picks | U47   | piece | 9.6  | 79       | picks | U47   | piece | 9.21 | 76       |
| picks | U47   | piece | 9.7  | 91       | picks | U47   | piece | 9.22 | 98       |
| picks | U47   | piece | 9.8  | 54       | picks | U47   | piece | 9.23 | 94       |
| picks | U47   | piece | 9.9  | 39       | picks | U47   | piece | 9.24 | 85       |
| picks | U47   | piece | 10.0 | 68       | picks | U47   | piece | 9.25 | 92       |
| picks | U47   | piece | 9.11 | 66       | picks | U47   | piece | 9.26 | 59       |
| picks | U47   | piece | 9.12 | 72       | picks | U47   | piece | 9.27 | 69       |
| picks | U47   | piece | 9.13 | 40       | picks | U47   | piece | 9.28 | 76       |
| picks | U47   | piece | 9.14 | 87       | picks | U47   | piece | 9.29 | 90       |
| picks | U47   | piece | 9.15 | 96       | picks | U47   | piece | 9.30 | 100      |

| total  |        |      |       | 2257    |      |      |      |      |          |

4. Compilation of pick consumption quotas for the first and second fully mechanized mining teams under the same production conditions

4.1. Analysis of cost drivers

Cost drivers can be divided into two parts, one is resource drivers, and the other is operation drivers.
Resource drivers are the factors that drive operations to consume resources, and job drivers are the factors that drive products to consume operations [4]. The consumption of shearer picks varies in proportion to the tonnage of coal mined at the working face, so it is determined that the consumption of pick materials is driven by output.

4.2. Determination of quota standards

Combined with the specific parameters of the fully mechanized mining face, the consumption distribution ratio of the number of picks in different teams of the fully mechanized mining operation center is analyzed as the ratio of the coal output. The situation of 116 working face of fully mechanized mining is shown in Table 3 below:

Table 3. Specific parameters of fully mechanized 116 working face

| Length of working surface | 120 m |
|---------------------------|-------|
| Working surface width     | 5 m   |
| Coal seam mining height   | 3.5 m |
| Bulk density of coal      | 1.3 t/m³ |
| Shearer cutting depth     | 0.8 m |

The actual production situation in September 2020 is as follows: The start-up time and the empty knife time of the first and second fully mechanized mining teams of X coal mine were observed and recorded. The specific data is shown in Table 4.

| date | Comprehensive mining team | date | Comprehensive mining team | date | Comprehensive mining team |
|------|---------------------------|------|---------------------------|------|---------------------------|
|      | Boot time/min | Empty knife time/min | Boot time/min | Empty knife time/min | Boot time/min | Empty knife time/min |
| 9.1  | 265           | 26   | 180                       | 13   | 9.16                       | 505           | 20               | 330               | 32               |
| 9.2  | 100           | 12   | 140                       | 24   | 9.17                       | 485           | 21               | 380               | 30               |
| 9.3  | 285           | 22   | 330                       | 30   | 9.18                       | 370           | 14               | 325               | 40               |
| 9.4  | 390           | 32   | 285                       | 35   | 9.19                       | 450           | 22               | 447               | 27               |
| 9.5  | 290           | 15   | 100                       | 38   | 9.20                       | 420           | 15               | 370               | 25               |
| 9.6  | 425           | 18   | 340                       | 40   | 9.21                       | 460           | 33               | 500               | 22               |
| 9.7  | 440           | 34   | 310                       | 42   | 9.22                       | 350           | 20               | 390               | 23               |
| 9.8  | 390           | 23   | 360                       | 48   | 9.23                       | 340           | 18               | 324               | 26               |
| 9.9  | 300           | 22   | 300                       | 55   | 9.24                       | 423           | 28               | 367               | 25               |
| 9.10 | 325           | 20   | 340                       | 52   | 9.25                       | 416           | 12               | 390               | 31               |
| 9.11 | 270           | 17   | 500                       | 26   | 9.26                       | 289           | 16               | 359               | 33               |
| 9.12 | 495           | 14   | 500                       | 40   | 9.27                       | 270           | 20               | 357               | 40               |
| 9.13 | 320           | 13   | 550                       | 39   | 9.28                       | 378           | 25               | 420               | 38               |
| 9.14 | 495           | 16   | 170                       | 19   | 9.29                       | 410           | 27               | 220               | 32               |
| 9.15 | 315           | 17   | 340                       | 35   | 9.30                       | 435           | 14               | 285               | 40               |

Table 4. Statistics on the start-up time of the shearers in the first and second teams of X coal mine

| date | Comprehensive mining team | date | Comprehensive mining team | date | Comprehensive mining team |
|------|---------------------------|------|---------------------------|------|---------------------------|
|      | Boot time/min | Empty knife time/min | Boot time/min | Empty knife time/min | Boot time/min | Empty knife time/min |
| 9.1  | 265           | 26   | 180                       | 13   | 9.16                       | 505           | 20               | 330               | 32               |
| 9.2  | 100           | 12   | 140                       | 24   | 9.17                       | 485           | 21               | 380               | 30               |
| 9.3  | 285           | 22   | 330                       | 30   | 9.18                       | 370           | 14               | 325               | 40               |
| 9.4  | 390           | 32   | 285                       | 35   | 9.19                       | 450           | 22               | 447               | 27               |
| 9.5  | 290           | 15   | 100                       | 38   | 9.20                       | 420           | 15               | 370               | 25               |
| 9.6  | 425           | 18   | 340                       | 40   | 9.21                       | 460           | 33               | 500               | 22               |
| 9.7  | 440           | 34   | 310                       | 42   | 9.22                       | 350           | 20               | 390               | 23               |
| 9.8  | 390           | 23   | 360                       | 48   | 9.23                       | 340           | 18               | 324               | 26               |
| 9.9  | 300           | 22   | 300                       | 55   | 9.24                       | 423           | 28               | 367               | 25               |
| 9.10 | 325           | 20   | 340                       | 52   | 9.25                       | 416           | 12               | 390               | 31               |
| 9.11 | 270           | 17   | 500                       | 26   | 9.26                       | 289           | 16               | 359               | 33               |
| 9.12 | 495           | 14   | 500                       | 40   | 9.27                       | 270           | 20               | 357               | 40               |
| 9.13 | 320           | 13   | 550                       | 39   | 9.28                       | 378           | 25               | 420               | 38               |
| 9.14 | 495           | 16   | 170                       | 19   | 9.29                       | 410           | 27               | 220               | 32               |
| 9.15 | 315           | 17   | 340                       | 35   | 9.30                       | 435           | 14               | 285               | 40               |

The actual production situation in September 2020 is as follows: The start-up time and the empty knife time of the first and second fully mechanized mining teams of X coal mine were observed and recorded. The specific data is shown in Table 4.

The output calculation formula is as follows:

\[
Q = L \times B \times M \times \gamma \times n \\
= L \times B \times M \times \gamma \times \frac{T - t_1}{\eta}
\]  

(1)
In the formula: \( Q \)--coal mining face output; \( L \)--working face length, m; \( B \)--shearer cutting depth, m; \( M \)--coal seam mining height, m; \( \gamma \)--coal bulk density, t/m³; \( n \)--the number of coal cutters of the shearer; \( T \)--start-up time; \( t_1 \)--time of empty cutter, min; \( \eta \)--average time of the shearer to cut one coal, min blade.

According to the working rules of coal enterprises, the average time of cutting one coal for the first team of fully mechanized mining is 85 min/cut, and the average time of cutting one coal for the second team of fully mechanized mining is 110 min/cut. According to the production motivation, the consumption of shearer accessories and the mining face. The coal tonnage changes proportionally, so the allocation ratio of the picks in the first and second fully mechanized mining teams is:

\[
\text{ratio} = \frac{Q_1}{Q_2} = \frac{120 \times 0.8 \times 3.5 \times 1.3 \times (370.2 - 20.3)/85}{120 \times 0.8 \times 3.5 \times 1.3 \times (340.3 - 33.4)/110} = 10/7
\]

According to the obtained distribution ratio, the consumption of pick materials can be distributed between the first and second fully mechanized mining teams. Taking the use of pick materials in September 2020 as an example, the calculation results are as follows:

Then the material consumption of picks for the first team of fully mechanized mining is

\[
2257 \times \left( \frac{10}{17} \right) = 1328;
\]

the consumption of picks materials for the second team of fully mechanized mining is

\[
2257 \times \left( \frac{7}{17} \right) = 929.
\]

As mentioned above, the main operating motivation of the comprehensive mining operation center is the tonnage of coal mining. Based on this, according to formula (2), the standard consumption per unit operation of the coal cutting pick material of the shearer can be calculated. The calculation results are as follows:

Unit standard consumption of pick material = consumption of pick material / consumption of operating motivation

\[
\text{Unit standard consumption of pick material for a team of fully mechanized mining} = \frac{1328}{120 \times 0.8 \times 3.5 \times 1.3 \times (370.2 - 20.3)/85 \times 30} = 0.02461 \text{ Pcs/ton}
\]

Unit standard consumption of pick material for the second team of fully mechanized mining = \[
\frac{929}{120 \times 0.8 \times 3.5 \times 1.3 \times (340.3 - 33.4)/110 \times 30} = 0.02541 \text{ Pcs/ton}
\]

5. Comparative analysis and control of material consumption

(1) On the whole, the number of cutters and cutting time of the first fully mechanized mining team are slightly higher than those of the second fully mechanized mining team, so that the consumption of pick materials in the first fully mechanized mining team is significantly higher than that of the second fully mechanized mining team. Based on the assessment, rewards and punishments, the workers' enthusiasm for work will be improved.

(2) The number of feeds and daily pick consumption of the first and second fully mechanized mining teams fluctuate greatly, reflecting the low reliability of the production system of the 116 working face, which is vulnerable to the geological structure and production of the working face. The influence of factors such as equipment.

6. Conclusion

The preparation of reasonable and scientific consumption quotas can help save materials, reduce enterprise costs, and reduce production costs, and lay a solid foundation for the internal performance evaluation of the team [3].

This paper selects the material consumption of the pick material in the coal cutting operation of the shearer in the comprehensive mining operation center as the research object, and elaborates the comparison of the pick consumption between the teams under the same production conditions. The application of work-based material consumption quotas in coal enterprises has been transformed from a theoretical design to a real case. Through a comparative analysis of physical consumption, it is easy to find out the real reasons for the differences between the teams and improve Process flow, eliminate and reduce non-value-added and ineffective operations, maximize internal potential and reduce cost consumption.
Acknowledgments
The authors would like to acknowledge the support of the Project of Shandong Province Higher Educational Science and Technology Program (Grant No.J17KA167), the 2018 Qingdao Social Science Planning Research Project (Grant No. QDSKL1801113). This research is also supported by SDUST Research Fund (Grant No.2018YQJH103).

References
[1] Ding Rijia, An Huiyu. Construction of a multi-level comprehensive budget management system for coal mines based on process [J]. China Mining Industry, 2017, 26(05): 30-34.
[2] Zhang Yiyi. Research on D Coal Company Cost Accounting Based on Activity-Based Costing [D]. Northeast Petroleum University, 2019.
[3] Zhang Guoyan, Yin Shixun, Zhu Shuangang, Yang Zengfu, Zhang Peijian. Discussion on the management of material consumption quota in coal enterprises[J]. Management Observation, 2018(32): 34-36.
[4] Liu Changbo. Research on SCG Coal Mine Budget Management Based on Activity Cost [D]. China University of Mining and Technology, 2019.
[5] Huang Chuanling. The application of material quota in coal mine management [J]. Enterprise Reform and Management, 2014(15): 113+108.