UDK 622.647.8

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INVESTIGATION OF PARAMETERS OF THE SIMULATION MODEL OF UNDERGROUND CONVEYER TRANSPORT SYSTEMS WITH HOPPERS

Annotation. This paper studies the influence of parameters incoming cargo traffic in simulation model of an underground conveyer transport system with accumulative hoppers on some parameters of the system. This allows to investigate that incoming cargo traffic variability affects both on the average outcoming cargo volume, system downtime, and on work of accumulative.

Keywords: underground conveyer transport system, accumulative hopper, simulation model, variance of incoming cargo volume.

Introduction

One of the key areas that determine the progress of technology and technology of underground mining of coal in the near future, is the concentration and intensification of work on providing high loading on coalface. In other words, the increase in coal production is planned not by building new mines, then by improving existing ones.

The intensification of work can be effective only when the minerals are extracted smoothly and promptly transported to the surface. To achieve this it is possible to use modern conveyor transport, which is not limited to the performance of repair and remediation. Due to lack of space, to increase the capacity of underground conveyor transport systems of coal mine accumulative hoppers are widely used [1, 2]. However, the effectiveness of their use is limited by insufficient mathematical software, the presence of which would optimize process operation of conveyor transport.

Thus, the development of mathematical and simulation models of accumulative hoppers and underground conveyor transport systems (UCTS) with accumulative hoppers that will allow stabilizing traffic flows and saving energy during transportation, as well as optimization of parameters is an urgent problem, the solution of which eventually lead to a significant reduction in cost loss products and mining companies.

Statement of the problem

The aim of this paper is studying the impact of irregularity of incoming cargo volume on the parameters of UCTS of coal mines with accumulative hoppers by simulation of the process of their operation. Accumulative hoppers are widely used in

underground conveyor transport systems of coal mines. Accumulative hoppers are used for independent work of related technological links of conveyor transport in times of emergency failures or stops for whatever reason, and to reduce the impact of downtime of conveyor lines on work clearing and preparatory faces. Application of accumulative hoppers in UCTS significantly increases the capacity and reliability of their work.

Using a mathematical model of the tree structure of UCTS with accumulative hoppers [3] in this paper we study the impact on incoming cargo volume on productivity of entire UCTS, which is implemented in the software for building simulation models Anylogic Free Release. We note that the proposed mathematical model of tree structure of UCTS with accumulative hoppers [3] calculation of outcoming cargo volume is based on the averages values of incoming cargo volume without their variability.

Studying of simulation model of UCTS

In this paper we study tree structure UCTS with accumulative hoppers with the following parameters:

Number of face lines – 4.

Number of hoppers in each face line – 2.

Number of shaft lines – 1.

Specific weight of cargo $\gamma = 1$ (t/m^3).

Coefficient of accidents of faces lines $\gamma_i^{(з)} = 0{,}193$.

Coefficient of accidents of shaft line $\gamma_i^{(с)} = 0{,}193$.

Minimum cargo volume in hoppers of faces lines $V_{1i}^{(з)} = 5$ (t).

Minimum cargo volume in hoppers of shaft line $V_{1i}^{(с)} = 10$ (t).

Volumes of hoppers of faces lines $V_i^{(з)} = 100$ (t).

Volumes of hoppers $V_i^{(с)}$ of shaft line are 200, 300 та 400 (t) according to each sequential accumulative hopper of shaft line.

Speed of conveyer lines $v_л = 1{,}6$ (m/s).

Parameter of recovery $\mu_i = 0{,}054$ (min^{-1}).

Limit values of batchers productivity in face lines $Q_i = 6$ (t/min).

Limit values of batchers productivity of shaft line are $Q_1^{(c)} = 12$, $Q_1^{(c)} = 18$ and $Q_1^{(c)} = 24$ (t/min) according to each accumulative hopper of shaft line.

In turn, the conveyor line has the following parameters:

Length of line $L_i = 300$ (m).

The efficiency of the drive line $\eta_i = 0,85$.

Line weight belt $q_{Лi} = 160$ (N/m).

Linear scales of rotating parts of rollers of upper and lower branches of conveyer line $q'_{p_i} = 250$ (N/m) q''_{p_i} – 250 and 90, N/m.

The angle of the conveyor $\alpha_i = \pi/90$, grad.

Coefficient taking into account local resistance of conveyor $k_{1i} = 1,3$.

The coefficient of resistance of the line with cargo on the conveyor rollers $\omega'_i = 0,03$.

Input cargo volume of UCTS simulated with function $f_\delta(t) = 5,6 + \delta \cdot \sin(t/100)$, where t – working time of conveyer line which receives cargo, a δ – parameter that varied. On fig. 1 we can see graphics that depict typical average values of output flow, system idle time, and energy consumption for transportation of cargo obtained during work of simulation model [4].

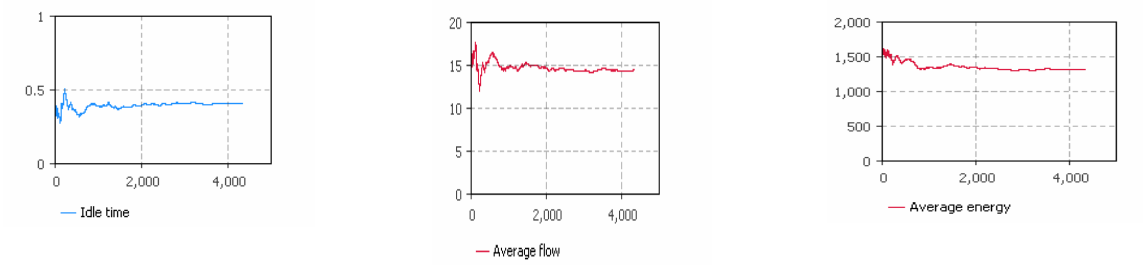

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Figure 1 – Characteristics of UCTS: a) average system idle time because of breaking the last conveyer line or absence the cargo in the last hopper of the system; b) average cargo flow that is transported; в) average energy consumption on cargo transportation

In table 1 you can see the results of testing of simulation model of UCTS with accumulative hoppers with different values of incoming cargo volume.

Table 1 – Results of testing of simulation model of UCTS

	$\delta = 0$ (constant signal)	$\delta = 1$ (with low amplitude of oscillations)	$\delta = 3$ (with middle amplitude of oscillations)	$\delta = 5$ (with high amplitude of oscillations)
Average output cargo flow (t/min)	$m_c = 15,44$	$m_c = 15,4$	$m_c = 14,59$	$m_c = 13,56$
Average energy consumption (kVt)	$w_c = 1401,6$	$w_c = 1397,2$	$w_c = 1325,8$	$w_c = 1227,9$
Idle time of system, (%)	35,7%	35,9%	39,2%	43,6%

From the table we can see that with increasing parameter δ the idle time of systems increases and the average output cargo flow and average energy consumption decrease. This behavior of simulation model can be explained by increasing in forced idle times of conveyor lines by achieving the number of cargo in the hoppers of their upper or lower limits. This, in turn, is a consequence of irregularity of incoming cargo flow.

Conclusions

The study found that the variability of input cargo flow of tree structure UCTS with accumulative hoppers has the significant impact on the average value of the output cargo flow. Namely, with increasing variability of incoming cargo flow reduces the average value of the output cargo flow. Thus, this study points to the necessity of further improvement of mathematical models of UCTS, and taking into account of irregularity of incoming traffic when calculating average values of parameters UCTS.

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УДК 622.647.8

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В работе проводится исследование влияния параметра входного грузопотока имитационной модели системы подземного конвейерного транспорта с аккумулирующими бункерами на некоторые параметры данной системы. Благодаря этому исследовано, что вариативность входного грузопотока влияет как на средний исходящий грузопоток, время простоя системы, а также на работу аккумулирующих бункеров.

Библ. 4, ил. 1,

УДК 622.647.8

Бабенко Ю.В. Дослідження параметрів імітаційної моделі системи підземного конвеєрного транспорту з бункерами / Ю.В. Бабенко // Системні технології. Регіональна міжвузівська збірка наукових праць. – Випуск ??(??). – Дніпропетровськ, 2016. – С. ??–??.

В роботі проводиться дослідження впливу параметру вхідного вантажопотоку імітаційної моделі системи підземного конвеєрного транспорту з акумулюючими бункерами на деякі параметри даної системи. Завдяки цьому досліджено, що варіативність вхідного вантажопотоку впливає як на середній вихідний вантажопотік, час простою системи, а також на роботу акумулюючих бункерів.

Бібл. 4, іл. 1.

UDK 622.647.8

Babenko Yu. Investigation of parameters of the simulation model of underground conveyer transport systems with hoppers / Yu. Babenko // System technologies. Regional interuniversity compendium of scientific works. – Vol? (?). – Dnipropetrovs’k, 2016. – Pp. ? –?.

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Refs.4, ill. 1.

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ISSN 1562-9945