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ScienceDirect

Procedia Engineering 206 (2017) 449–456

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on Industrial Engineering, ICIE 2017

Dynamics of Process, Algorithm, and System of Uninterrupted Action Loading Machine Feeding

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Abstract

Based on studying the peculiarities of dynamics of working processes of mining loading machines of uninterrupted action the article substantiates the principal and a corresponding method of automated control of the feed to the pile providing for the maximum possible productivity for the net loading time with a consideration of power and energetic recourses of the machine and the stochastic nature of the process. The analysis of the long-term experience in solving the problem proves the efficiency of using interrupted feed during the hard particle material loading. Realization of the worked out proposal with using modern means of microscopy accessories is fulfilled by the adequate using mathematical models of changing un the dynamics of the pile state at the loading organ influencing it, forming the productivity, the loads in the drive of the work organ and the process of running displacement of the machine. An algorithm, a program of optimum control, and the implementation schedule are developed based on the example of s widely used loading machine.

Peer-review under responsibility of the scientific committee of the International Conference on Industrial Engineering

Keywords: loading machine of uninterrupted action; the machine maximum productivity; automatic control of feeding to the pile; mathematical model; dinamic loads; the scheme of microprocessor-based system of optimal control.

1. Introduction

In the process of driving underground mining heading loading of the broken mining mass is one of the main parts of the technological cycle. Moreover, it is the process of loading and transportation of mining mass that often define the productivity of the whole complex of mining cutting works.

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1877-7058
Peer-review under responsibility of the scientific committee of the International Conference on Industrial Engineering.
10.1016/j.proeng.2017.10.500

In mining industry all over the world loading machines of various types using both as separate machines and as loading modules in the composition of roadheading machines are used. All loading organs can be divided into two types: periodical (bucket) and uninterrupted (gathering-arms and gathering-stars) action. Since 1916 when Joseph Joy got his first patent for the machine with gathering-arms, its construction has not been changed greatly, and loading organs using the idea of an apron (feeder) with pair gathering-arms organs moving on various trajectories [1,2] are widely used in underground loading machines and roadheaders all over the world.

Loading machines of uninterrupted action, in spite of their almost centenary industrial producing are hand-operated which can be explained with the complicacy of the process of interaction of the loading organ with the mining mass pile. On the other hand, it is the complicated stochastic character of forming the loads on the mechanism drive of gathering-arm that makes impossible the full using the machine resources even at the operator's great experience. Hence, the problem of creating an automatical device which should increase the reliability and efficiency of the machine in the whole and decrease of the labour intensity of the loading process for the operator is quite relevant.

2. History of working out the system of feeding control

The peculiarity of the technological process of mining mass loading by the machines of uninterrupted action is periodical feeding of the loading organ or the whole machine to the mining mass pile. It takes place because of the fact that the working elements of the loading organ make the choice of the material from the working zone formed on the apron (feeder) making it naked, which, in its turn, leads to the decrease of the gathered material portion and lowering the loading productivity. For compensation of the loaded material the feeding of the machine to the pile is realized, as a result of it the apron intrudes into the material and the volume of the working zone of loading elements increases. The increase of the feed value causes to the increase of productivity of the loading organ, loads to the drive of the executive elements and the power consumed, and the apron intrusion after some maximum value leads to great overloading of the drive and through some material off the apron. In this connection at considering the control system by the process of loading the speech is, in the first turn, about the constructing the automatic feed of the loading organ and of the machine as a whole to the mining mass pile.

Group of scientists of the Novocherkassk polytechnic institute (now Platov South-Russian state polytechnic university (NPI)) [3,4], the Kommunarsk mining-metallurgical institute (the town of Altchevsk, the USSR, the Republic of Ukrain) [5], the Institute of mining technical mechanics AS of the USSR (the city of Dnepropetrovsk) [6], as well as of the Kopeisk and Yasnogorsk plants producing the machines of such types went in for working out the automatical control by the loading machines of the type of PNB during the latest 50 years.

Among the realized in experimental samples machines: there were the machines with regulated direct current drive [5], with differentiated hydrodrive [3], asynchronous drive with generator and impulse regulators [5,7]. The machine of 1PNB-2D type with generator regulator of drive produced by the Kopeisk machine building plant successfully went through the industrial test [5,7], the other samples were tested in stand conditions.

As the movement of loading elements is uninterrupted but the feed of the loading organ is realized periodically, two conception of controlling are appeared: 1) the velocity of automated feed should change smoothly in the function of loading in the drive of the gathering part [3]; 2) interrupted of the machine, the beginning and ending of the cycle of which depend on the level of load in the drive [4].

The conception of uninterrupted regulated feed of the machines of uninterrupted action was based on the affirmation that after gathering the next portion of the material with the gathering-arms the pile evenly crumble as though "retreating" from the immobile standing machine, and it is necessary to feed the machine uninterruptedly compensating the pile retreat. But it happens only on small particle sizes of material pile of a small height. Investigation of loading of large particle size of material [7] showed that on such a pile periodical hanging and breaking down the material take place, and the volume in the active zone of loading elements and productivity of the whole organ change according to the complicates dependences. If the broken volume in the active zone is in 6-7 times more than the volume of a single gather, then the productivity of the loading organ in the area is stabilized and is saved practically maximum during 3-4 gatherings [7]. Such character of the working process makes the discrete control of feed more effective, i.e. the cycle of feed should include 2-4 gatherings at the unchangeable position of the apron relatively to the pile.