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ALGORITHM OF CONTROL OF COAL MINES UNDERGROUND CONVEYER TRANSPORT SYSTEM

Annotation. The control system of conveyer transport is represented as a two level hieratic system on first level of which an operator sets certain parameters for the lower level of control. A global criterion of efficiency of this system is complex value, which characterizes energy efficiency of transporting coal, and the minimum values of middle volumes of cargo in accumulative hoppers of the underground conveyer transport system are local criteria. We developed the algorithm of adaptive control of accumulative hoppers and underground conveyer transport system.

Keywords: underground conveyer transport system, adaptive control, hieratic system, criterion of efficiency accumulative hoppers, algorithm of control.

The main objective of managing conveyor transport of coal mines is to provide its maximum capacity with minimum power consumption for transportation of coal mass.

Conveyer transport systems of coal mines have difficult branched structure consisting of conveyers and hoppers which are connected together using batcher, loaders and unloaders.

Failures of conveyers often lead to downtime in lavas and as result to poor productivity of conveyer transport systems.

To increase carrying capacity conveyer transport systems of coal mines because of limited space accumulative hoppers (temporal redundancy) [1, 2] have received wide application

The accumulative hoppers permit due to the accumulation of a certain amount of cargo in a hopper during idle conveyors increase the capacity of an underground conveyor transport.

However, the effectiveness of the underground conveyor transport system of coal mines with hoppers is low. This is due to frequent downtime of conveyor lines due to overflow of hoppers, as well as the loss of electricity due to underload of conveyors.

One method of improving the efficiency of underground coal mine conveyor transport is controlling of accumulating hoppers using controllers and controlling the speed conveyor lines using frequency-controlled motors.

At the same time in accumulative hoppers using speed control feeder we support a specified number of goods in hopper, in particular, the input of the feeders at the given maximum volume of cargo in hopper V_{2i} batchers and off when the minimum volume of cargo in hopper V_{1i} (Fig. 1). In this case, the incoming traffic flows in the hoppers are not switched off, and their size should be smaller capacity batchers. This mode of operation allows the hoppers not to disable above hopper conveyor lines due to overflow of hoppers, which significantly reduces downtime conveyors because of their underload [3, 4].

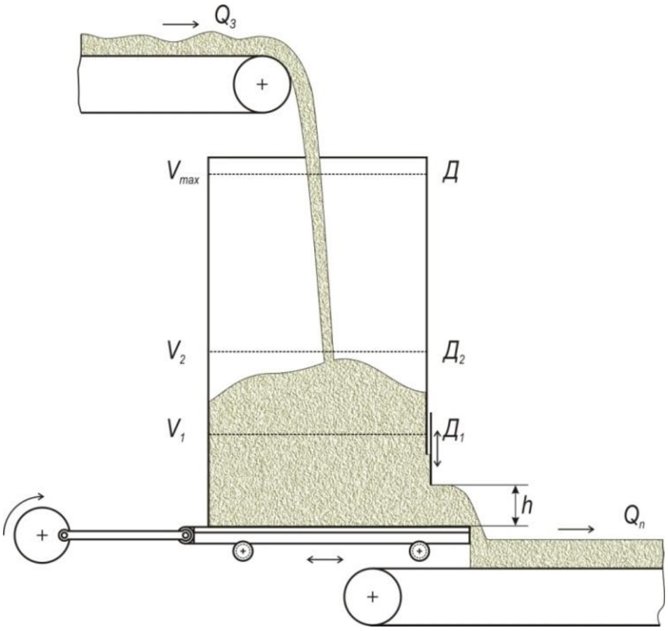

Fig. 1. Control of accumulative hoppers in mode of maintaining set cargo amount

On fig. 1 V_1 и V_2 – volumes of minimum and maximum rate of cargo in accumulative hopper; $V_{\max}$ – maximum volume of hopper; $Q_з$ – productivity of incoming cargo into hopper; $Q_п$ – productivity of batcher; h – height of slit of outlet hopper.

However, local control of each accumulating hopper is still insufficient to significantly improvement of the efficiency of an underground coal mine conveyor transport. To do this, you must agree with each hopper management control of the entire system of conveyor transport. This should provide maximum efficiency of the system of conveyor transport. I.e. this control system should provide maximum productivity and minimum cost for transportation of the coal.

Therefore, the creation of the control algorithm underground coal mine conveyor transport system is an urgent task.

Management underground conveyor transport system of coal mines can be represented as a two-level hierarchical system. On the upper level of the system operator, based on the current information about coming from the mines of coal traffic m_{Qi},, state of conveyers and process equipment underground conveyor transport system, determines the speed $v_{лi}$ and productivities of batchers $Q_{пi}$. Then transmits this information, i.e. $v_{\text{л}i}$ and Q_{ni}, to the lower level of control system of hoppers - controllers, which determine the maximum amount of goods in hoppers V_{2i} (Fig. 2).

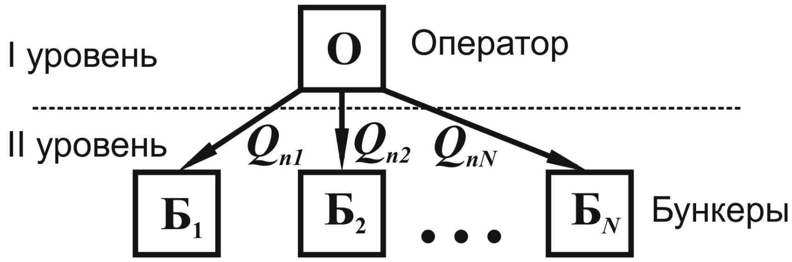

Fig 2. Structural scheme of underground conveyer transport system control

Input variables control system underground conveyor transport is the average cargo flows coming from the lava is m_{Qi}.

And the output variables of the control system is the mean value of the capacity of m_c and the average energy consumption of transportation w_c an underground coal mine conveyor transport [5].

Global objective function, i.e, measure of the effectiveness of the two-tier management system is a complex quantity [6]

$$K = c_1 m_c - 60 c_2 w_c \text{ (hrn/min)}, \tag{1}$$

where c_1 – cost price of one ton of coal and one kW of electricity ,hrn/t; c_2 – cost price of one kW of electricity, hrn/ kW.

Law of control of underground conveyor transport system is dependence m_c and w_c on the input phase and controlled parameters, as well as the parameters of the conveyors, hoppers accumulating volumes and velocities of the batchers [5]:

$$m_c = f_m(m_{Qi}, \square_i, \lambda_i, Q_{ni}, V_i, V_{1i}, V_{2i}); \tag{2}$$

$$w_c = f_w(m_{Qi}, \mu_i, \lambda_i, Q_{ni}, V_i, V_{1i}, V_{2i}, N_i), \tag{3}$$

where μ_i, λ_i – parameters of failures and recoveries of hoppers, 1/min; V_i – hopper volume, m^3; N_i – power that uses driver of i-th conveyer, kW.

The form of these functions depends on the structure of the system underground conveyor transport mode accumulating hoppers, in particular, the regime maintain a given level of cargo in a hopper the parameters coming from the lava freight traffic m_{Qi}, reliability of conveyers – parameters of failures and recoveries of conveyer transport system μ_i, λ_i, productivity of batchers Q_{ni}, hoppers volume V_i, and also minimum and maximum volume rate of cargo in accumulative hoppers V_{1i} and V_{2i}. For their definition is necessary to develop an algorithm for calculating medium capacity m_c and average energy consumption of transportation w_c of conveyor transport system in the case of control hoppers accumulation mode to maintain a given volume of cargo in them.

Parameters of conveyer transport system of coal mines which can be managed will be productivities of batchers Q_{ni} and maximum volume of cargo in hoppers V_{2i} in the case of control hoppers accumulation mode to maintain a given volume of cargo in them.

Structural analysis of underground coal mine conveyor transport systems have shown that they have self-similar tree structure [7].

In [5] was made an algorithm for calculating m_c and w_c for underground coal mine conveyor transport systems with dendritic self similar structure (fig. 3) in mode of maintaining set volume cargo in hopper.

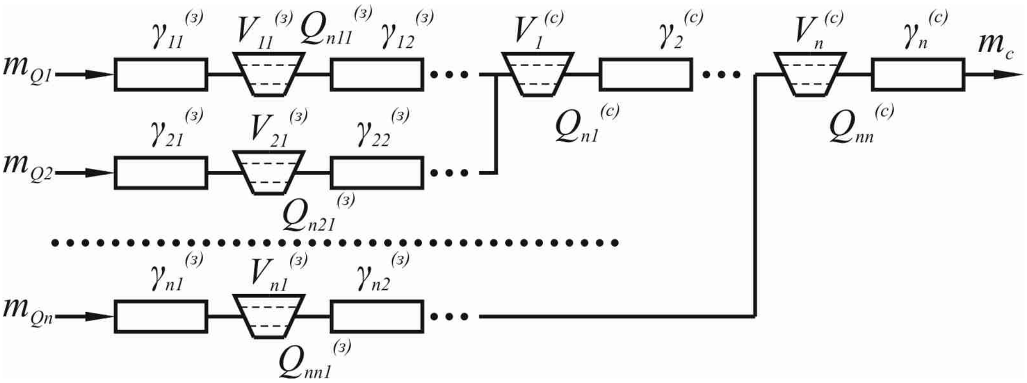

Fig. 3. Calculation scheme of dendritic self-similar structure of hoppers connection

On fig. 3 $\gamma_i^{(c)}, \gamma_{ij}^{(з)}$ – coefficients of failures of shafts and face paths of conveyer lines of conveyer transport system; $V_i^{(c)}, V_{ij}^{(з)}$ – volumes of hoppers of shafts and face paths, m^3; $Q_{ni}^{(c)}, Q_{nij}^{(з)}$ – productivity of batchers of hoppers of shafts and face paths, t/min.

This algorithm is a recursive relation.

Average carrying capacity of conveyer transport system shown in fig. 3 is determined by formula

$$m_c = m_{c_n}, \tag{4}$$

where

$$m_{c_i} = \left(1 - \frac{\gamma_{i+1}^{(c)}}{1+\gamma_{i+1}^{(c)}} e^{-\frac{\rho \Delta V_i^{(c)}}{m_i^{(s)}} \mu_i}\right) m_i^{(s)}, \tag{5}$$

$\gamma_{э_i}^{(c)} = \dfrac{\sum_{k=1}^{i} m_{Q_k}}{m_i^{(s)}} - 1$; $m_i^{(s)} = m_{c_{i-1}} + \dfrac{m_{Q_i}}{1+\gamma_{э_i}^{(з)}}$; $m_{c0} = 0$; $\Delta V_i^{(c)} = V_i^{(c)} - V_{2i}^{(c)}$; ($\mu_i = \mu_c$; $i = 1,n$; $m_i^{(s)} < Q_{n_i}$).

Here $\gamma_i^{(c)}$ – coefficients of accidents of conveyers of shafts paths, determined by formula: $\gamma_i^{(c)} = \lambda_i^{(c)} / \mu_i^{(c)}$, where $\lambda_i^{(c)}, \mu_i^{(c)}$ – parameters of failures and recoveries of conveyer transport system, 1/min; ; $\gamma_{\text{э}_i}^{(c)}$ – equivalent coefficients of accidents of shafts paths with hoppers; $\gamma_{\text{э}_i}^{(\text{з})}$ – equivalent coefficients of accidents of faces paths with hoppers; $m_i^{(s)}$ – average values of cargo coming into accumulative hoppers of shafts paths, t/min; μ – volume weight of transported cargo, t/m^3.

Here efficient coefficients of accidents of faces paths with hoppers are determined by formulas:

$$\gamma_{\text{э}_i}^{(\text{з})} = \frac{m_{Q_i}}{m_{c_i}^{(\text{з})}} - 1, \; (\gamma_{\text{э}_1}^{(c)} = \gamma_{\text{э}_1}^{(\text{з})}, \; i = 1,n), \tag{6}$$

where $m_{c_i}^{(\text{з})}$ – average carrying capacity *i*-th face path of conveyer transport system with hoppers [5].

Average energy costs of transporting in this case is determined by formulas

$$w_c = w_n^{(s)}, \tag{7}$$

where

$$w_i^{(s)} = \frac{w_{i-1}^{(s)}}{1+\gamma_{\text{э}_{i-1}}^{(c)}} + w_{i+1}^{(c)} + w_{i+1}^{(\text{з})}, \; (i=1,n), \tag{8}$$

$$\gamma_{\text{э}_{i-1}}^{c} = \frac{m_i^{(s)}}{m_{c_i}} - 1; \; m_i^{(s)} = m_{c_{i-1}} + \frac{m_{Q_i}}{1+\gamma_{\text{э}_i}^{(\text{з})}}; \; \gamma_{\text{э}_i}^{(\text{з})} = \frac{m_{Q_i}}{m_{c_i}} - 1 \; (w_0^{(s)} = w_1^{(\text{з})}; \; w_i^{(c)} = N_i^{(c)}).$$

Here $w_i^{(s)}$ – electricity power that uses conveyer transport system on transporting coal on the area till $i+1$ hopper of shaft line; $w_i^{(c)}$ – electricity power that uses *i*-th conveyer of shaft line on transporting coal; $w_i^{(\text{з})}$ – electricity power that uses *i*-th conveyer of pace line on transporting coal; $\gamma_{\text{э}_i}^{(\text{з})}$ – equivalent coefficients of accidents of *i*-th faces paths; $N_i^{(c)}$ – power that uses driver of i-th of shaft line conveyer on transporting coal, kW; m_{Q_i} – average productivity of *i*-th pace, t/min.

Besides, $w_i^{(\text{з})}$ for each pace line of conveyer can be determined according recursive ration, which was obtained for serial connection of conveyer and hoppers [5].

In case of serial connection of hoppers and conveyers in formulas (4)–(8) we should use $m_{Q1} = m_Q$; $\gamma_{\text{э}_1}^{(\text{з})} = \gamma_1^{(c)}$; $w_1^{(\text{з})} = w_1^{(c)}$; $m_{Qi} = 0$; $m_i^{(s)} = m_{c_{i-1}}$; $\gamma_{\text{э}_i}^{(\text{з})} = 0$; $w_i^{(\text{з})} = 0 \; (i = 2,...,n)$.

Parameters of conveyer transport system of coal mines which can be managed will be productivities of batchers Q_{ni}, which are set by operator on the uppers layer of management and maximum cargo volumes in hoppers V_{2i}, which are calculated by controllers in subsystems of management of accumulative hoppers in case of its management in mode of maintaining set cargo volume in them.

That’s why for management of accumulative hoppers of conveyer transport system of coal mines it is necessary to know dependencies V_{2i} from productivities of batchers Q_{ni}.

In [4] was solved the problem of determining the optimal average value of cargo volume in the accumulating hopper operating in a mode to maintain a set level of goods in hoppers.

In this case optimal average rates of cargo volume in accumulative hoppers $V_{i\min}$ are equal to the semi sum of maximum and minimum set cargo rates in hoppers, i.e.

$$V_{i\min} = \frac{V_{1i} + V_{2i}}{2} + \frac{\lambda_i}{(\lambda_i + \mu_i)\mu_i} \cdot \frac{m_i^{(s)}}{2\rho}, \tag{9}$$

where V_{1i}, V_{2i} – maximum and minimum set cargo values in accumulative hoppers.

Therefore, the objective function local management subsystem hoppers are the average value of the goods at the accumulating bunker. Therefore, the average cargo value in accumulative hoppers V_{ci} should reach to the average minimum rates of cargo volume in accumulative hoppers $V_{i\min}$, i.e.

$$V_{ci} \rho \, V_{i\min}. \tag{10}$$

On the other hand, according to [4], the average volume of cargo in accumulating hoppers, working in the mode of maintaining a given volume of goods in silos, can be determined by the formula

$$V_{ci} = \frac{V_{1i} t_{\text{з}i} + V'_{2i} t_{pi}}{t_{\text{з}i} + t_{pi}} + \frac{m_i^{(s)} t_{\text{з}i}^2 - \left(Q_{ni} - m_i^{(s)}\right) t_{pi}^2}{2\rho\left(t_{\text{з}i} + t_{pi}\right)}, \tag{11}$$

where $V'_{2i} = V_{2i} + \frac{\lambda_{i+1}}{\lambda_{i+1} + \mu_{i+1}} \frac{Q_{ni}}{\gamma} t_{pi}$; λ_i, μ_i – parameters of failures and recoveries of above hoppers conveyer lines, min^{-1}; λ_{i+1}, μ_{i+1} – – parameters of failures and recoveries of under hoppers conveyer lines, min^{-1}.

Here $t_{\text{з}i}$, t_{pi} – average time of loading and unloading of hoppers, which are determined by

$$t_{зi} = \frac{\rho\left(V_{2i} - V_{1i}\right)}{m_i^{(s)}} + \frac{\lambda_i}{\left(\lambda_i + \mu_i\right)\mu_i}, \tag{12}$$

$$t_{pi} = \frac{\rho\left(V_{2i} - V_{1i}\right)}{\left(\overline{Q}_{ni} - m_i^{(s)}\right)} + \frac{\lambda_i}{\left(\lambda_i + \mu_i\right)\mu_i} \cdot \frac{Q_{ni} m_i^{(s)}}{\left(\overline{Q}_{ni} - m_i^{(s)}\right)\left(Q_{ni} - m_i^{(s)}\right)}, \tag{13}$$

where $\bar{Q}_{ni} = \frac{\mu_{i+1}}{\lambda_{i+1} + \mu_{i+1}} Q_{ni}$.

Equating average values volume of cargo in hoppers V_{ci} to minimum values of volume $V_{ci\min}$, we will get equation for the unknown value of the specified maximum amounts of goods in hoppers V_{2i}, in which the average volume of cargo in bunkers takes a minimum value. As a result, according to (11), we will get the equation according to V_{2i} :

$$\frac{V_{1i} t_{зi} + V'_{2i} t_{pi}}{t_{зi} + t_{pi}} + \frac{m_i^{(s)} t_{зi}^2 - \left(Q_{ni} - m_i^{(s)}\right) t_{pi}^2}{2\rho\left(t_{зi} + t_{pi}\right)} = \frac{V_{1i} + V_{2i}}{2} + \frac{\lambda_i}{\left(\lambda_i + \mu_i\right)\mu_i} \cdot \frac{m_i^{(s)}}{2\rho} . \tag{14}$$

In obtained equation (14), according to (12) and (13), $t_{зi}$ and t_{pi} are functions from V_{2i}. Besides, $m_i^{(s)}$ is determined by difficult recursive ratios (see (5), [5]).

Thus determining V_{2i} from equation (14) is a difficult mathematical problem.

To simplify the problem of determining the maximum amount specified in the cargo-storage hoppers, you can use the scale to determine the quantities of cargo flows entering the accumulating hopper $m_i^{(s)}$. However, this requires high material costs.

Therefore, for the settlement of cargo in the hopper with the controller applies the adaptive control algorithm [3].

In this case to determine $m_i^{(s)}$ first using sensors of time we determine current time of loading $T_{зi}$ and unloading T_{pi} in accumulative hoppers of underground conveyer transport system in time of stopping and work of batcher accordingly.

Substitute in equation (12) $t_{зi}$ instead of the value of $T_{зi}$, from the resulting expression to determine the average value received by accumulative hoppers cargo flows by the formula:

$$m_i^{(s)} = \frac{\rho\left(V_{2i} - V_{1i}\right)}{T_{зi} - \frac{\lambda_i}{\left(\lambda_i + \mu_i\right)\mu_i}} . \tag{15}$$

Value of equation standing in the denominator on the right side of (15), we can express by m_{Qi} and $m_i^{(s)}$ by formula [5]:

$$\frac{\lambda_i}{(\lambda_i+\mu_i)\,\mu_i}=\frac{1}{\mu_c}\left(1-\frac{m_i^{(s)}}{\sum\limits_1^i m_{Qi}}\right), \tag{16}$$

where $\rightarrow_c = \mu_i$.

By substituting (16) into (15), we will obtain

$$m_i^{(s)}=\frac{\rho\left(V_{2i}-V_{1i}\right)}{T_{\text{з}i}-\left(1-m_i^{(s)}\Big/\sum\limits_1^i m_{Qi}\right)\dfrac{1}{\mu_c}}. \tag{17}$$

Let’s determine from the last equation $m_i^{(s)}$, as result we have:

$$m_i^{(s)}=\frac{\sqrt{\left(\mu_c T_{\text{з}i}-1\right)^2 m_{\varepsilon i}^2+2\rho\left(V_{2i}-V_{1i}\right)\mu_c m_{\varepsilon i}}-\left(\mu_c T_{\text{з}i}-1\right)m_{\varepsilon i}}{2}, \tag{18}$$

where $m_{\varepsilon i}=\sum\limits_1^i m_{Qi}$ ($m_{\varepsilon i}=m_Q$ – when we have serial connection of hoppers).

To determine average values of cargo $\bar{Q}_{ni}$, which is unloaded from accumulative hoppers, let’s substitute into equation (13) taking into account (16) instead of t_{pi} value T_{pi}. As result after transformation we will have

$$\bar{Q}_{ni}=m_i^{(s)}+\frac{\rho\left(V_{2i}-V_{1i}\right)+\dfrac{1}{\mu_c}\left(1-\dfrac{m_i^{(s)}}{m_{\varepsilon i}}\right)\cdot\dfrac{Q_{ni}m_i^{(s)}}{\left(Q_{ni}-m_i^{(s)}\right)}}{T_{pi}}, \tag{19}$$

Hence, knowing time of loading $T_{\text{з}i}$ and unloading T_{pi} of accumulative hoppers, average values of incoming from lavas cargo m_{Qi}, and also set values of minimum V_{1i} and maximum V_{2i} cargo volumes in accumulative hoppers of conveyer transport system of coal mines, can be detected from formulas (18) and (19) average values of incoming into hoppers cargo $m_i^{(s)}$ and average values of unloaded from hoppers cargo $\bar{Q}_{ni}$.

To determine maximum volumes of cargo in accumulative hoppers V_{2i}, which work in mode of maintaining set amount of cargo, when average volumes in hoppers V_{ci} have minimum values, let’s substitute into equation (14) instead of $t_{\text{з}i}$ and t_{pi} values $T_{\text{з}i}$ and T_{pi}. As result we will get equation relatively unknown maximum volumes of cargo in hoppers V_{2i}:

$$\frac{V_{1i}T_{\text{з}i}+V_{2i}T_{pi}}{T_{\text{з}i}+T_{pi}}+\frac{m_i^{(s)}T_{\text{з}i}^2-\left(Q_{ni}-m_i^{(s)}\right)T_{pi}^2}{2\rho\left(T_{\text{з}i}+T_{pi}\right)}+\frac{\left(Q_{ni}-\bar{Q}_{ni}\right)}{\rho}\,\frac{T_{\text{з}i}^2}{T_{\text{з}i}+T_{pi}}=$$

$$= \frac{V_{1i} + V_{2i}}{2} + \left(1 - \frac{m_i^{(s)}}{m_{\varepsilon i}}\right) \cdot \frac{1}{\mu_c} \cdot \frac{m_i^{(s)}}{2\rho} \,. \tag{20}$$

In obtained equation (20) values $m_i^{(s)}$ and $\bar{Q}_{ni}$ are determined by formulas (18) and (19).

The simplest and most effective method of solving equation (20) is the method of dichotomy (bisection) or sensing method. In this case, the unknown parameter V_{2i} is changed in limits $V_{1i} \le V_{2i} \le V_i$.

Hence, when we have set values of cargo flow m_{Qi}, productivity of batchers Q_{ni}, volumes of accumulative hoppers V_i and minimum cargo values in accumulative hoppers V_{1i}, and also current values of loading $T_{\text{з}i}$ and unloading T_{pi} of accumulative hoppers of conveyer transport system of coal mines, from equation (20) we can find values of maximum cargo volume V_{2i}^{*}, when average volumes of cargo in hoppers V_{ci} take minimum values equal to

$$V_{ci} \to V_{i\min} = \frac{V_{1i} + V_{2i}^{*}}{2} + \left(1 - \frac{m_i^{(s)}}{m_{\varepsilon i}}\right) \cdot \frac{1}{\mu_c} \cdot \frac{m_i^{(s)}}{2\rho} \,. \tag{21}$$

Hence the algorithm of adaptive control of underground conveyor transport system of coal mines can be represented as follows.

1. The generation of alternatives.

For this on set average values of cargo flow m_{Qi} and structure underground conveyor transport system we detect several alternatives of conveyer speeds $v_{\text{л}i}$ and productivities of batchers Q_{ni}. At the same time conditions must be satisfied (restrictions)

$$\sum_{1}^{i} m_{Qi} < Q_{ni} \le Q_{mi}, \; (i = 1,\ldots,n), \tag{22}$$

where Q_{mi} – maximal productivities of under-hopper conveyer lines of conveyer transport system, t/min.

Moreover, accumulative hoppers for operating in a set mode to maintain the cargo volume in them must be performed limitations

$$m_i^{(s)} < Q_{ni}\,;$$
$$V_{1i} < V_{2i} < V_i \,, \; (i = 1,\ldots,n). \tag{23}$$

2. Estimation of the mean values of cargo traffic loaded into the hopper and discharged from them.

For this purpose, sensors of time during loading and unloading of accumulative hoppers values determined at loading time $T_{\text{з}i}$ and unloading time T_{pi}. On this values

$T_{зi}$ and T_{pi} according to (18) and (19) we detect values of average cargo flow $m_i^{(s)}$, incoming into hoppers, and average cargo flow $\bar{Q}_{ni}$, unloaded from hoppers.

3. Determination of the maximum specified volumes of cargo in accumulating hoppers.

To do this, the obtained values of estimates $m_i^{(s)}$ and $\bar{Q}_{ni}$ from equation (20) we determine maximum values of cargo volume in accumulative hoppers V_{2i}^*, when average cargo volume in hoppers V_{ci}, operating in a set mode to maintain the cargo volume, have minimum values.

4. Definition of performance criteria and the objective function.

For this according to calculated values of V_{2i}^* according to recursive formulas (4)–(8) we determine cargo capacity m_c and energy consumption w_c of underground conveyor transport system.

On obtained values m_c and w_c according to (1) we can detect objective function K.

5. Repeating this process for various alternatives, i.e. defining the objective function K_s for different productivities of batchers $Q_{ni}^{(s)}$, we select from obtained objective functions K_s minimum value $K_{\min}$, i.e.

$$K_{\min} = \min_{1 \le s \le N} \{K_s\},$$

where N – number of alternatives.

Values of productivities of batchers Q_{ni} and maximum values of cargo volume in accumulative hoppers V_{2i}, corresponding to this minimum objective function $K = K_{\min}$, are optimal.

If you change structural diagram an underground conveyor transport associated with the promotion of lava or changing their number, as well as changes in value of the average cargo flows coming from the lava m_{Qi}, optimal values Q_{ni} and V_{2i}, in which the criterion of efficiency K takes a minimum value determined anew for the above given algorithm.

Calculations have shown that the energy efficiency of transportation of coal, i.e, objective function K of underground conveyor transport system of coal mines at the optimum values Q_{ni} and V_{2i}, obtained on the basis of made algorithm, increases up to 30 %.

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3 Кирия Р. В. Управление бункерами, работающими в системах конвейерного транспорта угольных шахт / Р. В. Кирия, В. Ю. Максютенко, Д. Д. Брагинец // Збірник наукових праць НГУ. – Дніпропетровськ: Національний гірничий університет, 2012. – № 37. – С. 230–236.

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Кирия Р. В. Алгоритм управления системой подземного конвейерного транспорта угольных шахт / Р. В. Кирия, Ю. В. Бабенко // Системные технологии. Региональный межвузовский сборник научных трудов. – Выпуск ??(??). – Днепропетровск, 2015. – С. ??–??.

Система управления конвейерным транспортом представлена как двухуровневая иерархическая система, на первом уровне которой оператор задает определенные параметры для нижнего уровня управления. Глобальным критерием эффективности этой системы является комплексная величина, характеризующая энергоэффективность транспортирования горной массы, а локальными критериями являются минимальные значения средних объемов груза в аккумулирующих бункерах системы подземного конвейерного транспорта. Разработан алгоритм адаптивного управления аккумулирующими бункерами и системой подземного конвейерного транспорта.

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Кирія Р. В. Алгоритм управління системою підземного конвеєрного транспорту вугільних шахт / Р. В. Кирія, Ю. В. Бабенко // Системні технології. Регіональна міжвузівська збірка наукових праць. – Випуск ??(??). – Дніпропетровськ, 2015. – С. ??–??.

Система управління конвеєрним транспортом представлена як дворівнева ієрархічна система, на першому рівні якої оператор задає певні параметри для нижнього рівня управління. Глобальним критерієм ефективності цієї системи є комплексна величина, що характеризує енергоефективність транспортування гірської маси, а локальними критеріями є мінімальні значення середніх об'ємів вантажу в акумулюючих бункерах системи підземного конвеєрного транспорту. Розроблено алгоритм адаптивного управління акумулюючими бункерами і системою підземного конвеєрного транспорту.

Бібл. 7, іл. 3.

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Kiriya R. Algorithm of control of coal mines underground conveyer transport system / R. Kiriya, Yu. Babenko // System technologies. Regional Interuniversity compedium of scientific papers. – Issue? (?). – Dnipropetrovsk, 2015. – Pp. ? –?.

The control system of conveyer transport is represented as a two level hieratic system on first level of which an operator sets certain parameters for the lower level of control. A global criterion of efficiency of this system is complex value, which characterizes energy efficiency of transporting coal, and the minimum values of middle volumes of cargo in accumulative hoppers of the underground conveyer transport system are local criteria. We developed the algorithm of adaptive control of accumulative hoppers and underground conveyer transport system.

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