

# **Mechanical Engineering, Automation and Control Systems**

Edited by  
Anna Bogdan, Nikita Martyushev and Stepan Bogdan



**TRANS TECH PUBLICATIONS**

# **Mechanical Engineering, Automation and Control Systems**

Selected, peer reviewed papers from the  
International Conference on Mechanical Engineering  
Automation and Control Systems 2014  
(MEACS 2014),  
October 16-18, 2014, Tomsk, Russia

*Edited by*

**Anna Bogdan, Nikita Martyushev and Stepan Bogdan**



**Copyright** © 2015 Trans Tech Publications Ltd, Switzerland

All rights reserved. No part of the contents of this publication may be reproduced or transmitted in any form or by any means without the written permission of the publisher.

Trans Tech Publications Ltd  
Churerstrasse 20  
CH-8808 Pfaffikon  
Switzerland  
<http://www.ttp.net>

Volume 756 of  
*Applied Mechanics and Materials*  
ISSN print 1660-9336  
ISSN cd 1660-9336  
ISSN web 1662-7482

Full text available online at <http://www.scientific.net>

***Distributed*** worldwide by

Trans Tech Publications Ltd  
Churerstrasse 20  
CH-8808 Pfaffikon  
Switzerland

Fax: +41 (44) 922 10 33  
e-mail: [sales@ttp.net](mailto:sales@ttp.net)

and in the Americas by

Trans Tech Publications Inc.  
PO Box 699, May Street  
Enfield, NH 03748  
USA

Phone: +1 (603) 632-7377  
Fax: +1 (603) 632-5611  
e-mail: [sales-usa@ttp.net](mailto:sales-usa@ttp.net)

printed in Germany

## Preface

International Conference on Mechanical Engineering, Automation and Control Systems 2014 (MEACS2014) was held at Tomsk Polytechnic University, Tomsk, Russia on October 16-18, 2014. MEACS2014 is a scientific forum for researchers and students to exchange ideas in the field of mechanical engineering, materials science, automation and control systems as well as for industry professionals to discuss technical issues and its implementation. The topics that have been discussed during the conference are as follows:

- 1 - Integrated Computer Control Systems in Mechanical Engineering
- 2 - Numerical simulation of applied problems
- 3 - Material Science in Mechanical Engineering
- 4 - Mechanical Engineering Processes and Metals Treatment

The main goal of the conference was multidisciplinary approach to solving the problems in the field of mechanics, materials science, control systems and process modeling.

MEACS2014 received more than 250 submissions from different countries. Every submission was reviewed and evaluated on the basis of relevance, originality, technical quality and clarity. The accepted papers were selected for publication in this special issue which covers a wide number of topics including material processing technology, numerical simulation, mechanical engineering etc.

On behalf of Organizing Committee of MEACS2014, we would like to thank the delegates, guests and keynote speakers for their contribution to the success of the conference.

## Committees:

### Technical Program Committee:

**Technical Program Chair:** Prof. *Oleg Stukach*, Tomsk Polytechnic University, Head of Tomsk IEEE Chapter & Student Branch of The Institute of Electrical and Electronics Engineers (IEEE), Russia

**Co-Chair:** *Ovechkin B.B.* – Prof., Dr., Tomsk Polytechnic University, Russia

*Panin V.E.* – Prof., academician, Tomsk Polytechnic University, Russia

*Sevostianov I.* – Prof., New Mexico State University, USA

*Psakhie S.G.* – Prof., Director of Institute of Strength Physics and Materials Science, SB RAN, Russia

*Kupchishin A.I.* – Prof., academician, International Higher Education Academy of Sciences, Kazakhstan

*Popov V.* – Prof., Technical University of Berlin, Germany

*Sodnomdorj Dari* – Prof., Mongolian University of Science and Technology, Mongolia

*Saidaminov Isokhon* – Prof., Dr., Tajikistan University of Technology, Tajikistan

*Uglov V.V.* – Prof., Belarusian State University, Belarus

*Sveshnikov V.K.* – Prof., Russian Academy of Electrotechnical Sciences, Russia

*Pavel Stibor* – Ing, Managing director, Spol. s.r.o. Domist, Czech Republic

*Nguyen Huu Loc* – assoc. prof., Dr., Hcm University Of Technology, Vietnam

*Lisitsyn V.M.* – Prof., Dr., Tomsk Polytechnic University, Russia

### Organizing Committee:

**Organizing Chair:** Prof. *Sonkin M.A.*, Vice-Rector for Research and Innovations, Tomsk Polytechnic University (TPU), Russia

**Co-Chairs:** *Martyushev N.V.*, Ph.D., Tomsk Polytechnic University, Russia

*Bogdan A.M.* – expert, R&D Department, Tomsk Polytechnic University, Russia

*Buhkanchenko S.E.* – Prof., Tomsk Polytechnic University, Russia

*Arlyapov A.Yu.*, Prof., Tomsk Polytechnic University, Russia

*Efremenkov A.B.* – Director of Yurga Institute of Technology, Russia

*Chinakhov D.A.* – Prof., Deputy Director for Science at Yurga Institute of Technology, Russia

*Yagodnikov D.A.* - Bauman Moscow State Technical University, Russia

*Kostikov K.S.* – Deputy Director of Institute of High Technology Physics, Tomsk Polytechnic University, Russia

*Simankin F.A.* – Prof., Tomsk Polytechnic University, Russia

*Knyazeva A.G.* – Prof., Dr., Tomsk Polytechnic University, Russia

*Godymchuk A.Yu.* – Ph.D., Tomsk Polytechnic University, Russia

*Trusova M.E.* – Ph.D., Tomsk Polytechnic University, Russia

*Sorokova S.N.* – Ph.D., Tomsk Polytechnic University, Russia

# Table of Contents

<b>Preface</b>	v
<b>Committees</b>	vi

## Chapter 1: Mechanical Engineering, Processing and Surface Engineering, Metals Treatment, Equipment and Tools

<b>On the Need to Increase Pressure and Flow Rate SCTE in the Grinding Zone</b> V.A. Yashkov.....	3
<b>Analysis of Force Dependences of Diamond Burnishing with Different Types of Burnishing Tools</b> Y.B. Chervach, V.A. Mezentsev, N.E. Galin and A.B. Kim .....	8
<b>Modal Analysis as a Means of Researching the Vibrations in Grinding</b> D.V. Ardashev.....	15
<b>Research on Fracture Mechanics and Dispersed Structure of the Polymeric Composite Materials under Abrasive Processing</b> A.A. Dyakonov and I.V. Shmidt.....	19
<b>Electric Drill Drive with Intermediate Rolling Members Reducer</b> V.S. Korotkov and S.V. Razumov .....	24
<b>Force Analysis of Double Pitch Point Cycloid Drive with Intermediate Rolling Elements and Free Retainer</b> E.A. Efremenkov, E.E. Kobza and S.K. Efremenkova.....	29
<b>Research Methods of Milling Technology Elements</b> A.N. Gavrilin, B.B. Moyzes and A.I. Cherkasov .....	35
<b>Geometric Model of the Interaction of the Grinding Wheel and Workpiece during Surface Grinding with the Periphery of a Straight Wheel</b> A.A. Dyakonov and L.V. Shipulin.....	41
<b>Prospects for Further Rock Cutting Mechanisms Development</b> M.B. Novoseltseva and E.N. Pashkov .....	47
<b>Technical Diagnosis of Internal Combustion Engines in the Parameters of Vibration</b> A.P. Syrbakov and M.A. Korchuganova .....	53
<b>The Effect of Electrolytic Hydrogenation on the Plastic Flow of Aluminum Alloy</b> A.V. Bochkaryova, A.G. Lunev, S.A. Barannikova and L.B. Zuev.....	59
<b>Study of Methods Relating to Increase of Contact Pitting Resistance in 45, 40H, 35HGSA Steel due to Development of Heterogeneous Structure Involving Mechanical Hardening Technique</b> A. Kirichek and S.V. Barinov .....	65
<b>Development of Bases and Evaluation Capabilities of the New Tribotechnology for Plain Bearings</b> V.V. Zelinsky and D.N. Suchilin.....	70
<b>Development of Parameters Describing Heterogeneous Hardened Structure</b> A. Kirichek and S.V. Barinov .....	75

<b>Investigating the Regularities of Surface Roughness Structuring while Processing with Surface Plastic Deformation for Calculation</b>	
I. Telkov .....	79
<b>Determination of the Energy Parameters of the Shock Mechanism Used to Harden the Surface by Plastic Deformation</b>	
A. Kirichek and S.A. Silant'ev .....	85
<b>Dependence of Silicon and Manganese Content in the Weld Metal on the Welding Current and Method of Gas Shielding</b>	
D.A. Chinakhov .....	92
<b>Influence of Power Supply Energy Characteristics upon the Stability of MMA Process</b>	
D.P. Il'yashchenko, D.A. Chinakhov and Y.M. Gotovshchik .....	97
<b>Calculation of the Heat Content of the Electrode Metal Droplet When Applying Power Supplies for Manual Arc Welding with Different Volt-Ampere Characteristic</b>	
D.P. Il'yashchenko, D.A. Chinakhov and Y.M. Gotovshchik .....	101
<b>Diffusion and Mechanical Stresses in a Material with Two-Component Coating at External Heating</b>	
M.V. Chepak-Gizbrekht and A.G. Knyazeva .....	105
<b>Towards Energy Intensity Reduction of Machining Fabrication Procedures</b>	
A.V. Karpov .....	111
<b>Machinability of Calcium Steel in Deep Hole Drilling with Small Diameters Gun Drills</b>	
S.V. Kirsanov and A.S. Babaev .....	116
<b>Study of the Rheological Properties of Materials at the Blade Processing on Example of Milling Nickel-Chromium Alloy 10H11N23T3 MR VD</b>	
A.I. Khaimovich, A.V. Balaykin and N.V. Galkina .....	120
<b>Influence of Chip Formation Characteristics on Flank Contact Load Distribution in Titanium Alloy Cutting</b>	
V. Kozlov and X. Li .....	126
<b>Increasing Efficiency by Applying the Arc Covered-Electrode Welding for Repairing Magnetized Pipelines</b>	
A.S. Kiselev, A.S. Gordynets, R.I. Dedyuh, Y.N. Saraev and V.P. Bezborodov .....	132
<b>Specifics of Welded Joint Destruction Obtained by Friction Stir Welding at Strain</b>	
E. Kolubaev, O. Sizova, A. Zaikina and A. Levihina .....	137
<b>Reduction of Metal Consumption in View of Mining Cutting Tools Operation</b>	
S.A. Prokopenko .....	144
<b>Assessing the Metal Consumption for Manufacturing a Conical Part by Hollow Billet Crimp-Expansion and Sheet Blanks Drawing Crimping</b>	
S. Zvonov and A. Shlyapugin .....	150

## Chapter 2: Material Engineering and Technologies

<b>Thermally Conductive Polymeric Materials and their Usage in LED-Devices</b>	
S.M. Lebedev, O.S. Gefle and E.T. Amitov .....	159

<b>Influence of Crystal Defects on the Reflectivity of the Aluminum</b> S.P. Umnov, O.K. Asainov and A.N. Lemachko.....	164
<b>Copper Removal from Industrial Wastewaters by Natural Clinoptilolite and Mordenite</b> V. Petranovskii, M. Khrepoun, A. Efimov and A. Pestryakov.....	169
<b>Inquiring into Structure of Hyperbranched Polyethylene Produced in Radical Polymerization Process</b> E. Koval, L. Echevskaya, M. Matsko, A. Pestryakov and E. Mayer.....	173
<b>Assumed Mechanism of Polymeric Deposit Formation in Recycle Propylene Washing Column during Bulk Polymerization</b> E. Mayer, A. Trofimova, V. Mashukov and A. Pestryakov.....	179
<b>Modeling of Mechanical Behavior of Ceramic Nanocomposites</b> I.K. Vaganova, E.G. Skripnyak, V.V. Skripnyak and V.A. Skripnyak.....	187
<b>Multiscale Simulation of Porous Quasi-Brittle Ceramics Fracture</b> V.V. Skripnyak, E.G. Skripnyak, V.A. Skripnyak, I.K. Vaganova, A.M. Bragov, A.K. Lomunov and L.A. Igumnov.....	196
<b>Mechanical Behavior of Light Alloys with Bimodal Grain Size Distribution</b> V.A. Skripnyak, E.G. Skripnyak and N.V. Skripnyak.....	205
<b>Influence of Layer-by-Layer Laser Sintering Modes on the Roughness and Thickness of Sintered Layer of Copper Powder</b> N.A. Saprykina, A.A. Saprykin and S.M. Emelyanenko.....	214
<b>Comparison of Activation Technologies Powder ECP-1 for the Synthesis of Products Using SLS</b> E.V. Babakova, A.V. Gradoboev, A.A. Saprykin, E.A. Ibragimov, V.I. Yakovlev and A.V. Sobachkin.....	220
<b>An Application of Spark Plasma Sintering for Compaction of Refractory Oxides and Nitrides</b> S.V. Matrenin, B.B. Ovechkin and R.V. Tayukin.....	225
<b>A Cylindrical Shell Made of Glass-Metal Composite</b> V.V. Pikul, V.K. Goncharuk and I.G. Maslennikova.....	230
<b>Formation of Gradient Multiphase Nanostructured Surface Layers Using the Electron-Ion-Plasma Combined Method</b> Y.F. Ivanov, A.D. Teresov, O.V. Ivanova, V.E. Gromov, E.A. Budovskikh and A.A. Klopotov.....	236
<b>Phase Formation in the Ti-Y-O System Formed Using High-Energy Methods</b> Y.F. Ivanov, E.A. Petrikova, A.D. Teresov, A.A. Klopotov, V.E. Gromov, E.A. Budovskikh, M.P. Kalashnikov and V.D. Klopotov.....	243
<b>Formation of Ceramic Crock Structure Made of Technogenic Raw Materials with Vanadium Component</b> A. Stolboushkin, A. Fomin and O. Stolboushkina.....	250
<b>Development of Composition and Research of Rheological Properties of Thermoplastic Slips on the Basis of Aluminium Nitride</b> A. Ditts, I. Revva, V. Pogrebenkov, Y. Pautova, A. Nazarova, E. Galashov and R. Tarnovskiy.....	257
<b>Hardening of Metallurgical Machinery Components by Facing with Heatproof, Hard Steels and Low Temperature Pre-Heating</b> N.N. Malushin, D.V. Valuev, V.L. Osetkovsky, A.V. Valueva and A. Serikbol.....	263

<b>Volume Self-Sustained Discharge in Atmospheric Pressure Gas with High Pulse Repetition Frequency</b>	
M.V. Zhuravlev, G.E. Remnev and B.G. Shubin .....	269
<b>Production Tribological Behavior Feature of Metallic Nanoparticle Additives</b>	
S.A. Belyaev, N.V. Martyushev and I.V. Belyaeva.....	275
<b>Structure and Properties of Multicomponent Tin Lead Bronzes upon Die-Casting Depending on Pouring Temperature</b>	
A.V. Korchmit, N.V. Martyushev, S.Y. Tarasov and O.S. Kvashnina.....	281
<b>Physical-Mechanical Properties of Corundum-Zirconium Ceramic Obtained by the Technology of Radial Magnetoimpulse Pressing</b>	
S.V. Akarachkin, A.A. Sivkov, A.S. Ivashutenko and N.V. Martyushev .....	286
<b>Influence of Phase Composition on Properties of Corundum-Zirconium Ceramic</b>	
A.S. Ivashutenko, N.V. Martyushev and V.P. Bezborodov.....	293
<b>Oxide Powder Plasma Processing by Low-Energy Ions of Titanium</b>	
E.M. Vodopyanov, A.V. Loginova, A.S. Ivashutenko and N.V. Martyushev.....	299
<b>Structure and Properties of Multicomponent Bronze Depending on the Crystallization Conditions</b>	
A.V. Korchmit and N.V. Martyushev .....	303
<b>Mechanical Properties of Spun Castings of Multicomponent Bronze Depending on the Casting Conditions</b>	
A.V. Korchmit and N.V. Martyushev .....	308
<b>Low-Melting Glass-Ceramic Composites with Low Linear Thermal Expansion Coefficient for Radio-Electronics</b>	
V.M. Pogrebenkov, K.S. Kostikov, E.A. Sudarev, A.V. Elistratova, K.S. Kamyshnaya and T.V. Kolesova .....	313
<b>Phase Composition and Mechanical Properties Modification in Cr/Ti System by Short-Pulsed High Intensity Ion Beams Treatment</b>	
V.I. Shymanski, G.E. Remnev, S.K. Pavlov and V.V. Uglov .....	319
<b>Investigation of Ultradispersed Powders <math>Fe_xO_y</math> Obtained in the Electric Discharge Plasma</b>	
A.A. Sivkov, A.S. Ivashutenko, A.A. Lomakina and I.I. Shanenkov.....	325

### **Chapter 3: Modelling and Numerical Simulation, Algorithms and Mathematical Methods for Applied Problems**

<b>Experimental Studies of Counter Vortex Flows Modeling</b>	
P. Churin, S. Kapustin, G. Orehov and O. Poddaeva.....	331
<b>Gas Injection into Porous Reservoir Partly Saturated by Water</b>	
M.K. Khasanov .....	336
<b>Experimental Study of Forest Fuel Ignition by the Source of Limited Energy Capacity</b>	
N. Baranovskiy and A. Zakharevich.....	342
<b>Finite Element Modeling of Delamination Propagation in Composite Laminates</b>	
Y.V. Skvortsov, S.A. Chernyakin, S.V. Glushkov and S.N. Perov .....	347

<b>Numerical Analysis of Inverse Problems for the Model of Transfer of Industrial Environmental Pollution in the Machine-Building</b>	
O.V. Soboleva and D.V. Mashkov.....	353
<b>Simulation of a Flexible Mirror Performance in the Problem of Adaptive Compensation for Aberrations in an Optical System</b>	
F. Kanev, D. Rytchkov and N. Makenova.....	359
<b>Calculation of Heat Exchange Characteristics Transpiration Cooling Systems</b>	
A.S. Yakimov.....	365
<b>Calculation of Effective Coefficient of Thermal Expansion for Composite ‘Glass-Eucryptite’ Changing during Sintering</b>	
A.G. Knyazeva, O.N. Kryukova and K.S. Kostikov.....	372
<b>Dynamic Susceptibility of a System</b>	
O.M. Gerget, V.A. Kochegurov and E.Y. Titarenko.....	378
<b>An Improvement of the Concept Design Analysis Method by the Use of the Avoidance Function</b>	
A.A. Khamukhin and M.H. Eres.....	382
<b>Dependence of the Effective Diffusion Coefficient of a Matrix Composite on the Size of Inhomogeneities</b>	
M. Anisimova and I. Sevostianov.....	389
<b>Influence of the Shaper Design of Pneumohydraulic Impact Device on the Form and Duration of the Impact Impulse</b>	
O.O. Angatkina, P.Y. Krauinsch and V.N. Deryusheva.....	394
<b>Influence of Method Used for Calculating of Effective Properties on Stressed-Strain State of Composite Plate under Nonstationary Heating</b>	
Y.A. Chumakov and A.G. Knyazeva.....	402
<b>Numerical Simulation of Multilayer Composites Failure under Dynamic Loading</b>	
S.A. Zelepugin and A.S. Zelepugin.....	408
<b>Study of the Effect of the Rolling Mill Inter-Stand Tension on the Strip Gauge Deviation</b>	
A.A. Radionov, I.Y. Andryushin, A.S. Karandaev, V.R. Khramshin and R.R. Khramshin.....	414
<b>Thermo-Physical Model of the Lamellate System Grinding</b>	
I.V. Shmidt and A.A. Dyakonov.....	420
<b>Tessellation Methods for Modeling the Material Structure</b>	
L. Burtseva, F. Werner, B. Valdes, A. Pestryakov, R. Romero and V. Petranovskii.....	426
<b>Optimization Method in 2-D Problems of Material Body Cloaking</b>	
G. Alekseev and A. Lobanov.....	436
<b>Mathematical Modelling of an Arch Tooth Surface as an Envelope</b>	
N.R. Shcherbakov, A.M. Bubenchikov and S.M. Kazakavitschyus.....	442
<b>Model of Automatic Distribution of Topologically Related Objects to Layers in Navigation Systems</b>	
S.V. Ereemeev.....	447
<b>Theoretical and Experimental Study of Led Luminaire</b>	
S.Y. Gurin, B.V. Akimov and B.P. Gritsenko.....	453

<b>The Evolution Equations of Shock Deformation Problems with Plane Surfaces of Discontinuities in Elastic Inhomogeneous Mediums</b>	
V. Ragozina and Y. Ivanova .....	459
<b>Numerical Study of Shock Wave Interaction with Protective Stopping with Regard to the Type of its Setting</b>	
A.E. Baganina, D.Y. Paleev and V.Y. Beglyakov .....	465
<b>Asymptotic Model of Free Convection Flow on a Vertical Surface in Porous Media with Newtonian Heating</b>	
A.A. Bocharova, I.V. Plaksina and A.A. Obushnyy .....	469
<b>Two-Wave Processes in the Magnetic Vibrations of a String</b>	
A.K. Tomilin .....	476
<b>Attenuation of Acoustic Waves in Metal Barriers</b>	
A.E. Baganina, D.Y. Paleev and A.A. Kazantsev .....	482
<b>Comparison of Cable Insulation Control in Weak and Strong Electric Fields</b>	
N.S. Starikova, V.V. Redko and G.V. Vavilova .....	486
<b>Numerical Investigation of Compression Wave Attenuation in Water Barriers</b>	
A.E. Baganina, D.Y. Paleev and M.Y. Blaschuk .....	491
<b>The Synthesis, Designing and Analysis of the Spatial Mechanisms with Imposed Constraints</b>	
A. Fomin .....	495
<b>Organization of Continuous Process Simulation via E-Network</b>	
D. Tarakanov, G. Tcapko, S. Tsapko and I. Savenko .....	500
<b>Numerical Simulation of Neural Network Components of Controlling and Measuring Systems</b>	
S.N. Danilin, M.V. Makarov and S.A. Shchanikov .....	507
<b>Numerical Simulation of High-Speed Orthogonal Cutting of Metals</b>	
A.S. Zelepugin and S.A. Zelepugin .....	513
<b>Buckling Analysis of Stiffened Plates by Ritz Method</b>	
L.M. Savelyev and O.V. Borisova .....	518
<b>Boundary Element Approach in Impedance Cloaking Problem</b>	
A. Baydin and O. Larkina .....	524
<b>The Influence of Grain Form on Effective Diffusion Coefficient of Polycrystalline</b>	
M.V. Chepak-Gizbrekht and A.G. Knyazeva .....	529
<b>Mathematical Modeling of Pulsed Electric-Sintering Powders</b>	
S.N. Sorokova, A.G. Knyazeva, A.I. Pobol and G.G. Goranskyi .....	534
<b>Stressed-Strain State of Multi Layer Foil under One-Axis Tension</b>	
V.N. Demidov and A.G. Knyazeva .....	540
<b>Determination of Effect of Salt Content in Cooling Liquid on the Result of Cable Capacitance per Unit Length Measurement</b>	
M.G. Grigoriev, G.V. Vavilova and N.S. Starikova .....	546
<b>A Simple Method for Solving Dynamic Problems of Robotics</b>	
A.M. Bubenchikov, E.E. Libin and Y.P. Hudobina .....	552
<b>The Method of the Centerless Roundness Measuring with Corrective Adjustment</b>	
O.V. Zakharov, A.V. Korolev, A.A. Korolev and A.V. Kochetkov .....	556

## Chapter 4: Control and Automation Systems, Manufacturing Applications

### Mobile Water Treatment Complex

- A.G. Goryunov, F. Manenti, K.A. Kozin, S.A. Baydali, I.S. Nadezhdin and R.V. Potemin ..... 565

### Method of Control of Object Positioning System and Device Scheme

- V. Kurgankin and V. Zamyatin ..... 571

### Frequency Domain Sensors and Frequency Measurement Techniques

- F.N. Murrieta-Rico, V. Petranovskii, O.Y. Sergiyenko, D. Hernandez-Balbuena, A. Pestryakov and V. Tyrsa ..... 575

### Predictive Inverse Neurocontrol with Recycled Reference Trajectory

- K.V. Zmeu, N.A. Markov, B.S. Notkin and I.A. Shipitko ..... 585

### Improvement of Algorithms for Automatic Gauge Control System of the Hot-Rolling Mill

- A.S. Karandaev, V.R. Khramshin, I.Y. Andryushin, A.G. Shubin and B.M. Loginov ..... 592

### Synthesis of Three-Dimensional Models from Drawings Based on Spectral Graph Theory

- A. Zakharov and A. Zhiznyakov ..... 598

### Production Processes Management by Simulation in Tecnomatix Plant Simulation

- V.V. Kokareva, A.N. Malyhin and V.G. Smelov ..... 604

### On Creation of Energy-Saving Hydraulic Impact Devices

- S. Lazutkin ..... 610

### Measurement of the Current Transfer Function for Power Transducers of Current to Voltage

- P.F. Baranov, V.N. Borikov and E.I. Tsimbalist ..... 615

### Utilization Prospects of Coalbed Methane in Kuzbass

- O.V. Tailakov, D.N. Zastrellov, V.O. Tailakov and A.B. Efremenkova ..... 622

### Multidimensional Fuzzy Control System Development of Oil Transportation and Treatment Technological Processes Based on the Input/Output Parameters Model in the Precise Terms Set Form

- A. Sagdatullin ..... 626

### Intellectual Control of Oil and Gas Transportation System by Multidimensional Fuzzy Controllers with Precise Terms

- A. Sagdatullin, A. Emekeev and E. Muravyova ..... 633

### Adaptive Structural Reconfigurable Algorithms of Control

- S.V. Shidlovskiy and V.I. Syryamkin ..... 640

### Development of a Combined Algorithm for Request Distribution Using Multi-Objective Optimization Methods

- A.O. Igumnov, D.M. Sonkin and S.A. Khrul ..... 646

### Developing a Procedure for Technical Status Control of a Turbine Compressor Package Blades

- Y. Klochkov, L. Papic, I. Vasileva and A. Gazizulina ..... 652

**Determination of Cutting Forces in Oblique Cutting**

A.V. Filippov and E.O. Filippova ..... 659

**Chapter 5: Image and Signal Processing, Recognition, Information Processing and Applied Technologies****Object's Border and Position Allocating in an X-Ray Image**

I.V. Tsapko and A.V. Vlasov ..... 667

**Benchmark for FFT Libraries**

S. Chilingaryan, A. Shkarin, R. Shkarin, M. Vogelgesang and S. Tsapko ..... 673

**Imaging Based on Signal from Side-Scan Sonar**

I.V. Prokhorov and A.A. Sushchenko ..... 678

**Adaptive Neuro-Fuzzy Recognition Technology Intersecting Objects**

S. Gorbachev and V. Syryamkin ..... 683

**Development of a Neuronetwork Component for Technical Systems of Mechanical Engineering**

S.N. Danilin, M.V. Makarov and S.A. Shchanikov ..... 689

**Application of Convolutional Neural Networks for Automatic Number Plate Recognition on Complex Background Images**

A.A. Druki, J.A. Bolotova and V.G. Spitsyn ..... 695

**Use of Local Characteristics of Self-Similarity of Digital Images for Solving the Problems of Crack Detection**

A.L. Zhiznyakov and D.G. Privezentsev ..... 704

**Expert Evaluation of the Quality of the Development of New Technics' Samples: Experience in the Development of a New Kind of Multipurpose Shield-Type Heading Machine**

D. Nesteruk, M. Momot, V. Beglyakov and E. Politsinskaya ..... 709

**Mobile Devices for Plants Models Obtaining with the Possibility of Data Transition (by Ethernet)**

I.O. Ilyin, A.V. Kudryavtsev and V.A. Onufriev ..... 714

**Keyword Index** ..... 719**Author Index** ..... 725

## **CHAPTER 1:**

# **Mechanical Engineering, Processing and Surface Engineereng, Metals Treatment, Equipment and Tools**



# On the Need to Increase Pressure and Flow Rate SCTE in the Grinding Zone

Yashkov V.A.

<sup>1</sup>Murom Institute of Vladimir State University, Orlovskaya Street, 602264, Murom, Russia  
zirjd@mail.ru

**Keywords:** Grinding, mathematical modeling, the temperature.

**Abstract.** This work describes the hydrodynamic phenomena in internal grinding team's abrasive wheels with radially movable segments.

## Introduction

One of the most pressing problems in modern engineering is the high-abrasion holes of machine parts (e.g. cylinders), the surface layer of which should meet the highest standards. The processing of the holes with the help of abrasive tools is connected with a number of difficulties arising primarily due to the complexity of supplying coolant technological environment (SCTE) in the cutting zone through a narrow gap between the wheel and the workpiece under the action of strong wind flows generated by a rotating tool. This leads to a decrease in processing performance because of the danger of thermal defect formation in the surface layers of ground parts.

## Discussion

The basic ways of increasing the productivity of the tool for grinding holes are the intensification of cutting and increasing the contact area of a circle with the workpiece.

The traditional scheme of internal grinding with the abrasive wheel eccentrically positioned in relation to a solid billet does not allow to ensure the qualitative increase in productivity due to restrictions imposed by the complexity of the supply coolants in the processing area, a small contact area of a circle and the workpiece, the complexity of a substantial intensification of cutting without grinding born in the processed pieces and growing imbalance of tools reducing the accuracy of processed holes.

Therefore, increasing the productivity of the tool for internal grinding by increasing the contact area of the circle and the workpiece and creating conditions for a reliable income of SCTE in the cutting area is promising.

The analysis of scientific technical and patent literature led to the conclusion that the most effective way of internal grinding is a method of centrifugal grinding with the help of the tool with prefabricated radial sliding abrasive segments [1] (Fig. 1).

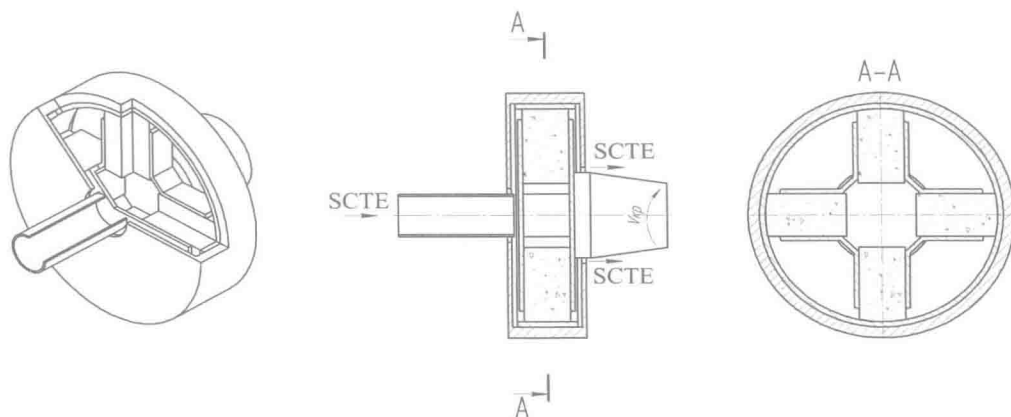


Figure 1. The method of centrifugal grinding with the help of the tool with prefabricated radial sliding abrasive segments

The described method of grinding presupposes that with the help of the precast abrasive tool with a radially movable segments is placed coaxially with two of workpieces (3), flow-organizing capacity of segments 4, 5 for coolants. The liquid is fed through the left hole in lid 6 and discharged through the larger hole on the right-side tank cover (5). When the tool is rotating, coolants accelerate and form rotating-liquid ring, cooling and washing the workpiece effectively. The well-known works recorded the average pressure coolants in the working area reaching 1.3 MPa.

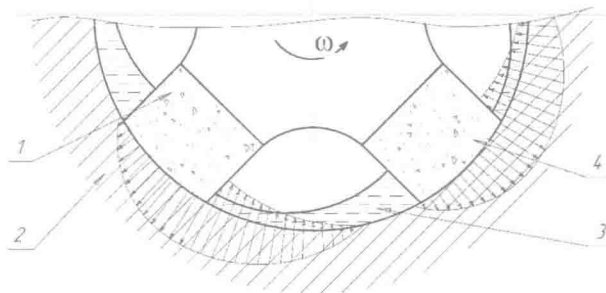


Figure 2. The scheme of heat transfer between the abrasive segments, the workpiece and the cutting fluid

From the viewpoint of heat transfer, the scheme of internal grinding with the abrasive wheel can be represented in the following diagram (Figure 2): abrasive segments 1 and 4 moving one after another produce heat spreading in the workpiece 3 and 4 SCTE. Because of the Peclet criterion ( $Pe = 5.38 \cdot 10^4$ ) abrasive segments 1 and 4 are fast-moving sources of heat spreading to the processed part and SCTE [2]. In this case lowering the temperature of the workpiece in accordance with Newton – Richman's law describes the process of heat exchange between the workpiece and cutting fluids as follows (1)

$$(T_s - T_{scte}) = \frac{q}{\alpha} \quad (1)$$

where  $q$  ( $W/m^2$ ) is the heat flux density,  $\alpha$  ( $W/m^2K$ ) is a heat transfer coefficient defined by the formula (2)

$$\alpha = 6 \cdot 10^4 V^{0.8} \quad (2)$$

where  $T_s$  is the temperature of the detail and  $T_{scte}$  is the temperature of coolants.