

Development of the preventive maintenance system for belt conveyors reducers

Boris Gerike^{1,2,*}, Ivan Panachev², Eugene Kuzin³

¹Federal Research Center of Coal and Coal Chemistry SB RAS, 650003, 10 Leningradsky av., Kemerovo, Russian Federation

²T.F. Gorbachev Kuzbass State Technical University, 650000, 28 Vesennaya st., Kemerovo, Russian Federation

³Branch of T. F. Gorbachev Kuzbass State Technical University in Prokopyevsk, 653039, Kemerovo region, 19a Nogradskaya str., Prokopyevsk, Russia

Abstract. Heavy operating conditions of mining machines as well as the high level of dynamic loads lead to reduction of their service life. The quantitative estimation of the machine reliability by one of the feature – service life – has become widely distributed in all the branches of engineering. Technical diagnosis is one of the important methods of improving the reliability in operating conditions. The diagnostics subsystem should provide for: non-destructive inspection of a technical condition of objects, the definition of sudden and parametric failures of mining machines and their systems, the detection of gradual failures by predicting changes in the monitored parameters, a continuous and periodic technical inspection. The obtained results given in this article prove the possibility of creating a group of common diagnostic criteria suitable for assessing the technical state of reducers of mining machines and equipment, but also being a prerequisite for the effective short-term prediction of the parameters under study when developing adaptive mathematical models.

1 Introduction

All the parts of mining machines and equipment can be subdivided into the following groups:

1. The first group includes dipper teeth and cutting lips; bases and canopies of powered supports; augers; bulldozer bars, blades; crawler shoes, idler rollers, pins, bushings, sprockets of crawler undercarriage and other parts with the service life duration depending on abrasive wear;

2. The second group includes slotted and threaded parts, gear couplings, mounting seats for rolling bearings of shafts, machine tools, surfaces of gearing, etc. with the service life duration determined by mechanical wear of their surfaces;

* Corresponding author: gbl_42@mail.ru

3. The third group includes parts of internal combustion engines of dump trucks, bulldozers, scrapers, diesel locomotives, thermal rock fracturing and jet drilling rigs, etc. with their service life duration limited by molecular – chemical or corrosive mechanical wear;

4. The fourth group includes rolling and plain bearings, shock absorbers, springs, connector rods, connecting rod bolts, etc. with their surface life duration depending on metal fatigue strength.

2 Formulation of the Problem

At present, the coal mines operate a significant number of belt conveyors [1, 2], and the performance indicators of the entire coal industry of Kuzbass depend on their operating condition. In the nearest future, it is expected that power consumption and technical equipping of belt conveyors increase, as well as the performance and length of rock mass transportation, variable frequency drives are widely introduced.

The increasing volumes of coal production by integrated mechanized coal faces, together with an increase in production safety require the creation of reliable transport systems. High efficiency and trouble-free performance along with reduction of energy consumption present the main challenge faced by manufacturers of production lines of mine belt conveyors. Another no less important goal is reduction of the cost of their maintenance and repairs [3, 4]. To ensure reliable operation of a belt conveyor for as long as possible, it is required to find the causes of failure of the various constituent elements [5-7]. The analysis of downtime caused by failure of a belt conveyor reducer shows that it varies from 7.4% to 18.2% and accounts on average for 12%, with the average recovery time is from 24 to 48 hours. It should be noted that the most common failure is belt rupture (up to 50%), while the average time to fix this failure is from 1.5 to 2 hours. Hence, identification of the actual technical condition of mine belt conveyor reducers is really quite an urgent objective.

3 Results of Study

The vibration control method [8-10] proved to be useful in checking the technical condition of mechanical equipment. The vibration diagnostics is used to monitor the current state of equipment, to identify possible defects, to assess the remaining service and to define repair time and scope. The analysis of domestic and foreign experience of monitoring the technical condition of systems with rotational motion of power assemblies shows that for the detection of potential failures the most effective (77%) is control of the machinery condition by vibration parameters [11], and with the involvement of other methods of the functional diagnostics – like spectral oil analysis [12] and thermal control, the accuracy of recognition of the cause of the defect increases to 95%.

The functional diagnostics, in terms of safe operation of mining machinery, should play a key role in the field of research and development, production and quality control of the process equipment. And while in the coal mining and ore mining industries the forms of technical service of technological equipment based on its actual condition [1, 8] are becoming more common, in the manufacture of such equipment new forms of quality control are not yet implemented in spite of the introduction of quality standards GOST ISO 9000-2011. Defects that arise in the gearbox manufacturing process can be divided into errors in the manufacture of gearbox elements and errors in gearbox assembly.

A full analysis of the technical condition of the gearbox after assembly and trial running on the test bench will allow us to identify and localize manufacturing defects, but also to

eliminate possible supply of poor quality products to the consumer. In addition, the findings could form the basis for development of automated quality control system.

The analysis of vibration control methods allows us to conclude that it is appropriate to apply the method of support masks for automation of control of products manufactured for the coal industry. This method is based on the fact that the defects formed as a result of assembly operations generate a vibration in certain frequency bands with a certain ratio of the values of controlled parameters. The method of support masks makes it possible to set the width of the frequency band, its position and the values of the evaluation criteria, which are compared with the current values in random order. Based on the analysis of the controlled parameter changes in the frequency band (the number of bands may vary from 6 to 30), the condition of the equipment is evaluated and forecasted [4].

Frequency ranges of the spectrum mask (band width) are usually taken based on the following conditions:

1. "High-energy" components of the spectrum accompanying the misbalance or misalignment – $(0,5...1,5) \times f_r$ and $(1,5...2,5) \times f_r$;
2. "Low-energy" components of vibrations accompanying the defects of rolling bearings – $(7,5...15,5) \times f_r$;
3. $(2,5...10,5) \times f_r$ – total failure of the system stiffness;
4. The first medium frequency band $(3... 15) \times f_r$;
5. The second medium frequency band $(15...40) \times f_r$;
6. The first high frequency band $40 \times f_r...20$ kHz;
7. $(0,1...0,9) \times f_r$ – for detection of oil wedge defects of slide bearings;
8. $(n \pm 1) \times f_r$ – for detection of damages in the components of couplings.

The use of modern automation technologies for control of equipment technical condition enables an individual approach to each manufactured mechanism in the evaluation of its technical condition and sets the thresholds of the initial operable and limit state. As an example, Figures 1 and 2 show the spectrum of the vibration signal and its averaged spectral mask in 1 checkpoint of gearbox RKC-400 manufactured by JSC "Anzheromash" (Fig. 3). The measurements were made by analyzers "Corvet", and the signal was processed on Safe Plant software platform developed by NGO "Diatekh".

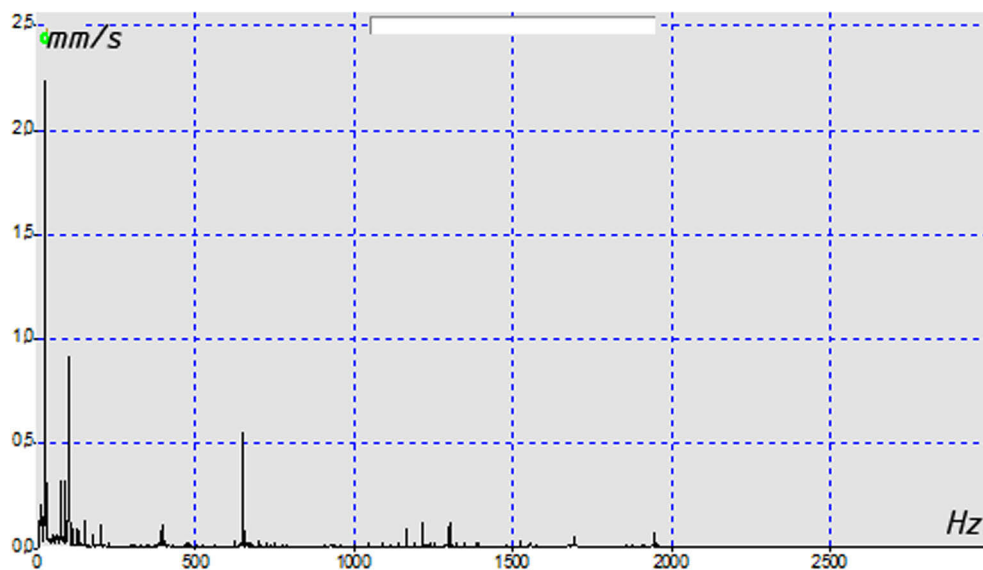


Fig. 1. Vibration signal spectrum

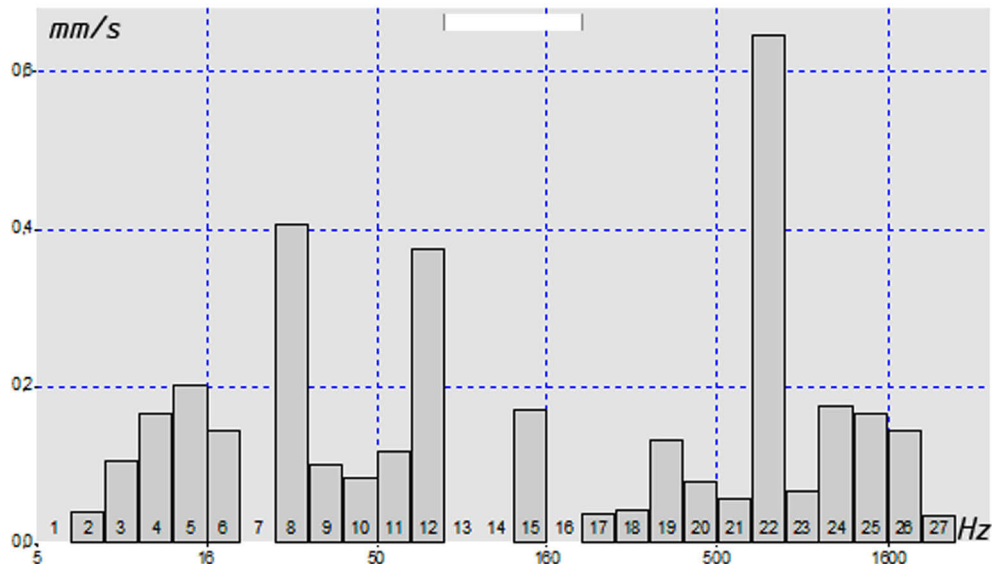


Fig. 2. Vibration signal spectrum mask

In the presented example, the frequency range (2; 3000 Hz) is divided into 27 bands, each of which is normalized by the RMS value of vibration speed V determined for both forward and reverse rotation of the output shaft.

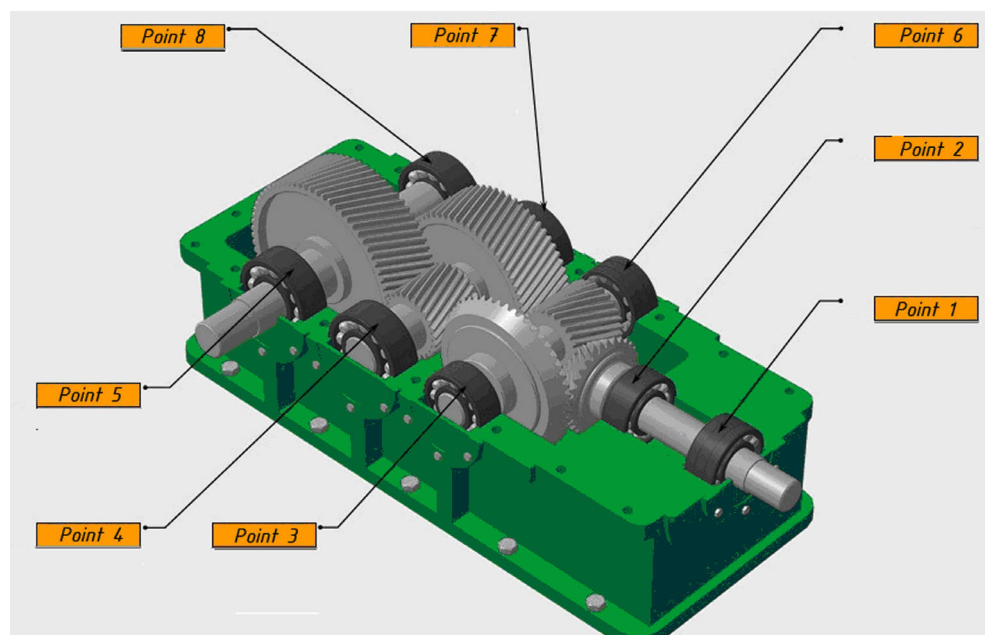


Fig. 3. Vibration measurement points on gearbox RKC-400

The most typical defects inherent to reducers of mining machines occur at frequencies shown in Tables 1 and 2.

Table 1. Frequencies typical for gearing defects in in-line reducers

Frequency	Type of manufacturing defect	Type of assembly defect	Type of wear defect
f_r	Misbalance		
$k \times f_{r1}$ and $k \times f_{r2}$ ($k = 1, 2$, less often 3 and 4), $m \times f_z \pm n \times f_r$ ($m, n = 1, 2, \dots$)	Variable gear pitch error	Violation of alignment (misalignment of shafts)	
$k \times f_r$ $k = 1, 2, \dots, 20$ and higher		Increased gear backlash	
f_z	Permanent gear pitch error		
$k \times f_z, k \times f_r$ growth of noise component $m \times f_m \pm n \times f_r$ ($m, n = 1, 2, \dots$)			Abrasive wear
$k \times f_r, m \times f_z \pm n \times f_r$ $m \times f_m \pm n \times f_r$ (amplitude fluctuation, $n = 0, 1, 2, \dots$)			Teeth chipping
$k \times f_r$, $m \times f_z \pm n \times f_r$, $m \times f_m \pm n \times f_r$ (amplitude fluctuation, $n = 0, 1, 2, \dots$), growth of noise component			Cracks and (or)broken teeth

Table 2. Defects in the gear part of the planetary reducer and their key diagnostic parameters

Type of defect	Diagnostic signs
Sun pinion shaking	$f_o, n f_o^* \pm f_o, k f_z \pm f^*$
Sun pinion misalignment	$2f_o, 2n f_o^* \pm 2f_o, k f_z \pm 2f^*$
Sun pinion teeth defect	$k n f_o^* \pm k f_o, k f_z \pm k f^*$
Satellite gear misalignment	$4f_g \pm k f_v, k f_z \pm 2f_g$
Satellite gear teeth defect	$2k f_g \pm k f_v, k f_z \pm k f_g$
Crown misalignment	$2n f_v, k f_z \pm 2n f_v$
Crown teeth defect	$k n f_v, k f_z \pm k_1 n f_v$
Engagement defect	$k f_z$
Shaking of final drive carrier	$k f_v, f_o \pm f_v, k f_z \pm k f_v$
Satellite gear bearing defect	$k f_v, f_o \pm f_v, k f_z \pm f_g/2$
Defect of sun pinion bearing	$k f_r$ + growth of RMS MF, impact pulses appear at MF
Bearing lubrication defect	Impact pulses appear at HF, growth of RMS at HF

In industrial conditions (mine Taldinskaya-Zapadnaya of OJSC "SUEK-Kuzbass") an integrated method of the technical state estimation has been tested on the drive units of mine belt conveyor 3LL1600 (conveying length $L = 850$ m, technical performance $Q = 3500$ m / h, the belt speed $v = 0 - 4$ m / s) by the parameters of the lubricating oil, vibration and thermal control.

4 Conclusion

The proposed approach to the standardization of mechanical vibration parameters can be used in practice at development of the enterprise standard for normalization of vibration of manufactured products for inclusion in the product data sheet.

The development of a large number of spectrum masks for a wide standard line of mining equipment is one of the prerequisites for release by mining machinery plants of quality products and the transition to new forms of mining machines maintenance and repair.

The results of evaluation of the technical condition of the 3LL1600 conveyor drives using the integrated method based on monitoring of parameters of vibro-acoustic signals, emission-spectral analysis of the composition of working oil and thermal visual control of support units of rolling bearings make it possible to track changes in the technical condition of the reducer elements depending on its load and speed.

The proposed approach will not only increase the accuracy of the assessment of the technical condition of mining equipment gear units but will also help to organize the work on creation of normative and methodological base for building predictive models of changes in the technical condition on the basis of a significant amount of accumulated statistical information on the development of those or other defects of belt conveyor reducers.

References

1. Ansari F., Uhr P. and Fathi M., *International Journal of Services, Economics and Management*, **6**, 14 (2014)
2. Ierace S., Cavalieri S., *Management and Production Engineering Review*, **4**, 37 (2013)
3. Shafiei-Monfared S. and Jenab K., *IEEE Transactions on Engineering Management*, **59**, 293 (2012)
4. Almgren T., Andréasson N., Palmgre M., Patriksson M., Strömberg A.B., Wojciechowski A. and Önnheim M., *Proceedings of 4th World Conference on Production & Operations Management and the 19th International Annual EurOMA Conference, University of Amsterdam* (Amsterdam, 2012)
5. Franco Jefferds dos Santos Silva, Herbert Ricardo Garcia Viana, André Nasser Aquino Queiroz, *Journal of Quality in Maintenance Engineering*, **22**, 418 (2016)
6. Gajanand Gupta, Rajesh P Mishra, *Journal of Quality in Maintenance Engineering*, **22**, 130 (2016)
7. Dehghanian P. and Aminifar F., *IEEE Transactions on Power Delivery*, **28**, 761 (2013)
8. Prabhakar D. and Raj V.P., *International Journal of Scientific & Technology Research*, **2**, 56 (2013)
9. Anil Rana, *Journal of Quality in Maintenance Engineering*, **22**, 180 (2016)
10. Golmakani H.R. and Morteza P., *J of Quality in Maintenance Eng.*, **20**, 51 (2014)
11. Hussan Saed Al-Chalabi, Jan Lundberg, Majid Al-Gburi, Alireza Ahmadi, Behzad Ghodrati, *Journal of Quality in Maintenance Engineering*, **21**, 207 (2015)
12. Hartman J.C. and Tan C.H., *The Engineering Economist*, **59**, 136 (2014)
13. Hussan S. Al-Chalabi, Jan Lundberg, Andi Wijaya, Behzad Ghodrati, *Journal of Quality in Maintenance Engineering*, **20**, 306 (2014)
14. Gustafson A., Schunnesson H., Galar, D. and Kumar, U., *International Journal of Mining, Reclamation and Environment*, **27**, 75 (2013)

E3S Web of Conferences

Proceedings



The 1st International Innovative Mining Symposium
(in memory of Prof. V. Pronoza)



ENVIRONMENT, ENERGY &
EARTH SCIENCES

E3S Web of Conferences

**The 1st International
Innovative Mining Symposium
(in memory of Prof. Vladimir Pronoza)**

Kemerovo, Russian Federation, April 24-26, 2017

Edited by:

M. Tyulenev, S. Zhironkin, A. Khoreshok, S. Voth,
M. Cehlar and Y. Tan

The logo for 'edp sciences' features the lowercase letters 'edp' in a stylized, lowercase font, followed by the word 'sciences' in a clean, lowercase sans-serif font.

Organizing Committee

Aksenov Vladimir V., DSc, Prof., Head of Laboratory of Mining Geotechnical Engineering of the Institute of Coal of SB RAS, Kemerovo, Russia

Asmelash Abay, PhD, Assoc. Prof., College of Natural and Computational Sciences, Mekelle University, Ethiopia

Barysheva Galina A., DSc, Head of Economics Department, National Research Tomsk Polytechnic University, Tomsk, Russia

Cehlár Michal, PhD, Prof. Ing., Dean of Mining Faculty, Technical University of Kosice, Kosice, Slovak Republic

Demirel Nuray, PhD, Middle East Technical University, Turkey

Gasanov Magerram A., DSc in Economics, Prof., National Research Tomsk Polytechnic University, Tomsk, Russia

Gvozdikova Tatyana N., PhD, Director of Mezhdurechensk Branch of T.F. Gorbachev Kuzbass State Technical University, Mezhdurechensk, Russia

Khoreshok Alexey A., DSc, Prof., Director of Mining Institute, T.F. Gorbachev Kuzbass State Technical University, Kemerovo, Russia

Kostyuk Svetlana G., Vice-Rector, T.F. Gorbachev Kuzbass State Technical University, Kemerovo, Russia

Krechetov Andrey A., PhD, Acting Rector, T.F. Gorbachev Kuzbass State Technical University, Kemerovo, Russia

Lesin Yury V., DSc, Prof., Kuzbass State Technical University, Kemerovo, Russia

Markov Sergey O., PhD, Assoc. Prof., Surveying and Geology Department, T.F. Gorbachev Kuzbass State Technical University, Kemerovo, Russia

Misnikov Oleg S., DSc, Dean, Tver State Technical University, Tver, Russia

Myaskov Alexandr V., DSc, Dean, National University of Science and Technology MISiS, Russia

Seroni Anyona, PhD, Assoc. Prof., Jomo Kenyatta University of Agriculture and Technology, Kenya

Tyulenev Maxim A., PhD, Prof., T.F. Gorbachev Kuzbass State Technical University, Kemerovo, Russia; Yurga Technological Institute of National Research Tomsk Polytechnic University, Russia

Vöth Stefan, Dr.-Ing., Prof., TFH Georg Agricola, Bochum, Germany

Janočko Juraj, PhD, Technical University of Kosice, Kosice, Slovak Republic

Zhironkin Sergey A., DSc, Prof., National Research Tomsk Polytechnic University, Tomsk, Russia

Contents

00001 Preface: the role of T.F. Gorbachev State Technical University as the Flagship of Kemerovo Region Innovative Development

A. Krechetov

Perspective Mining Technologies

01001 The Length Of Bearing Pressure Zone For The Flat Seams Extraction In A Linear Deformation Rock

V. Gogolin, Y. Lesin and A. Djagileva

01002 The influence of advancing speed of powered mining stope with single face on earth's surface displacing in Kuzbass

A. Renev, S. Svirko, A. Bykadorov and V. Fedorin

01003 Energy Consumption in the Process of Excavator-Automobile Complexes Distribution at Kuzbass Open Pit Mines

I. Panachev, B. Gerike, I. Kuznetsov and A. Shirokolobova

01004 Slope Stability Assessment and Underground Mine Design Analysis of Achibo-Sombo Underground Conventional Coal Mine, Southwest Ethiopia

M. Haftu, B. Konka, K. Woldeargay and A. Abay

01005 Geomechanics of rock array for chamber system of coal deposits development on the example of finalizing by KGRP complex

A. Bykadorov, D. Degtyarev, S. Smirnov and O. Pechenegov

01006 Justification of the Optimal Granulometric Composition of Crushed Rocks for Open-Pit Mine Road Surfacing

V. Shalamanov, V. Pershin, S. Shabaev and D. Boiko

01007 Optimization of transportless technological schemes for coal seams quarrying

T. Gvozdikova, E. Plotnikov and E. Usova

01008 The features of three- and four-tier internal dumps capacity calculation with the additional capacity preparation in the dump tiers

T. Gvozdikova, E. Kuznetsov, A. Rudakova and S. Markov

01009 The Relationship Between the Manifestations of Rock Pressure and the Relative Deformation of Surrounding Rocks

S. Kostyuk, N. Bedarev, O. Lyubimov and A. Shaikhislamov

01010 Computer Simulation of Electroosmotic Soils Treatment

M. Gucal and A. Pokatilov

01011 Innovative numerical modelling of technogenic rock arrays structure

S. Markov, M. Tyulenev, O. Litvin and E. Tyuleneva

01012 Definition of the form of coal spontaneous combustion source as the inverse problem of geoelectrics

D. Sirota, V. Ivanov and V. Khyamyalyaynen

- 01013 Numerical Simulation of Primary Roof Collapse in Production Workings
I. Ermakova and V. Klimov
- 01014 The Study of Processes of Electrochemical Treatment of Soils at the Pilot Test Site
S. Prostov, E. Shabanov and A. Shadrin
- 01015 The study of stress-strain state of stabilized layered soil foundations
M. Sokolov, S. Prostov and V. Zykov
- 01016 Justification of parameters and technology of retaining prism filling to eliminate landslide
V. Balakhnin, O. Veretennikova, R. Pobegaylo and E. Mezina
- 01017 Use of Deep Peat-Processing Products for Hydrophobic Modification of Gypsum Binder
O. Misnikov and V. Ivanov
- 01018 Software for Automated Production Line of Peat Briquettes
V. Lebedev and O. Puhova
- 01019 Assessment process of concept for mining and its impact on the region
M. Cehlár, J. Janočko, Z. Šimková and T. Pavlik
- 01020 Experimental Study of Methane Hydrates in Coal
V. Smirnov, V. Dyrdin, T. Kim, A. Manakov and A. Khoreshok
- 01021 Expert evaluation of innovation projects of mining enterprises on the basis of methods of system analysis and fuzzy logics
A. Pimonov, E. Raevskaya and T. Sarapulova
- 01022 Gas hydrates in coal seams and their impact on gas-dynamic processes in underground mining
T. Kim, V. Dyrdin, V. Smirnov and V. Nesterov

Environment Saving Development of Mining

- 02001 Environmental and Economic Efficiency of Comprehensive Technology of Sulfur Oxides, Nitrogen Oxides and Mercury Removal from Flue Gases
S. Grigashkina, T. Galanina, V. Mikhailov, T. Koroleva and E. Trush
- 02002 Utilization prospects for coal mine methane (CMM) in Kuzbass
O. Tailakov, D. Zastrellov, V. Tailakov, M. Makeev and P. Soot
- 02003 The Experience of Using Innovative Artificial Filter Arrays on South Kuzbass Open Pit: Case Study
M. Tyulenev, Y. Lesin, E. Tyuleneva and E. Murko
- 02004 The results of air treatment process modeling at the location of the air curtain in the air suppliers and ventilation shafts

A. Nikolaev, N. Alymenko, A. Kamenskih and V. Nikolaev

02005 Mitigating Against Conflicts in the Kenyan Mining Cycle: Identification of Gaps in the Participation and Recourse for Rights Holders (Civil Society & Community)

S. Anyona and B. Rop

Innovative Mining Equipment

03001 Modeling of Power Consumption of the Mining Equipment Using “The Probabilistic Automata Method”

A. Zakharova, V. Kashirskikh, I. Lobur, N. Shauleva and V. Borovtsov

03002 Application of Machine Learning for Dragline Failure Prediction

A. Taghizadeh and N. Demirel

03003 Kinematic Parameters Of Rotary Transmission With Hydraulic Cylinders

M. Blaschuk, A. Dronov, A. Koperchuk, R. Chernukhin and V. Litvinenko

03004 The results of cutting disks testing for rock destruction

A. Khoreshok, L. Kantovich, V. Kuznetsov, E. Preis and D. Kuziev

03005 Grinding efficiency improvement of hydraulic cylinders parts for mining equipment

A. Korotkov, V. Korotkov, L. Mametyev, L. Korotkova and T. Terjaeva

03006 The Smart Grid using in the Kuzbass open-pit coalmine

I. Semykina, A. Evstratov and G. Lebedev

03007 Multifunctional Testing Rig for Machinery Safety Equipment

S. Vöth, J. Tschersich and Tim Schwartz

03008 Development of the preventive maintenance system for belt conveyors reducers

B. Gerike, I. Panachev and E. Kuzin

03009 Determination of Load Performance of Two-Bar Girder Lining

Y. Glazkov, A. Kazantsev, D. Nesteruk, V. Aksenov and A. Efremenkov

03010 Ways of increasing excavator fleet productivity in Russian coal open pits (Kuzbass case study)

M. Drygin, N. Kurychkin and A. Bakanov

03011 Strategy of Russian Coal Mining Enterprises' Excavator Park Technical State Correction

M. Drygin, N. Kurychkin and A. Bakanov

03012 The innovative development of machine building as a driver of import substitution

S. Zhironkin, M. Gasanov, G. Barysheva, K. Kolotov and O. Zhironkina

03013 “Smart Service” as an innovative system of service for mining companies in Kuzbass

L. Samorodova, L. Shut'ko, Y. Yakunina and O. Lyubimov

03014 Special Modes of AC Drives Operation in the Mining Industry

L. Payuk, N. Voronina, O. Galtseva, D. Zhang and A. Rogachev

03015 Impact of the number of blades of the geokhod cutting body on cutting forces
V. Aksenov, V. Sadovets, E.Rezanova and D. Pashkov

03016 Comparison of technological efficiency of gravitational devices for preparation of
large diluted coal
V. Udovitsky, V. Kandinsky and A. Begunov

03017 The intelligent mechatronic system for open pit mining to increase the operation life
of equipment
I. Semykina, V. Zavyalov and V. Kashirskikh

Economic and Social Development of Mining Regions

04001 The principles of municipal industrial clusters' establishment on the territory of
advancing social-and-economic development of mono-town
O. Ivanova, G. Antonov and S. Bereznev

04002 The innovative strategy of social and economic development of mining region
S. Bereznev, O. Zonova and E. Lubkova

04003 The analysis of strategies for the mining regions' development in Russia as a
condition of effective management of economy
N. Zaruba, N. Egorova and P. Kosinskij

04004 Increasing the efficiency of coal mining based on the concept of Shewhart-Deming
variability management
V. Mikhailchenko and Y. Rubanik

04005 Evaluation of consumer satisfaction with the quality of training of young
professionals by the universities for enterprises of coal-mining complex
V. Mikhailchenko and I. Seredkina

04006 Innovative development of the economy as the most important factor in ensuring the
financial security of the mining region
N. Kudrevatykh, T. Snegireva and A. Tselischeva

04007 Theoretical Foundations of the New Industrialization of the Mining Region under
Globalization
L. Kusurgasheva, O. Nedospasova and E. Zhernov

04008 Problems and Prospects of Sustainable Development of Mining Regions
I. Levitskaya, N. Pastukhova and O. Dubrovskaya

04009 Innovations as borders of stages of coal industry historical development
E. Sigareva, S. Popov, S. Baturin, N. Sidorova and M. Borisova

04010 Using innovative interactive technologies for forming linguistic competence in
global mining education
G. Chistyakova, E. Bondareva, K. Demidenko, E. Podgornaya and O. Kadnikova

- 04011 Technological convergence and innovative development of natural resource economy
F. Agafonov, A. Genin, O. Kalinina, O. Brel and O. Zhironkina
- 04012 Structural problems of mining region innovative development (Kuzbass, Western Siberia)
E. Dotsenko and N. Ezdina
- 04013 Neo-industrialization of Kuzbass economy in innovative development of coal industry and machinery
A. Balabanova, V. Balabanov, E. Dotsenko and N. Ezdina
- 04014 The problems of correlation the life quality and interpersonal dialogue in legal practice of mining regions
V. Zolotukhin, E. Stepantsova, M. Kozyreva, A. Tarasenko and A. Stepantsov
- 04015 Demographic and migration policy in the mining region and its impact on the ecological consciousness of the population
V. Zolotukhin, A. Bel'kov, E. Stepantsova, M. Kozyreva and A. Tarasenko
- 04016 Cross-cultural analysis of the verbal conflict behavior of the graduate mining engineers
I. Pevneva, O. Gavrishina, A. Rolgayzer, M. Agienko and A. Myaskov
- 04017 The impact of human factor on labor productivity at the mining enterprises
G. Pinigina, I. Kondrina, S. Smagina, V. Tatsienko and A. Meshkov
- 04018 Enhancing the Role of Educational Services of Higher Education System in the Competitive Specialists Training for Industry
O. Kuznetsova, S. Kuznetsova, E. Yumaev, V. Kuznetsov and I. Plotnikova
- 04019 Formation and Development of the Training System for Innovative Development of Regional Industry
O. Kuznetsova, S. Kuznetsova, E. Yumaev, V. Kuznetsov and O. Galtseva
- 04020 Evaluating the Effectiveness of Internal Corporate Controls in Coal Mines Illustrated By the Example of JSC "SUEK-Kuzbass"
E. Kucherova, T. Ponkratova, T. Tyuleneva and N. Cherepanova
- 04021 The communication aspect of specialists' professional competence
L. Znikina, N. Mamontova and P. Strelnikov

The development of mining technologies is impossible without innovations in the entire complicated process of extraction of mineral resources, investment in the modernization of mining equipment and the development of human capital. The aim of The 1st Scientific Practical Conference "International Innovative Mining Symposium (in memory of Prof. Vladimir Pronoza)" is to create a platform for international discussion of mining problems by specialists, experts and researchers. Today, the innovative development of mineral resource sector in industrial regions challenges the system of higher mining education. The role of engineering pedagogy is increasing in globalization of mining and engineering humanization.

ISBN: 978-2-7598-9016-3

