

DEVELOPING PRODUCTION MODELS FOR SPECIFIC GEOLOGICAL CONDITIONS OF COAL SEAM 7, HA LAM COAL JOINT STOCK COMPANY - VINACOMIN

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Abstract: VINACOMIN is among firms applying successfully merchandise to coal mining. However, the company's output depends on many factors such as height mirror stage, Length oven mechanization longwall, recovery height, length extraction column (oven longwalls), labor organization and specific geological conditions. Therefore, it has caused difficulties for the company in the implementing of production plan. The authors conducted the survey, and collected data from 2017-2019 as a basis for building a prediction model for quantity. Research results help the company to proactively plan, thereby to overall improve productivity and profits and to decrease general manufacturing costs for company.

Keywords: Merchandise, production plans, prediction model for quantity, mining technology motorization synchronized.

1. INTRODUCTION

Mechanization in underground coal mining is a significant policy of Vietnam's coal industry to enhance the excavation capacity, increase productivity, and lower coal production costs. Currently, the entire industry has 04 mechanized galleries with thick seams at the coal mines of Khe Cham, Vang Danh, and Ha Lam, of which the effectiveness is apparent (the technical and economic aspects are more prominent than the existing manual galleries) (Bui et al., 2020).

Ha Lam Coal Joint Stock Company (HLC) is an underground coal mining company of the Vietnam National Coal - Mineral Industries Holding Corporation Limited (VINACOMIN). HLC is one of the pioneers in VINACOMIN that uses synchronous mechanization in underground coal mining. Since its implementation, HLC has demonstrated the economic and

technical efficiency of the new technology. Coal seam 7 is one of the two galleries using synchronous mechanization Technology, which can succeed thanks to the favorable conditions production of thick seams and gentle slopes. However, HLC still encountered many difficulties in mining because the mines' production organization charts were constantly broken due to changed conditions.

Meanwhile, the company has not established a reasonable production organization model to adapt to each specific exploitation condition, nor has it used optimal technological solutions to deal with those conditions. During the excavation, the coal seam is frequently blocked due to cutting stones and ground subsidence that must be handled, significantly affecting productivity and production efficiency. This article aims to solve the current difficulties in HLC's production and labor arrangement in coal seam 7 when confronted with

specific geological conditions, optimizing the economic and technical indicators of mining technology, strongly promoting the effectiveness of new technology in underground coal mining, and maintaining the company's leading position in the coal industry.

2. CURRENT SITUATION OF MINING IN COAL SEAM 7 IN SPECIFIC GEOLOGICAL CONDITIONS

2.1. Overview of production organization and labor assignment at coal seam 7

Currently, HLC is applying synchronous mechanization technology for 2 galleries: (i) Gallery 7-3.1 of coal seam 7, and (ii) Gallery 11 - 1.16 of coal seam 11. Generally, these coal seams' geological and mining conditions are relatively supportive for applying synchronous mechanization technology.

In coal seam 7, the working regime is three shifts per day and night. The economic - technical parameters of the coal seam 7 are shown in Table 1.

Table 1. The main economic - technical index of coal seam 7

No.	Criteria	Unit	Quantity
1	Average thickness of coal bed	m	23.3
2	Average coal bed slope angle	Degree	0 - 15
3	Length in the direction of the area to the size limit	m	325
4	Bank face height	m	3
5	The lowest coal layer thickness	m	20.3
6	Length of tunnel	m	154
7	Volumetric weight of coal	T/m ³	1.648
8	Mining coefficient	-	0.95

No.	Criteria	Unit	Quantity
9	Coal recovery coefficient of lower roof	-	0.85
10	Number of mining lines per cutting cycle	Line	2
11	Output of single-stream coal mining	T	2,372
12	Output of coal mining per cutting cycle	T	2,135
13	Time of excavation cycle	Shift	3
14	Number of shifts for 1 working day and night	Shift	3
15	Cycle completion factor	-	0.9
16	Output of coal mining per day and night	T	4,270
17	Transition time	Day	60
18	Output of coal mining per month	T	106,745
19	Mining capacity (rounded)	T/year	1,280,000
20	Cost of emulsifying oil for 1000 tons	Liter	4.9
21	Number of workers per day and night	Person	90
22	Direct labor productivity	T/working day	47.4
23	Preparation tunnel per 1000T	m	1.1
24	Clean water cost per 1000T	m ³	209
25	Cutting teeth cost per 1000T	Pcs	5

2.2. The specific geological and mining conditions at coal seam 7

During the operation in coal seam 7, HLC encountered difficulties and handled congestion related to the geological and hydrogeological conditions. Having to stop working machinery and equipment in the seam to manage these phenomena has disrupted the excavation in the two lines, affecting the deduction and production cycle

rate and reducing the output and labor productivity.

During the field survey, the research team collected, gathered, and processed statistics on the production situation in coal seam 7 from January 2017 to May 2018. After removing the abnormal data, the calculation results are summarized in Table 2.

Table 2. Summary of results of analysis of the effects of specific conditions (Bui et al., 2020)

No.	Criteria	Unit	Average value	Maximum value	Minimum value
1	Percentage of days without cutting rocks	%	16.22		
2	Percentage of days without subsidence	%	38.83		
3	Percentage of days without subsidence and rock cutting	%	5.85		
4	Average time for cutting stone when needed	Working day/day and night	8.26	30.38	0.65
5	Average time for subsidence treatment when needed	Working day/day and night	3.12	19.68	0.08
6	Overall average output	Tons/day and night	3,548	6,903	
7	The average output of days for cutting stone	Tons/day and night	3,718		
8	The average output of days when the ground is only subsided	Tons/day and night	3,540		
9	The average output of days for cutting rocks and treating ground subsidence	Tons/day and night	3,478		

With the abovementioned conditions, the output and exploitation capacity were significantly impacted.

In the last six months of 2017 and even the first five months of 2018, the output and productivity decreased critically because the production organization and personnel assignment were affected stones and subsidence.

2.3 The current situation of production organization at mechanized galleries when encountering specific conditions

Dealing with the subsidence, HLC manage the following works: (i) Locating the anti-subsidence prop shield; (ii) Preparing necessary machinery and materials; (iii) Determining the volume of

drilling holes drilled into the bank ground;
(iv) Pumping chemicals into drilling holes;
(v) Checking prop shield condition after handling (Fig 3 and 4).

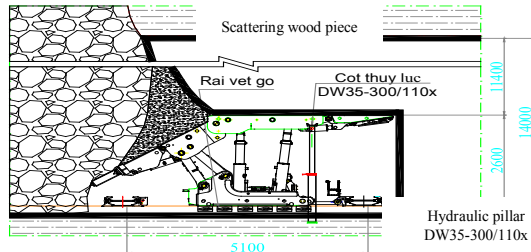
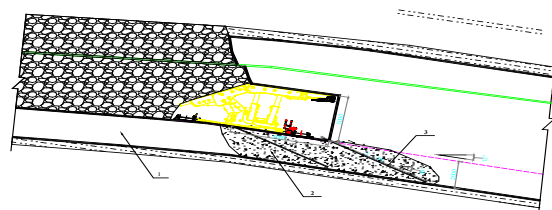


Fig 1. Treatment of prop shield subsidence by scattering wooden pieces with a single hydraulic prop.



1- the ground part removed the prop; 2 - chemically pumped ground; 3 - chemical injection drilling hole

Fig 2. Handling of the prop shield into the ground by chemical injection solution.

Other safety production issues in HLC are floating ground and sedimentary rock interburden. At HLC, these phenomena are treated with industrial explosives (drilling and blasting), and the processing time depends on the site-specific conditions. The general workload is determined as follows:
(i) Locating clamping rock and floating hydraulic prop; (ii) Preparing machinery and materials; (iii) Drilling boreholes; (iv) Blasting and ventilating; (v) Monitoring after processing.

Although the company develops technical solutions, there is no statistical process to develop production organization and human resource arrangement models for changes in mining conditions.

3. DEVELOPMENT OF PRODUCTION IN SPECIFIC GEOLOGICAL CONDITIONS OF COAL SEAM 7

In various geological and mining conditions that change at different positions in the gallery, the production and personnel arrangement have to change accordingly for better adaptation and productivity. In most cases, the number of workers increases to deal with the complexity during the operation. However, as there is production deduction, productivity sinks in the meantime.

Table 3. shows the gallery's main economic - technical criteria after the adaptation

No.	Criteria	Unit	Quantity (1)
Dealing with sedimentary rock interburden at 20 % of the gallery in 1 day and night			
1	Number of mining line per excavation cycle	Line	1
2	Output of single-stream coal mining	T	2,544
3	Output of coal mining per excavation cycle	T	2,035
4	Time of excavation cycle	Working day	1
5	Number of shifts per working day and night	Working day	3
6	Cycle completion factor	-	0.8
7	Mining output per day and night	T	4,07
8	Expected transition time	Day	60
9	Output of coal mining in 1 month	T	129,142
	- Dealing with sedimentary rock interburden in half a month		105,82
	- Dealing with sedimentary rock interburden in 1 month		
10	Number of workers working in 1 day and night	Person	90

No.	Criteria	Unit	Quantity (1)
11	Mining capacity	T/year	
	- Dealing with sedimentary rock interbunden in half a month		1,280,000
	- Dealing with sedimentary rock interbunden in 1 month th		1,050,000
12	Direct productivity	T/working day	
	- Dealing with sedimentary rock interbunden in half a month		55
	- Dealing with sedimentary rock interbunden in 1 month		41
Cutting stone 50 % of the length of the bank in 1 day and night			
1	Number of mining lines per cutting cycle	Line	1
2	Output of single-stream coal mining	T	1.520
3	Output of coal mining per cutting cycle	T	912
4	Time of a cutting cycle	Working day	1
5	Number of shifts for 1 working day and night	Working day	3
6	Cycle completion factor	-	0,6
7	Output of coal mining for 1 day and night	T	1.824
8	Expected transition time	Day	60
9	Output of coal mining in 1 month	T	99.944
	- Cutting stone in 1/2 month		47.424
	- Cutting stone in 1 month		
10	Number of workers working in 1 day and night	Person	90
11	Mining capacity	T/year	990.000
	- Cutting stone in 1/2 month		320.000
	- Cutting stone in 1 month		

No.	Criteria	Unit	Quantity (1)
12	Direct labor productivity	T/working day	
	- Cutting stone in 1/2 month		42,6
	- Cutting stone in 1 month		20,3
Cutting in case the bank subsidies in the ground			
1	Number of mining lines per cutting cycle	Line	2
2	Output of single-stream coal mining	T	3.258
3	Output of coal mining per cutting cycle	T	2.280
4	Time of a cutting cycle	Working shift	3
5	Number of shifts for 1 working day and night	Working shift	3
6	Cycle completion factor	-	0,7
7	Output of coal mining for 1 day and night	T	4.561
8	Output of coal mining in 1 month	T	131.616
9	Mining capacity	T/year	1.300.000
10	Expected transition time	Day	60
11	Number of workers working in 1 day and night	Person	96
12	Direct labor productivity	T/working day	47,7

4. CONCLUSION

HLC is one of the companies in VINACOMIN that successfully applied the synchronous mechanization process in coal excavation. With two longwall galleries of annual capacity of 600,000 tons and 1.2 million tons, HLC has made a success and affirmed its leading position in the industry. In production, the company has proactively and flexibly developed a model of

organization production under normal working conditions and handled specific conditions with technological solutions. However, business efficiency can be improved by perfecting the production organization and arranging labor in special production conditions. The article focused on the actual situation of production organization for coal seam 7 of HLC in 2 specific cases: (i) coal mining meets stone pillars, and (ii) coal mining has subsidence. In both cases, the coal mining organization was performed in 3 shifts and performed the mining stage, recovering the roof coal in 2 lines each day and night. Despite many disadvantages, it still basically ensures the exploitation capacity and output, allowing HLC to increase its initiative in production, ensure coal production, improve labor productivity, and lower coal product costs.

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