



University of Banja Luka  
Faculty of Mechanical Engineering  
26<sup>th</sup> - 28<sup>th</sup> May 2011

# DEMI 2011

*10<sup>th</sup> Anniversary International Conference  
on Accomplishments in  
Electrical and Mechanical Engineering and  
Information Technology*

# PROCEEDINGS

ZBORNIK RADOVA

BANJA LUKA, May 2011.



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**PROCEEDINGS OF THE 10<sup>th</sup> ANNIVERSARY INTERNATIONAL CONFERENCE ON  
ACCOMPLISHMENTS IN ELECTRICAL AND MECHANICAL ENGINEERING AND  
INFORMATION TECHNOLOGY**

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# CONTENT

<b>KEYNOTE LECTURES</b> .....	<b>1</b>
1. Claudio R. Boër SUSTAINABLE INNOVATION AND INNOVATION FOR SUSTAINABILITY: THE EVOLUTION AND INVOLUTION OF PRODUCTION PARADIGMS .....	3
2. Giambattista Ravano COOPERATION MODELS BETWEEN UNIVERSITIES AND INDUSTRY IN APPLIED RESEARCH, SWITZERLAND CASE STUDY AND SOME PRACTICAL EXAMPLES .....	5
3. Radivoje Pešić, Stevan Veinović TRANSPORT ECOLOGY AND GLOBAL CLIMATE CHANGE .....	7
4. Milosav Ognjanović DESIGN CONSTRAINTS AND ROBUST DESIGN AS THE MODERN APPROACH TO MECHANICAL STRUCTURE DEVELOPMENT DESIGN CONSTRAINTS AND ROBUST DESIGN AS THE MODERN APPROACH TO MECHANICAL STRUCTURE DEVELOPMENT .....	21
5. Neven Duić RENEWABLE ENERGY AS A DRIVER OF ECONOMIC GROWTH .....	35
6. Stojan Petrović, Božidar Nikolić, Emil Hnatko, Jovo Mrđa, Stevan Veinović MALICIOUS ECOLOGY ON VEHICLES AND TRAFFIC EXAMPLE .....	55
<b>A. MECHANICS AND DESIGN</b> .....	<b>57</b>
7. Michail Leparov, Georgi Dinev, Marieta Jancheva ABOUT RECEIPTS OF VARIANTS OF TECHNICAL OBJECTS .....	59
8. Leparov M., Yancheva M. ABOUT THE INTEGRATION OF ASSEMBLY UNITS .....	65
9. Darko Knežević, Aleksandar Milašinović, Zdravko Milovanović ANALYSIS OF INFLUENCE OF LENGTH OF DEVELOPMENT OF BOUNDARY LAYER ON FLOW RATE THROUGH RADIAL CLEARANCE WITHIN HYDRAULIC CONTROL COMPONENTS .....	71
10. Nebojša Radić, Goran Sekulić, Dejan Jeremić ANALYTICAL-NUMERICAL STRESS ANALYSIS OF SPUR GEARS WITH STRAIGHT TEETH .....	77
11. Georgy Dinev, Marieta Yancheva CAD DESIGN OF FLEXIBLE FRICTION COUPLING .....	83
12. Dragan Lišanin, Marinko Petrović, Nenad Grujović, Jelena Borota COMPARATIVE ANALYSIS OF THE FORMATION OF SMALL GRAIN GUIDANCE .....	87
13. Pavle Stepanić, Željko Đurović, Aleksa Krošnjar, Aleksandra Pavasović COMPARISON OF TECHNIQUES FOR DETECTION OF FAILURE ROLLING ELEMENT BEARINGS .....	93
14. Strain Posavljak, Miodrag Jankovic, Katarina Maksimovic CRACK INITIATION LIFE OF NOTCHED METALLIC PARTS EXPOSED TO LOW CYCLE FATIGUE .....	99

15	Srđan Bošnjak, Zoran Petković, Miloš Đorđević, Nebojša Gnjatović, Nenad Zrnić DESIGN IMPROVEMENTS OF THE BUCKET WHEEL WITH DRIVE .....	111
16.	Aleksandar Marinković, Aleksandar Čočić, Bratislav Stojiljković, Milan Vulićević DESIGN OF TESLA-TIFFANY CASCADE FOUNTAIN AS A SAMPLE OF TESLA`S RESEARCH CREATIVITY IN FIELD OF MECHANICAL ENGINEERING .....	117
17.	Svetislav Lj. Marković DESIGN SEALS FOR REAL CONNECTIONS .....	123
18.	Valentina Golubović-Bugarski, Drago Blagojević, Đorđe Čiča, Branislav Sredanović DETECTION OF STRUCTURAL DAMAGE LOCATION USING FREQUENCY RESPONSE FUNCTION DATA .....	129
19.	Dragi Stamenković, Mato Perić DETERMINATION OF RESIDUAL STRESSES IN TUBULAR WELDED STRUCTURAL COMPONENTS .....	135
20.	Živko Pejašinić, Zorana Tanasić, Goran Janjić EFFECT OF MATERIAL PROPERTIES OF MEASURING FORCE TRANSDUCER ELASTIC ELEMENTS TO METROLOGIY CHARACTERISTICS .....	145
21.	Siniša Kuzmanović, Milan Rackov EVALUATION OF CONCEPTUAL SOLUTIONS OF UNIVERSAL HELICAL TWO STAGE GEAR UNITS .....	151
22.	Ivica Čamagić, Nemanja Vasić, Zijah Burzić FATIGUE ANALYSIS FROM FRACTURE MECHANICS ANGLE .....	159
23.	Slobodanka Boljanović, Stevan Maksimović, Strain Posavljak FATIGUE LIFE ESTIMATION OF CRACKED STRUCTURAL COMPONENTS .....	165
24.	Ibrahim Badžak, Remzo Dedic, Mersida Manjgo HYDRAULIC INSTALLATION OF EKO CONTAINER .....	173
25.	Vesna Ranković, Nenad Grujović, Goran Milovanović, Dejan Divac, Nikola Milivojević PREDICTION OF DAM BEHAVIOUR USING MULTIPLE LINEAR REGRESSION AND RADIAL BASIS FUNCTION NEURAL NETWORK .....	179
26.	Nenad Zrnić, Srđan Bošnjak, Vlada Gašić, Miodrag Arsić SOME ASPECTS IN FAILURE ANALYSIS OF CRANES .....	185
27.	Stevan Maksimović, Ivana Vasović, Mirko Maksimović SOME ASPECTS TO DESIGN OF AIRCRAFT STRUCTURES WITH RESPECTS TO FATIGUE AND FRACTURE MECHANICS .....	191
28.	Andrija Vujičić, Nenad Zrnić STATE-OF-THE-ART IN LIFE CYCLE ASSESSEMENT AS A CORE OF LIFE CYCLE DESIGN .....	203
29.	Mersida Manjgo, Ljubica Milović, Zijah Burzić STRESS INTENSITY FACTOR AND ITS EFFECT OF STRUCTURAL INTEGRITY .....	209
30.	Vukojević Nedeljko, Hadžikadunić Fuad, Pavić Mate VIBRATORY STRESS RELIEVING OF TANK FLANGS .....	215

31.	Ranko Antunovic VIBRODIAGNOSTICS OF ROTATION MACHINES .....	221
<b>B. PRODUCTION TECHNOLOGIES AND ENGINEERING .....</b>		<b>229</b>
32.	Kramar D., Soković M., Kopač J. ADVANCED CUTTING TECHNOLOGY – HIGH-PRESSURE JET ASSISTED MACHINING .....	231
33.	Milan Milovanović, Milentije Stefanović ANALYSIS OF THE EFFECTS OF APPLYING NEW MATERIALS .....	241
34.	Tomasz Kudasik, Tadeusz Markowski, Olimpia Markowska, Sławomir Miechowicz APPLICATION OF RAPID PROTOTYPING RESINS FOR PHOTOELASTIC TESTING .....	247
35.	Slavica Cvetković AUDITING PROCESS DESIGN COMPANY LOGISTICS SYSTEM .....	253
36.	Andonovic Vladan, Vrtanoski Gligorce CAD/CAM TECHNOLOGY IN DENTAL MEDICINE .....	259
37.	Zoran Janjuš, Aleksandar Petrović, Aleksandar Jovović, Radica Prokić-Cvetković, Predrag Ilić CHANGES VOLTAGE COMPACTION POLYPROPYLENE FILLED WITH GLASS POWDER .....	265
38.	Miletic Ostoja, Todić Mladen CHANGING THE WALL THICKNESS PROFILE IN THE PROCESS OF PROFILING .....	271
39.	Plavka Skakun, Miroslav Plančak, Dragiša Vilotić, Mladimir Milutinović, Dejan Movrin, Ognjan Lužanin COMPARATIVE INVESTIGATION OF DIFFERENT LUBRICANTS FOR BULK METAL FORMING OPERATIONS .....	275
40.	Borislav Kovljenić COMPLEXITY ANALYSIS OF CAD/CAM SYSTEMS INTEGRATION IN ERP BUSINESS ENVIRONMENT .....	281
41.	S. Aleksandrović, T. Vujinović, M. Stefanović, V. Lazić, D. Adamović COMPUTER CONTROLLED EXPERIMENTAL DEVICE FOR INVESTIGATIONS OF TRIBOLOGICAL INFLUENCES IN SHEET METAL FORMING .....	285
42.	Radu Alexandru Roșu, Viorel Aurel Șerban, Mihaela Popescu, Uțu Dragoș Cosmin Locovei DEPOSITION OF TITANIUM NITRIDE LAYERS BY REACTIVE PLASMA SPRAYING .....	291
43.	Sławomir Miechowicz, Tadeusz Markowski, Tomasz Kudasik, Olimpia Markowska DESIGN AND FABRICATION OF MEDICAL MODELS WITH RAPID PROTOTYPING TECHNIQUES AND VACUUM CASTING .....	297
44.	Djordje Vukelic, Branko Tadic, Janko Hodolic, Igor Budak, Milovan Lazarevic DEVELOPMENT AN EXPERT SYSTEM FOR MACHINING FIXTURE DESIGN .....	303
45.	Bogdan Nedić, Gordana Globočki-Lakić DEVELOPMENT MODEL FOR CONTROL METAL CUTTING PROCESS .....	309



46.	Aurel Prstić, Zagorka Acimović-Pavlović, Zvonko Gulišija, Mirjana Stojanović DEVELOPMENT OF EPC PROCESS FOR MANUFACTURING PARTS IN AUTOMOTIVE INDUSTRY .....	315
47.	Obućina Murčo, Škaljić Nedim, Smajić Selver EFFECT OF SURFACE ROUGHNESS ON WOOD ADHESION .....	321
48.	M. Stefanović, D. Vilotić, M. Plančak, S. Aleksandrović, Z.Gulisija, D. Adamović FORMING LIMIT INDICATORS IN METAL FORMING .....	327
49.	Runčev Dobre, Gligorče Vrtanoski, Ljupčo Trpkovski HEATED TOOL BUTT WELDING OF POLYETHYLEN PIPES .....	337
50.	Marija Mihailović, Aleksandra Patarić, Zvonko Gulišija, Miroslav Sokić INCREASING PRODUCTION EFFICIENCY THROUGH CASTING QUALITY IMPROVING BY ELECTROMAGNETIC FIELD APPLYING .....	343
51.	Zorana Tanasić, Goran Janjić, Bobrek Miroslav, Živko Pejašinić INFLUENCE OF ORGANIZATIONAL CULTURE ON BUSINESS PERFORMANCE .....	349
52.	Robert Molnar, Drago Soldat INNOVATION-THE KEY FACTOR IN ENTREPRENEURIAL CYCLES .....	355
53.	Vid Jovišević, Stevo Borojević, Gordana Globočki-Lakić, Branislav Sredanović LABORATORIES UNDER REQUIREMENTS OF DIRECTIVES AND STANDARDS OF EUROPEAN UNION .....	361
54.	Sanja Petronic, Andjelka Milosavljevic, Biljana Grujic, Radovan Radovanovic Radmila Pljakic LASER SHOCK PEENING OF N-155 SUPERALLOY EXPOSED TO AGGRESSIVE MEDIUM .....	367
55.	Bogdan Marić, Ranko Božičković LEAN CONCEPT TOOLS IN PROCESS OF TECHNICAL SYSTEMS OVERHAUL .....	373
56.	Ranko Radonjić, Milan Šljivić, Živko Babić, Milentije Stefanović NUMERICAL SIMULATION OF HOLE FLANGING OF CIRCULAR SHEETS ..	379
57.	Dejan Lukić, Velimir Todić, Mijodrag Milošević, Goran Jovičić ONE APPROACH TO THE DEVELOPMENT AND IMPLEMENTATION OF FLEXIBLE MANUFACTURING SYSTEMS .....	385
58.	Milentije Stefanović, Srbislav Aleksandrović, Dragan Adamović PAPER ABOUT PAPERS IN THE AREA OF METAL FORMING PRESENTED AT <i>DEMI</i> CONFERENCES HELD SO FAR .....	391
59.	Todic Mladen, Miletic Ostoja POSITION OF THE NEUTRAL SURFACE DEFORMATION AT BENDING TWO LAYER COMPOSITES .....	399
60.	Milena Cosić, Zagorka Acimović-Pavlović, Zvonko Gulišija, Mirjana Stojanović, Zoran Janjušević POSSIBILITY TO USE RHEOCASTING PROCESS FOR MANUFACTURING PARTS IN AUTOMOTIVE INDUSTRY .....	405
61.	Zvonko Gulišija, Marija Mihailović, Aleksandra Patarić, Zoran Janjušević PROPERTIES OF THE WROUGHT AI ALLOY 7075 OBTAINED BY ELECTROMAGNETIC CASTING PROCESS .....	409
62.	Vrtanoski Gligorce, Andonovic Vladan RAPID TECHNOLOGY IN DENTAL BIOMECHANICS .....	413



63.	Stevo Borojević, Vid Jovišević, Gordana Globočki-Lakić, Đorđe Čiča, Branislav Sredanović, Marko Radisavljević SELECTION OF VARIANT FOR MATERIAL FLOW TYPE IN CONDITIONS OF GROUP APPROACH USING THE SOFTWARE SYSTEM TECNOMATIX PLANT SIMULATION .....	419
64.	Velimir Todić, Dejan Lukić, Mijodrag Milošević, Jovan Vukman TECHNOLOGICAL BASIS FOR THE DEVELOPMENT AND IMPLEMENTATION OF FLEXIBLE MANUFACTURING SYSTEMS .....	427
65.	Goran Janjić, Predrag Nagraisalović, Zorana Tanasić, Miroslav Bobrek, Živko Pejašinić THE PROCESS OF MEASURING EQUIPMENT MANAGEMENT AND ITS AUTOMATIZATION .....	433
66.	S. Mazzola, P. Pedrazzoli, G. Dal Maso, C. R. Boër VIRTUAL ENVIRONMENT PLATFORM FOR INDUSTRIAL OPERATION AND MAINTENANCE .....	441
<b>C. THERMOTECNIQUE AND ENERGETICS .....</b>		<b>447</b>
67.	Nataša Soldat, Mirjana Radišić BASIC ASPECTS OF DEFINING MECHANICAL-TECHNOLOGICAL SOLUTIONS FOR THE PRODUCTION OF BIOGAS FROM LIQUID MANURE	449
68.	Crnojević C., Lečić M. DETERMINATION OF PRESSURE DROP TWO-PHASE FLOW OIL AND GAS FOR ISOTHERMAL FLOW IN HORIZONTAL PIPELINE .....	453
69.	Igor Andreevski, Gligor Kanevče, Ljubica Kanevče, Aleksandar Markoski, Sevde Stavreva DEVELOPMENT AND APPLICATION OF REGULATORY DISPERSION MODEL FOR AIR POLLUTION ASSESSMENT .....	459
70.	Gordana Tica, Veljko Đuričković, Petar Gvero DIMENSIONING OBJECT'S COOLING SYSTEM FOR PREDETERMINED KNOWN RELIABILITY .....	465
71.	Mića Vukić, Velimir Stefanović, Predrag Živković, Mirko Dobrnjac EXPERIMENTAL INVESTIGATION OF THERMAL AND FLOW PROCESSES IN SHELL AND TUBE HEAT EXCHANGERS .....	475
72.	Popov G., Klimentov Kl., Kostov B. INVESTIGATION OF THE ENERGY CONSUMPTION IN REGULATING THE FLOW RATE OF PUMP SYSTEMS .....	481
73.	Đorđe S. Čantrak, Slavica S. Ristić, Novica Z. Janković LDA, CLASSICAL PROBES AND FLOW VISUALIZATION IN EXPERIMENTAL INVESTIGATION OF TURBULENT SWIRL FLOW .....	489
74.	Popov G., Klimentov Kl., Kostov B. METHODS TO ESTIMATE THE ENERGY CONSUMPTION IN REGULATING THE FLOW RATE OF PUMP SYSTEMS .....	495
75.	Majid Soleimaninia NUMERICAL INVESTIGATION OF HEAT TRANSFER ENHANCEMENT IN NATURAL CONVECTION AND FORCED CONVECTION IN A FLUID SATURATED VARIABLE POROSITY MEDIUM .....	501

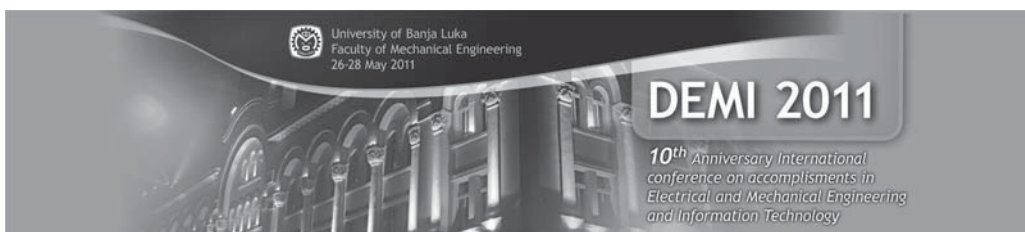
76.	Milica Grahovac OBJECTIVE FUNCTION DEFINITION FOR PRIMARY HVAC SYSTEM TOTAL COSTS MINIMIZATION .....	515
77.	Diana Alina Bistran, Manuela Pănoiu, Tihomir Latinović, Marcel Topor PARALLEL SOLUTIONS TO ACCELERATE MATHEMATICAL ALGORITHMS IN HYDRODYNAMIC STABILITY PROBLEMS .....	523
78.	Sevde Stavreva, Marko Serafimov, Igor Andreevski REDUCING CONSUMPTION OF ENERGY OF DATA CENTERS .....	533
79.	N. Manić, V. Jovanović, D. Stojiljković RESULTS OF EXPERIMENTAL INVESTIGATION OF PELLET STOVE ACCORDING TO EN 14875 .....	539
80.	Mirjana Radišić, Nataša Soldat SOME EXPERIENCES IN THE PRODUCTION OF BIOGAS FROM LIQUID MANURE .....	549
81.	Aleksandar Stjepanović, Slađana Stjepanović, Ferid Softić, Zlatko Bundalo TEMPERATURE CHARACTERISTICS OF PHOTOVOLTAIC MODULE .....	555
82.	Predrag Živković, Gradimir Ilić, Mirko Dobrnjac, Mladen Tomić, Žana Stevanović, WIND POTENTIALS ASSESMENT IN COMPLEX TERRAIN .....	561
83.	Ljubo Glamočić WIND POWER RESOURCES IN THE REPUBLIC OF SRPSKA .....	567
84.	Milovan Kotur, Gostimir Radić COVENANT OF MAYORS FORESEEN ACTIVITIES AT DISTRICT HEATING COMPANY – TOPLANA A.D. BANJA LUKA .....	575
85.	Milovan Kotur, Branko Usorac, Petar Gvero, Gordana Tica PARTIAL REPLACING HEAVY FUEL OIL WITH BIOMASS IN THE DISTRICT HEATING COMPANY IN GRADIŠKA .....	581
86.	Milovan Kotur, Zoran Knežević, Petar Gvero, Gordana Tica BIOMASS PROJECT IN DISTRICT HEATING COMPANY (DHC) IN PRIJEDOR, BIH .....	587
<b>D. TRAFFIC MEANS .....</b>		<b>593</b>
87.	Stojan Petrović, Božidar Nikolić, Emil Hnatko, Jovo Mrđa, Stevan Veinović MALICIOUS ECOLOGY ON VEHICLES AND TRAFFIC EXAMPLE .....	595
88.	Zlatomir Živanović, Zoran Jovanović, Željko Šakota A COMPARATIVE ANALYSIS OF CNG AND HYBRID BUSES VS DIESEL BUSES .....	607
89.	Milan Milovanović, Dragoljub Radonjić, Saša Jovanović ADJUSTMENTS OF VEHICLES WITH GAS DRIVE .....	613
90.	Dalibor Jajcevic, Raimund Almbauer APPLICATION OF A CYCLIC BOUNDARY CONDITION FOR CFD SIMULATIONS OF A 2-CYLINDER IC-ENGINE .....	619
91.	Melisa Velic, Semir Mulalic, Adnan Pecar CALCULATING THERMODYNAMIC PROPERTIES BY CREATING AND USING MODEL OF A DIESEL ENGINE WITH SIX CYLINDERS .....	627

92.	Mile Raičević, Miroslav Demić, Nebojša Rako, Predrag Milenković DETERMINING THE DURATION OF VIBRATION MEASUREMENTS OF HUMAN BODY IN LABORATORY CONDITIONS BY SUBJECTIVE METHODS .....	633
93.	Miroljub Tomić, Stojan Petrović, Slobodan Popović, Nenad Miljić DUAL PORT INDUCTION SYSTEM FOR DMB 1.4 MPI ENGINE .....	651
94.	Blažević A., Bibić Dž., Filipović I. FUNCTION AND ADOPTION OF IC ENGINES DUAL MASS FLYWHEEL .....	661
95.	Jelena Eric Obucina, Jovanka Lukic HYDRAULIC PUMP IN THE OF VEHICLE STEERING SYSTEM .....	667
96.	Aleksandar Davinić, Radivoje Pešić, Dragan Taranović, Miroslav Ravlić IGNITION SYSTEM OF MULTIPROCESSING OTTO/DIESEL ENGINE .....	673
97.	Filipović I., Milašinović A., Blažević A., Pecar A. IMPACT OF THE SPECIFIC ABSORBERS ON THE DYNAMIC LOAD OF THE IC ENGINE'S CRANKSHAFT .....	681
98.	Jasna Glišović, Jovanka Lukić, Danijela Miloradović IMPROVEMENTS OF GROUND VEHICLES FUEL ECONOMY USING REGENERATIVE BRAKING .....	687
99.	Predrag Živković, Mladen Tomić, Gradimir Ilić, Mirko Dobrnjac, Vladimir Lazović, INFLUENCE OF TRAFFIC ON AIR QUALITY IN NIŠ .....	693
100.	Boran Pikula, Ivan Filipović, Mirsad Trobradović INVESTIGATION OF DYNAMICS CHARACTERISTICS OF HYBRID VEHICLES .....	699
101.	Vladan Ivanovic, Decan Ivanovic, Vladimir Pajkovic LANDFILL GAS AS A FUEL FOR A VEHICLE FLEET FOR THE CITY LANDFILL .....	705
102.	Jovanka Lukić, Radivoje Pešić, Dragan Taranović NVH INVESTIGATION OF POWER STEERING SYSTEM HYDRAULIC PUMP .....	711
103.	Vojislav B. Krstić, Božidar V. Krstić, Vukić N. Lazić POSSIBILITY OF DETERMINATION THE ROUTES FOR TRANSPORTATION OF HAZARDOUS GOODS ON THE BASIS OF THE RISK LEVEL .....	717
104.	Božidar V. Krstić, Vojislav B. Krstić, Ivan B. Krstić POSSIBILITIES DETERMINATION OF THE OPTIMAL STRATEGY FOR PREVENTIVE MAINTENANCE OF THE CARDAN SHIFT VEHICLE USING POLYCRITERION OPTIMIZATION .....	723
105.	Pikula Boran, Filipovic Ivan, Kepnik Goran RESEARCH OF THE EXTERNAL AERODYNAMICS OF THE VEHICLE MODEL .....	731
106.	Vladimir R. Pajković ROAD TRAFFIC SAFETY PERFORMANCE IN MONTENEGRO .....	739
107.	Dobrivoje Ninkovic SURVEY OF METHODS FOR CALCULATING THE WAVE ACTION IN THE MANIFOLDS OF INTERNAL COMBUSTION ENGINES .....	745
108.	Dragan Taranovic, Radivoje Pesic, Jovanka Lukic, Aleksandar Davinic TEST BENCH FOR NON-STANDARD MEASUREMENT CHARACTERISTICS OF RECIPROCATING COMPRESSOR .....	759

109.	Branislav Aleksandrović, Rajko Radonjić, Marko Đapan, Aleksandra Janković THE RESEARCH OF CORRELATIONS BETWEEN MOTORCYCLE OSCILLATORY PROCESSES DURING THE NONSTEADY MODES OF MOTION .....	765
110.	Izudin Delić, Izet Alić TRENDS IN DEVELOPMENT OF CATALYTIC CONVERTER OF INTERNAL COMBUSTION ENGINES (ICE) .....	771
111.	Pantelija Dakić, Sreten Perić MONITORING OIL FOR LUBRICATION OF TRIBOMECHANICAL ENGINE ASSEMBLIES .....	777
<b>E. MECHATRONICS .....</b>		<b>793</b>
112.	Milan Paripović ANALYSES THE DAMAGE CAUSED BY ATMOSPHERIC DISCHARGE AND OVERVOLTAGE PROTECTION .....	795
113.	Slaviša Todorović, Miroslav Rogić AUTOMATION AND OPTIMIZATION OF PROJECT OPERATIONS IN THE BRIDGE CRANE DESIGN PROCESS .....	801
114.	Corina Daniela Cunțan, Ioan Baci, Loredana Ghiorghioni DC STABILIZER WITH DIGITAL CONTROL .....	807
115.	Marija Milićević, Vladimir Kaplarevic, Zoran Dimić, Vojkan Cvijanović, Mirko Bučan DEVELOPMENT OF DISTRIBUTED CONTROL SYSTEM FOR ROBOTS CONTROL BASED ON REAL-TIME LINUX PLATFORM .....	813
116.	Miroslav Rogić, Bojan Knežević, Branislav Ristić DEVELOPMENT OF THE CONCEPT OF INTERACTIVE EDUCATION IN MECHATRONICS .....	819
117.	Ivan B. Krstić, Božidar V. Krstić, Dragan I. Milosavljević EFFECTIVENESS DETERMINATION OF ELECTRONIC DEVICES PREVENTIVE MAINTENANCE .....	825
118.	Mihailo P. Lazarević, Vasilije Vasić, Aleš Hace, Karel Jezernik FURTHER RESULTS ON MODELING, INTEGRATED DESIGN AND SIMULATION OF A MECHATRONIC SYSTEM WITH FPGA .....	831
119.	Miroslav Grubišić, Snježana Rezić IMPACT OF SENSOR FAILURE ON WORK OF ELECTRONICALLY CONTROLLED DIESEL ENGINES .....	837
120.	Miroslav Kostadinović, Zlatko Bundalo, Dušanka Bundalo IMPLEMENTATION OF PLANTWEB ALERTS IN A DELTAV SYSTEM .....	843
121.	Vahid Bagher Poor, Majid Hashemipour IMPLEMENTATION OF RFID TECHNOLOGY AND SMART PARTS IN WIRELESS MANUFACTURING SYSTEMS .....	849
122.	Tihomir Latinovic, Sorin I Deaconu, Remiquez Labudski, Marcel Topor INTELLIGENT APPROACH FOR MOBILE ROBOT SIMULATOR WITH ROBOSIM SOFTWARE .....	857

123. Milutinovic D., Glavonjic M., Slavkovic N., Kokotovic B., Milutinovic M., Zivanovic S., Dimic Z. MACHINING ROBOT CONTROLLED AND PROGRAMMED AS A MACHINE TOOL .....	863
124. Vladimir Kaplarević, Marija Milićević, Jelena Vidaković, Vladimir Kvrđić NEW APPROACH FOR REDSIGNING ROBOT PROGRAMING SYSTEM BASED ON L-IRL PROGRAMING LANGUAGE .....	873
125. Kostic Aleksandra, Velic Melisa, Bektesevic Jasmin PRACTICAL STRATEGIES FOR STABILISATION OF ALGORITHMS BASED ON SECULAR EQUATIONS OF RSPDTM .....	877
126. Platon Sovilj, Nenad Čabrilo, Vladimir Vujičić, Ivan Župunski REMOTE MEASUREMENTS BY ZIGBIT WIRELESS MODULE .....	885
127. K. Abhary, D. Djukic, H-Y. Hsu, Z. Kovacic, D. Mulcahy, S. Spuzic, F. Uzunovic SOME ASPECTS OF KNOWLEDGE ENGINEERING .....	893
128. Nenad Miloradović, Rodoljub Vujanac, Blaža Stojanović STACKING AISLE WIDTH FOR FORKLIFT TRUCKS IN PALLETIZED STORAGE AND HANDLING SYSTEMS .....	899
129. Mihajlo J. Stojčić, Bojan Knežević THE CONTROLLER DESIGN FOR TRACKING TRAJECTORY WITH CONTROLLED JERK .....	905
130. Deaconu, S. I., Opreša N, Popa, G. N., Latinovic T. ULTRASONIC WELDING SYSTEM FOR AUTOMOTIVE WIRINGS INDUSTRY .....	911
131. Dražen Pašalić, Zlatko Bundalo, Dušanka Bundalo, Miroslav Kostadinović WIRELESS SENSOR NETWORKS IN HOME AUTOMATION .....	917
132. Mihailo Lazarević, Petar Mandić, Vasilije Vasić SOME APPLICATIONS OF NEUROARM INTERACTIVE ROBOT AND WEBOTS ROBOT SIMULATION TOOL .....	923
<b>F. MAINTENANCE OF TECHNICAL SYSTEMS .....</b>	<b>929</b>
133. Rusmir Bajrić, Enver Omazić, Fehmo Mrkaljević AVAILABILITY ANALYSIS OF IRREDUNDANT TECHNICAL SYSTEMS .....	931
134. Aleksandar Živković, Milan Zeljković, Milorad Rodić, Milivoje Mijušković COMPUTER AND EXPERIMENTAL DETERMINATION OF THE HUB UNIT LIFE .....	937
135. Danijela Nikolic, Vanja Sustersic, Jasmina Skerlic DECENTRALIZED WASTEWATER TREATMENT SYSTEMS IN LARGE SETTLEMENTS .....	943
136. Ivan B. Krstić, Dragan I. Milosavljević, Božidar V. Krstić DETERMINATION THE PERIODICITY OF MANAGING OF PREVENTIVE MAINTENANCE OF TECHNICAL SYSTEMS .....	949
137. Mihaela Popescu, Radu Alexandru Roșu, Carmen Opreș, Ibolyka Bran ENVIRONMENT PROTECTION FOR WELDING AND ALLIED TECHNIQUES ..	955
138. Milomir Čupović, Desimir Jovanović, Bogdan Nedić FTA AND FMEA IN PREDICTING INCIDENTAL CONDITIONS IN CABLE CARS AND SKI LIFTS .....	961

139.	Milorad Pantelić, Srđan Bošnjak MAINTENANCE AND LIFECYCLE OF THE EXCAVATION UNITS .....	967
140.	Dusan Jovanic, Drago Soldat MODELING MAINTENANCE ACTIVITIES ON A WELDED CONSTRUCTION USING IDEF0 METHODOLOGY .....	973
141.	Jasmina Skerlic, Vanja Sustersic, Danijela Nikolic NATURAL SYSTEMS OF WASTEWATER TREATMENT IN SMALL SETTLEMENTS .....	979
142.	Miodrag Milutinović, Vladimir Popović PROCEDURES FOR RISK BASED MANAGEMENT AND MAINTENANCE RIMAP PRINCIPLE .....	985
143.	Dragoslav Dobraš, Sead Avdić PURPOSE AND METHOD EDUCATION OF INTERNATIONAL RECOGNIZED PERSONNEL FOR WELDING .....	997
144.	Aleksandar Majstorović SAFETY PARTS OF BODY TO RESPIRATION WITH BREATHING APPARATUS IN DANGEROUS ZONE .....	1003
145.	Stojan Simić STATUS OF MAINTENANCE SERVICE IN COMPANIES IN REGION IN TIMES OF RECESSION .....	1009
146.	Remigiusz LABUDZKI IDENTIFY CHARACTERISTICS OF OBJECTS IN MACHINE VISION.....	1015



## NATURAL SYSTEMS OF WASTEWATER TREATMENT IN SMALL SETTLEMENTS

Jasmina Skerlic<sup>1</sup>, Vanja Sustersic<sup>2</sup>, Danijela Nikolic<sup>3</sup>

**Summary:** *A small group of settlements include settlements with less than 5 000 inhabitants. In these settlements, it is recommended natural treatment systems for the wastewater treatment. In the most of cases, this system is land natural treatment systems. It is a complex (biological, chemical and physico-chemical) process of removing the pollution of waste water, which occurs at the surface and upper levels of the soil. The land is used as a process of tertiary treatment of waste water, primarily for the removal of nutrients, or as a secondary treatment process, for removal the organic pollution of waste water. The most represent treatment systems are: irrigated land with waste water, rapid infiltration of waste water through the soil, and spreading of soil with waste water.*

**Key words:** *wastewater treatment, decentralized systems, large settlements*

### 1. INTRODUCTION

During the past decades, increasing attention has emerged for environmentally sound, sustainable, low-cost and effective wastewater treatment technologies based on ecological principles, namely ecological technology or natural treatment systems. The environmentally-sound attribute of ecological technology is its capability of resource recovery and reuse (water and nutrients) while at the same time consuming little or no energy and chemicals. The different types of natural treatment systems correspond with the different ecosystems along the land-water gradient, starting from the land-side with high-rate infiltration fields, overland flow systems, constructed wetlands and finally waste stabilisation ponds or lagoons.

It is recommended Natural Treatment Systems for wastewater treatment of small villages, which are mostly cases of so land treatment systems. It is a complex (biological, chemical and physico-chemical) process of removing wastewater pollution which occurs at the surface and upper levels of the land. The purification involved microorganisms that live in soil and plants that the growth or are there planted, then the interaction between the soil and waste pollution water, such as chemical precipitation, adsorption, ion exchange. This complex process is held the control by

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regulating the amount of waste water used to water the land, to avoid the penetration of untreated wastewater in groundwater or to drainage into surface watercourses, and to their pollution. In addition, wastewater is added the amount that can be "accepted" the land, and to avoid overcoming anaerobic conditions in the soil, resulting in a decline in the capacity of wastewater treatment.

## 2. DESCRIPTION OF PROCESS IN NATURAL TREATMENT SYSTEMS

Land can be used as a process of tertiary wastewater treatment (purified in the secondary treatment), primarily to remove nutrients; or as a secondary treatment process for removing organic pollution of waste water. The three most common treatment system are: (i) irrigated land waste water, (ii) rapid infiltration of wastewater through the soil, and (iii) spreading of soil with waste water. The lagoons, where water plants are grown and fish which are then processed into animal feed or used in the industry, can be used for wastewater treatment, where the focus is, usually, on the increase biomass and less on the effect of purification of waste water, which is generally quite weak.

### 2.1 Irrigation

Irrigation (Fig. 1) is the most commonly used system. It is considered the most reliable and best system of purification of waste water land and provides the best quality of processed waste water. Irrigation may be defined as the application of water to soil for the purpose of supplying the moisture essential for plant growth. Irrigation plays a vital role in increasing crop yields and stabilizing production. In arid and semi-arid regions, irrigation is essential for economically viable agriculture, while in semi-humid and humid areas, it is often required on a supplementary basis. It is usually irrigated arable land, where crops are grown and other crops whose sales reimburse part of costs of such a system of purification. Selection of plants to be grown also depends on the number of factors: the capacity of the adoption of nitrogen, water, and adopted by the tolerance increased soil moisture, resistance to pollution from waste water, and in this respect suitable are various types of grasses.

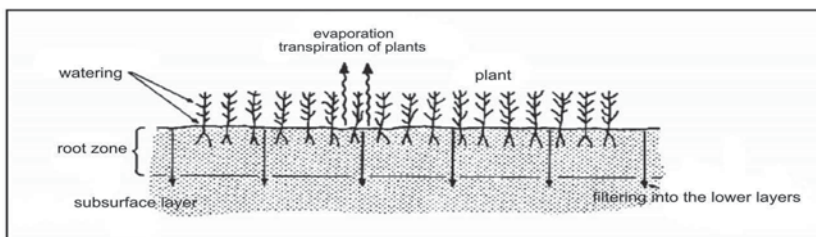


Fig.1 Purification of waste water irrigation land

### 2.2 Rapid infiltration

Rapid infiltration land treatment system consisting of periodic waste water filling of shallow channels or pools from soil exhumed large permeability (sandy and ravelly soil), Fig. 2a, where the water purified during trickling through the layer of soil to

the groundwater levels. If purified waste water can not allow into the groundwater, it is collected by drainage (perforated) pipes Fig. 2b, into the proper channels or pull out the surface through a system of wells, the Fig. 2c.

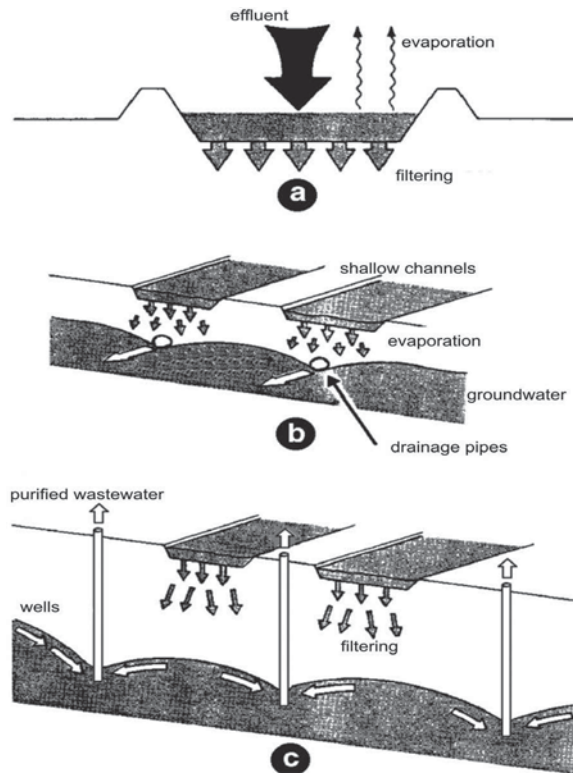


Fig. 2 Rapid infiltration through soil: (a) scheme processes, (b) drainage pipes, (c) a system of wells

The largest part of the wastewater is drainage (usually no vegetation). For the treatment of effluent septic tanks, in the processes of wastewater treatment of the smallest settlements, this procedure could come into consideration, provided that the problem would not be important odor emissions.

Rapid infiltration is less restrictive than other types of land treatment. Rapid infiltration basins offer the advantage of being less dependent on climate than other natural treatments systems. Vegetation is not a required design element, so the length of the growing season does not impact effectiveness unless a high degree of nitrogen removal is necessary. However, the life spans of rapid infiltration systems have been reported to be potentially reduced due to saturation of the soil with phosphorus and heavy metals.

For onsite wastewater treatment, sand mounds are more common than basins, when rapid infiltration is implemented. Sand mounds are used only when the upper portion of the soil profile is conducive to rapid infiltration, and may be appropriate

where soil permeability is too slow or too fast, or where shallow bedrock or a shallow water table exists.

### 2.3 Overland flow

Overland flow is a treatment system where a treasure inclined smooth soil low permeability, overgrown with vegetation cover, on top of the slope poured with the wastewater that flows in a thin layer, gradient, down the slope and collects at the base.

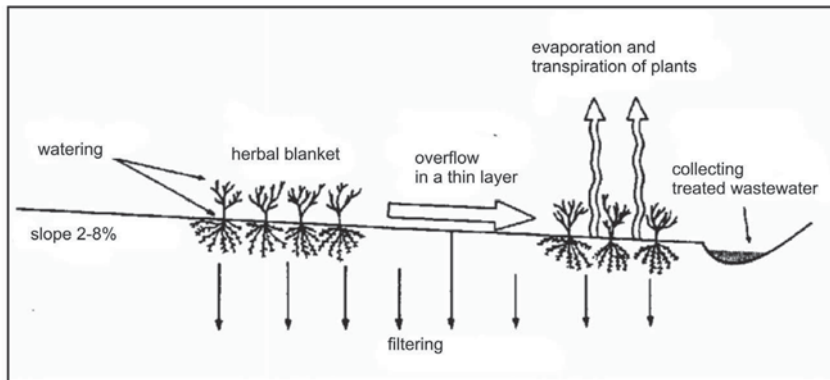


Fig. 3 Purification of waste water overflows the land

The choice of plants is essential to in this system because it significantly influences the capacity and filtration efficiency.

Land treatment systems are characterized by relatively large investment costs but low operation costs. It is recommended that received biomass is not used for human consumption, or must first establish whether the biomass has a pathogenic microorganisms and toxic substances (heavy metals, pesticides, etc.) originating from waste water. The overland flow process differs from the other land treatment processes in that treatment of the effluent occurs on or above the land surface, rather than in the subsurface. In this process, effluent is spread evenly along the top of a vegetated slope. The slope is gentle enough so that sheet flow occurs over the vegetated land, where chemical, physical, and biological processes improve the quality of the effluent. Sedimentation, filtration, and biochemical activity are the primary treatment processes at work in overland flow. Besides controlling erosion, the vegetation removes nitrogen and other nutrients from the effluent, and also filters out suspended solids. Microorganisms such as bacteria and algae, attach to the vegetation and break down dissolved organics. Additional biochemical activity occurs in the top layer of saturated soil. Overall, effluent treated by overland flow is of relatively high quality. Suitability for discharge to streams, however, will be dependent on local discharge requirements, as well as the characteristics of the receiving water body. Evapotranspiration and percolation into the subsurface, provides some reductions in the amount of water that is eventually discharged. Percolation, however, is necessarily limited by the low-permeability soils that are required at the treatment site.

Overland flow depends on sheet flow across the land and vegetation surfaces, so this option can be implemented only where underlying soils will restrict infiltration.

For this reason, overland flow can provide an alternative to the other land treatment options, where site conditions limit the use of drainage fields, spray irrigation, rapid infiltration, and other methods that require percolation into the subsurface.

## **2.4 Wet fields**

Wet fields, or constructed wetlands can be (i) systems with free water surface (free water surface systems) and (ii) systems with the flow of water below the surface (subsurface flow systems) such systems are the advocate in practice.

Analysis should include investment and operating costs during 15 years (cost cutting, waste deposit plants, planting new plants, control waterproofing, root replacement filter layer, etc.). The analysis should cover the costs and benefits of the community bearing in mind the purpose of fertile land that would be used for such purposes. In America, for example, wet fields with free surface over, are used rarely for primary treatment, because of potential exposure to pathogens, but generally for effluent polishing lagoons, filters etc. Fields with the flow below the surface are used mostly for the treatment of primary effluent to secondary standards, but it should be noted that the application of this technique only in development and that it is necessary for her to do a careful assessment of benefits and costs to investment and in the long-term exploitation. In this regard special attention should be given to certain types of pollution such as nutrients, oil and grease, metals and micropollutants organic (detergents, various chemicals used in households, pharmaceuticals, metabolites). Removal of nitrogen that is achieved by wet fields according to the literature is good, although the natural level is usually higher than 1 mg/l, organic nitrogen accumulate in vegetation and may later be released or recycled.

Nitrate removal is generally good. Removal of phosphorus by wet fields is not entirely efficient. As for the metals data are not enough and they are rare and diverse. So eg. removal efficiency for cadmium ranges from 75-99%, 40-96% for copper, 0-86% for lead, 49-88% for nickel, and 33-96% for zinc. The accumulation of toxic organic and inorganic micropollutants can form toxic fields. Worrying is their ability to penetrate into groundwater, and even the fact that they are detected in the drinking water. It was found that irrigation and filtration through the soil can cause water pollution, certain medications. An important aspect of the assessment the impact of this technology is the problem with climate factors (eg. the appearance of large rainfall that cause flooding and major changes in load swampy fields or sensitive plant and animal species in different physical and chemical factors).

## **3. BENEFITS**

Benefits of natural treatment systems are needed primarily to less energy for these systems, because most of the energy taken from the natural environment; but the potential weaknesses of these systems are numerous, as are the systems that must be design and create exactly the present location, its geography, microclimate, soil, and other characteristics, with carefully chosen and dimensioned plant for the pretreatment of wastewater.

Creating such systems requires multidisciplinary knowledge, the experts in different fields; keeping the process a lot difficult, because of the sensitivity of the process on the environment, and process control is a demanding and relatively

expensive. These are all reasons to possible wider use of natural processes of purification of waste water treatment of small settlements can not be approached without a comprehensive and long-term monitoring test facility, from which order to collect enough data for the relevant assessment acceptance of natural purification process for wastewater treatment of small settlement.

Selection of any purification systems for a small settlements, is of crucial importance to the plants in small areas are not left to itself, because it is difficult, practically impossible to provide all the necessary logistics for the operation of these systems.

#### 4. CONCLUSION

Natural wastewater treatment systems are simple, cost-effective and efficient methods to purify the growing amount of wastewater produced by our society. They can be applied as secondary or tertiary purification treatment, allowing the removal of most of the bacteria, microorganism and the destruction of the organic matter. Among them phytodepuration, lagoon purification and storage in tanks gave good results in terms of yield and are quite diffused all over the world.

The selection of a natural wastewater treatment system requires the consideration of a number of factors, including wastewater volume and pollutant characteristics, site soils and geology, and climate.

Their extreme simplicity in building, operation and maintenance make these systems competitive with the conventional (sewer) wastewater treatment methods.

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