

UDC 621
CODEN: MINSC5
In print: ISSN 1857 – 5293
On line: ISSN 1857 – 9191

**MECHANICAL ENGINEERING
SCIENTIFIC JOURNAL**

**МАШИНСКО ИНЖЕНЕРСТВО
НАУЧНО СПИСАНИЕ**

Volume 34
Number 1

Skopje, 2016

<i>Mech. Eng. Sci. J.</i>	Vol.	No.	pp.	Skopje
	34	1	1–360	2016
<i>Маш. инж. науч. спис.</i>	Год.	Број	стр.	Скопје

**MECHANICAL ENGINEERING – SCIENTIFIC JOURNAL
МАШИНСКО ИНЖЕНЕРСТВО – НАУЧНО СПИСАНИЕ**

Published by
Faculty of Mechanical Engineering, Ss. Cyril and Methodius University in Skopje, Republic of Macedonia
Издава

Машински факултет, Универзитет „Св. Кирил и Методиј“ во Скопје, Република Македонија

Published twice yearly – Излегува два пати годишно

INTERNATIONAL EDITORIAL BOARD – МЕЃУНАРОДЕН УРЕДУВАЧКИ ОДБОР

Slave Armenski (Faculty of Mechanical Engineering, Ss. Cyril and Methodius University in Skopje, Skopje, R. Macedonia), **Aleksandar Gajić** (Faculty of Mechanical Engineering, University of Belgrade, Belgrade, Serbia), **Čedomir Duboka** (Faculty of Mechanical Engineering, University of Belgrade, Belgrade, Serbia), **Maslina Daruš** (Faculty of Science and Technology, University Kebangsaan Malaysia, Bangi, Malaysia), **Robert Minovski** (Faculty of Mechanical Engineering, Ss. Cyril and Methodius University in Skopje, Skopje, R. Macedonia), **Wilfried Sihn** (Institute of Management Science, Vienna University of Technology, Vienna, Austria), **Ivan Juraga** (Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Zagreb, Croatia), **Janez Kramberger** (Faculty of Mechanical Engineering, University of Maribor, Maribor, Slovenia), **Karl Kuzman** (Faculty of Mechanical Engineering, University of Ljubljana, Ljubljana, Slovenia), **Clarisse Molad** (University of Phoenix, Phoenix, Arizona, USA), **Todor Neshkov** (Faculty of Mechanical Engineering, Technical University of Sofia, Sofia, Bulgaria), **Zlatko Petreski** (Faculty of Mechanical Engineering, Ss. Cyril and Methodius University in Skopje, Skopje, R. Macedonia), **Miroslav Plančak** (Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia), **Remon Pop-Iliev** (Faculty of Engineering and Applied Science, University of Ontario, Institute of Technology, Oshawa, Ontario, Canada), **Predrag Popovski** (Faculty of Mechanical Engineering, Ss. Cyril and Methodius University in Skopje, Skopje, R. Macedonia), **Dobre Runčev** (Faculty of Mechanical Engineering, Ss. Cyril and Methodius University in Skopje, Skopje, R. Macedonia), **Aleksandar Sedmak** (Faculty of Mechanical Engineering, University of Belgrade, Belgrade, Serbia), **Ilija Čosić** (Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia), **Rolf Steinhilper** (Faculty of Engineering Science, University of Bayreuth, Bayreuth, Germany)

Editor in Chief Одговорен уредник
Assoc. Prof. Igor Gjurkov, Ph.D. **Вон. проф. д-р Игор Ѓурков**
Co-editor in Chief Заменик одговорен уредник
Prof. Darko Danev, Ph.D. **Проф. д-р Дарко Данев**
Assoc. Prof. Dame Dimitrovski, Ph.D., secretary **Вон. проф. д-р Даме Димитровски, секретар**

Technical editor managing Технички уредник
Vlagoja Bogatinoski **Благоја Богатиноски**

Lectors Лектура
Carie Polk Baily (English) **Сарие Полк Бајли (англиски)**
Georgi Georgievski (Macedonian) **Георги Георгиевски (македонски)**

Proof-reader Коректор
Alena Georgievska **Алена Георгиевска**

UDC: "St. Kliment Ohridski" Library – Skopje УДК: НУБ „Св. Климент Охридски“ – Скопје
Copies: 300 Тираж: 300
Price: 520 denars Цена: 520 денари

Address Адреса
Faculty of Mechanical Engineering **Машински факултет**
(Mechanical Engineering – Scientific Journal) (Машинско инженерство – научно списание)
Editor in Chief Одговорен уредник
P.O.Box 464 пошт. фах 464
МК-1001 Skopje, Republic of Macedonia МК-1001 Скопје, Република Македонија
Mech. Eng. Sci. J. is indexed/abstracted in INIS (International Nuclear Information System)
www.mf.ukim.edu.mk

PREFACE

The GREDIT Conference 2016 (GREEN Development, Infrastructure and Transport) was held in Skopje, Republic of Macedonia, from 30th of March till 2nd of April 2016. The Conference was organized by: Ss. Cyril and Methodius University in Skopje, Faculty of mechanical engineering, Faculty of electrical engineering and information technologies, Faculty of technology and metallurgy, Faculty of medicine; BENA – Balkan environmental association; FUEL – R&D Centre for fuels engines and lubricants; 6th Star and Pakomak from Skopje.

The venue of the Conference was the Technical Campus of the University. 230 articles from 543 authors from 13 countries were presented at the plenary session, 6 oral sessions and 4 poster sessions of the Conference.

The topics of the GREDIT 2016 were:

- Air – water – soil pollution
- Risk assessment – sustainable development
- Renewable energy resources and management of natural resources
- Agriculture, Agro ecology, Food Quality safety
- Management of urban and industrial waste
- Climate change – biodiversity – Energy efficiency
- Green smart cities/societies – green architecture and landscape design
- Public health – environmental medicine
- Legal framework – GIS and remote sensing control and
- Round table on: Higher education and Industrial environment

Selected papers from the GREDIT2016 International Conference are published in this issue of the Mechanical Engineering-Scientific Journal.

Dame Dimitrovski

ПРЕДГОВОР

Конференцијата ГРЕДИТ 2016 (Зелен развој, инфраструктура и транспорт) се одржа во Скопје, Република Македонија од 30 март до 2. април 2016 година. Организатори на конференцијата се: Универзитетот Св. Кирил и Методиј во Скопје, Машинскиот факултет, Факултетот за електротехника и информациски технологии, Технолошко-металуршкиот факултет, Медицинскиот факултет; БЕНА – Балканската асоцијација за животна средина; ФУЕЛ – Центарот за истражување и развој на горива, мазива и мотори; 6^{-та} ѕвезда и Пакомак од Скопје.

Настаните од Конференцијата земаа место на Техничкиот кампус на Универзитетот. 230 трудови, од 543 автори од 13 земји, беа презентирани во рамките на пленарната, 6^{те} орални и 4^{те} постер сесии на Конференцијата.

Темите на Конференцијата ГРЕДИТ 2016 беа:

- Загадување на воздух, почва и вода
- Проценка на ризик – одржлив развој
- Обновливи извори на енергија и управување со природните ресурси
- Земјоделие, Агроекологија и безбедност на храна
- Управување со урбан и индустриски отпад
- Климатски промени – биодиверзитет – енергетска ефикасност
- Зелени градови/општества – зелена архитектура и просторно планирање
- Јавно здравје, Медицина поврзана со животната средина
- Правна рамка во животната средина и ГИС системи и
- Кржнa маса: Високото образование и животната средина во индустријата

Избор на трудови од Меѓународната конференција ГРЕДИТ 2016 е објавен во ова издание на Машинско инженерство – научно списание.

Даме Димитровски

<i>Mech. Eng. Sci. J.</i>	Vol.	No.	p-p.	Skopje
	34	1	1–360	2016
<i>Маш. инж. науч. спис.</i>	Год.	Број	стр.	Скопје

TABLE OF CONTENTS (СОДРЖИНА)

PREFACE (Предговор)..... 1–2

TRANSPORT LOGISTICS AND VEHICLES (ЛОГИСТИКА ЗА ТРАНСПОРТ И ВОЗИЛА)

503 – Aleksandar Zahariev, Igor Gjurov
IMPROVING VEHICLE PERFORMANCE USING INDEPENDENT ELECTRIC DRIVE AND ACTIVE ANTI-ROLL BARS
(Подобрување на перформансите на возило со независен електричен погон и активни торзиони стабилизатори)..... 11–18

504 – Igor Gjurov
SIMULATION STUDY OF THE EFFECT OF A SWITCHABLE CONTROL ADAPTIVE SUSPENSION ON VEHICLE'S TRANSIENT RESPONSE
(Симулациско проучување на влијанието на адаптивниот систем за потпирање врз преодниот режим на движење на возилото) 19–25

INDUSTRIAL MANAGEMENT (ИНДУСТРИСКИ МЕНАЏМЕНТ)

505 – Kire Dimanoski, Gligorče Vrtanoski, Gordan Stojić
SIMULATION MODEL FOR DIMENSIONING CAPACITY OF BORDER RAILWAY STATIONS
(Симулациски модел за проектирањето на капацитетот на пограничните железнички станици) 27–33

506 – Milena Jakimoska, Mite Tomov, Mikolaj Kuzinovski
MODEL OF INTERNAL PROCESS AUDIT IN ORGANIZATIONAL SYSTEMS
(Модел за внатрешна проверка на процес во организациски систем) 35–40

INDUSTRIAL DESIGN (ИНДУСТРИСКИ ДИЗАЈН)

507 – Sofija Sidorenko, Violeta Vidoevska
BIOLOGICALLY INSPIRED DESIGN APPLIED IN THE PROCESS OF PRODUCT DEVELOPMENT
(Биолошко-инспириран дизајн применет во процесот на развој на производи) 41–50

GREDIT – Section 1

Air – water – soil pollution

(Воздух – вода – загадување на почвата)

- 508 – Arianeta Deva Nura, Etleva Hamzaraj**
MICROBIOLOGICAL INVESTIGATION FOR ASSESSMENT OF WATER QUALITY IN GJAKOVA WATERSHED
(Микробиолошко испитување за оценка на квалитетот на водата во вододелницата во Ѓаковица) 51–57
- 509 – Arzu Morkoyunlu Yüce, Tekin Yeken**
LEVELS AND SPATIAL DISTRIBUTION OF HEAVY METALS IN *ENTEROMORPHA* SP. FROM IZMIT BAY (TURKEY)
(Нивоа и просторна дистрибуција на тешки метали во *Enteromorpha* sp. од Измитскиот залив (Турција))..... 59–64
- 510 – Boško Boškovski, Slobodan Bogoevski, Trajče Stafilov, Gordana Ruseska, Mihail Kočubovski**
MIGRATION OF ARSENIC AND OTHER MICRO ELEMENTS IN ANTHROPOGENIC CONTAMINATED SOILS
(Миграција на арсен и други микро елементи во антропогено контаминирани почви) 65–69
- 511 – Marijan Laks, Daniel Stefanovski, Julijana Dimzova**
NO_x EMISSIONS FROM HEAVY FUEL OIL BOILERS
(Емисија на азотни оксиди NO_x од ложишта на течни горива во воздух)..... 71–78
- 512 – Ismet Beqiraj, Dritan Topi, Armela Mazreku, Xhaklina Cani**
HEAVY METALS IN PETROLEUM COKE AND THEIR ASSOCIATION TO ENVIRONMENTAL RISK
(Тешки метали во нафтениот кокс и нивната поврзаност со еколошки ризик) 79–84
- 513 – Ismet Beqiraj, Dritan Topi, Xhaklina Cani, Lumturi Hoxha**
SOIL POLLUTION FROM OILFIELDS' EXPLOITATION IN ALBANIA – INCIDENCE OF THE MARINZA OILWELL EXPLOSION
(Загадување на почвата од експлоатацијата на нафтените полиња во Албанија – Инцидентот со експлозијата на нафтениот извор Маринца)..... 85–90
- 514 – Jonida Tahiraj, Elda Marku, Aurel Nuro**
A PRELIMINARY STUDY OF THE PRESENCE OF SOME ORGANIC POLLUTANTS IN TOPSOIL SAMPLES IN INDUSTRIAL AREA OF ELBASAN, ALBANIA
(Прелиминарна студија на присуството на некои органски загадувачи во примероци од горниот слој на почвата во индустриската област на Елбасан, Албанија)..... 91–97
- 515 – Lumturi Hoxha, Spiro Drushku, Ismet Beqiraj, Dritan Topi**
ENVIRONMENTAL IMPACT OF OIL REFINING INDUSTRY IN ALBANIA CASE OF BALLSH OIL REFINERY PLANT
(Влијанието врз животната средина на нафтно-преработувачката индустрија во Албанија, Случај со **фабриката за рафинирање на нафта** во Балш) 99–105
- 516 – Majlinda Daci-Ajvazi, Lulzim Zeneli, Nexhat M. Daci, Sevdije Govori, Albana Mehmeti, Dafina Hoxha**
KOSOVO COAL ASH A POLLUTANT AND ADSORBENT FOR ORGANIC AND INORGANIC POLLUTANTS
(Косовскиот јагленов прав загадувач и адсорбент на органски и неоргански загадувачи)..... 107–112
- 517 – Mirela Alushllari, Nikolla Civici**
THE IMPACT OF INDUSTRIAL WASTE OF THE FORMER BATTERY PRODUCTION FACTORY ON SURFACE SOIL AROUND IT
(Влијанието на индустрискиот отпад од поранешната фабрика за производство на акумулатори врз површинската почва околу неа) 113–118
- 518 – Slobodan Bogoevski, Boško Boskovski, Trajče Stafilov, Gordana Ruseska, Mihail Kočubovski**
SELECTIVE EXTRACTION AND PASSIVATION OF ARSENIC AND OTHER MICRO ELEMENTS OF ANTHROPOGENIC CONTAMINATED SOILS
(Селективна екстракција и пасивизација на арсен и други микро елементи од антропогено контаминирани почви) 119–125

- 519 – Stojan Srbinoski**
 INTENSE RAINFALL AND DEGREE OF REMOVAL OF POLLUTING PARTICLES FROM THE AIR
 OVER SKOPJE
 (Интензивни врнежи и степенот на отстранување на загадувачките честички од воздухот
 над Скопје)..... 127–132
- 520 – Sonja Ketin, Selim Saćirović, Svetlana Stevović, Rade Biočanin**
 MONITORING OF GROUDWATER AFTER THE ACCIDENT SITUATIONS
 (Мониторинг на подземни води по непогоди) 133–142

GREDIT – Section 2
Risk assesement and sustainable development
 (Процена на ризик и одрлив развој)

- 521 – Maja Peceva, Taško Rizov, Atanas Kočov**
 CHEMICAL LEASING AS A NEW BUSINESS MODEL CONTRIBUTING
 TO SUSTAINABLE INDUSTRIAL DEVELOPMENT
 (Хемиски лизинг како нов бизнис модел кој придонесува за одржлив индустриски развој) 143–147

GREDIT – Section 3
Renewable energyresources and management of natural resources
 (Обновливи извори на енергија и менаџмент со природни ресурси)

- 522 – Armela Mazrreku, Ismet Beqiraj, Dritan Topi**
 ALKALINE CATALYTIC APLICATION IN THE PRODUCTION OF BIODIESEL FROM VEGETABLE OILS
 (Примена на алкална катализа во производство на биодизел од растителни масла)..... 149–154
- 523 – Armela Mazrreku, Ismet Beqiraj, Dritan Topi**
 COMPARATIVE PERFORMANCE OF BIODIESEL PRODUCED FROM VEGETABLE OILS WITH
 CONVENTIONAL FUELS
 (Споредба на перформансите на биодизелот произведен од растителни масла
 со традиционалните горива) 155–160
- 524 – Blerim Baruti, Ilirjan Malollari, Milaim Sadiku, Nushe Lajqi, Florent Dobroshi, Mensur Kelmendi, Mehush Aliu**
 TREATMENT POSSIBILITY TO USE SOLAR PHOTOVOLTAIC SYSTEMS
 IN PUBLIC LIGHTING IN THE MUNICIPALITY OF MITROVICA
 (Испитување на можноста за користење на соларни фотоволтаични системи
 во јавно осветлување во општината Митровица)..... 161–164
- 525 – Filip Mojsovski**
 SOLAR DRYING OF RASPBERRY
 (Соларно сушење на малини)..... 165–168
- 526 – Igor Aleksovski, Slavčo Aleksovski, Zagorka Koneska**
 CHEMICAL COMPOSITION OF BIO-OIL PRODUCED BY FAST PYROLYSIS OF WOOD CHIPS
 (Хемиски состав на био-масло добиено со брза пиролиза на струготини од дрво) 169–172
- 527 – Xhaklina Cani, Ismet Beqiraj, Lorina Liçi, Ilirjan Malollari**
 CHARACTERIZATION OF CRUDE OIL FROM VARIOUS NATURAL RESOURCES
 IN ALBANIA USING INSTRUMENTAL ANALYSIS
 (Карактеризација на суровата нафта од различни природни ресурси во Албанија користејќи
 инструментална анализа)..... 173–177

GREDIT – Section 4
Agriculture, Agroecology, Food quality safety
 (Агрокултура, агроекологија, квалитет на храна)

- 528– Bahtir Hyseny, Rifat Morina, Alush Musaj**
 COMPLEX MEDIA AND GENETIC MANIPULATION FOR IMPROVEMENT AND PRODUCTION
 OF NEW PRODUCT BY *KLUYVEROMYCES MARXIANUS*
 (Комплексен медиум и генетска манипулација за подобрување и производство на нов производ
 со *Kluuveromyces marxianus*)..... 179–184

- 529 – Dorina Bonea, Viorica Urechean, Marin Soare**
 SCREENING OF DROUGHT AND HEAT TOLERANT HYBRIDS IN MAIZE
 (*ZEA MAYS L.*) USING SELECTION INDEX AND RANKING METHOD
 (Скрининг на хибриди на пченка толерантни на суша и топлина (*Zea mays L.*)
 со користење на индекс за селекција и метод на рангирање) 185–191
- 530 – Leomira Osmani-Lataj, Dritan Topi, Valdete Vorpsi, Erta Dodona**
 MINERAL COMPOSITION OF HAZELNUT (*CORYLUS AVELLANA*) VARIETIES CULTIVATED IN
 ALBANIA; DAILY MINERAL ELEMENT REQUIREMENTS TO CONSUMERS
 (Минералниот состав на сортите на лешник (*Corylus avellana*) култивирани
 во Албанија; Дневни потреби за минерални елементи на конзументите)..... 193–198
- 531 – Rodica Soare, Maria Dinu, Cristina Babeanu, Elena Bonciu**
 RESEARCHES CONCERNING YIELD AND MORPHOLOGICAL AND BIOCHEMICAL
 CHARACTERISTICS OF SOME KALE VARIETIES (*BRASSICA OLERACEA L. VAR. ACEPHALA*)
 AND CHINESE CABBAGE (*BRASSICA RAPA VAR. CHINENSIS*)
 (Истражувања во врска со приносот и морфолошките и биохемиските карактеристики на некои
 сорти келџ (*Brassica Oleracea L. Var. Acephala*) и кинеската зелка (*Brassica Rapa Var. Chinensis*)) 199–204
- 532 – Sadik Heta, Fatmira Shehu, Drita Bajraktari**
 THE RISK OF ANTIBIOTIC RESIDUES IN CHICKEN EGGS IN KOSOVO
 (Ризикот од резидуи од антибиотици во јајцата од кокошки во Косово)..... 205–207
- 533 – Marin Soare, Payla Iancu, Dorina Bonea, Păniță Ovidiu**
 SALICYLIC ACID PRIMING EFFECT ON THE GERMINATION CHARACTERISTICS FOR BEAN
 (*PHASEOLUS VULGARIS L.*) UNDER INDUCED DROUGHT CONDITIONS
 (Ефектот на квасење во салицилна киселина врз карактеристиките на ртење
 на гравот (*Phaseolus vulgaris L.*) во услови на индуцирана суша)..... 209–214
- 534 – Ilirjana Boci, Ederina Ninga, Xhuljeta Hamiti, Pranvera Lazo**
 EVALUATION OF INCIDENCE OF DDT [1,1,1-TRICHLORO-2,2-DI (4-CHLOROPHENYL) ETHANE]
 IN ANIMAL FAT
 (Евалуација на честотата на појавата на ДДТ [1,1,1-трихлоро-2,2-ди (4-хлорофенил) етан]
 во животинска маст)..... 215–220
- 535 – Ilirjan Postoli, Fatmira Shehu**
 THE IMPORTANCE OF THE IMPLEMENTATION OF HYGIENE PRACTICES IN FOOD BUSINESS
 OPERATORS
 (Важноста на примената на хигиенските навики кај операторите во прехранбената индустрија)..... 221–223

GREDIT – Section 5

Management of urban and industrial waste (Менаџмент со урбан и индустриски отпад)

- 536 – Ekaterina Serafimova**
 ANALYSIS OF WASTE SLUDGE FROM MUNICIPAL WASTEWATER TREATMENT PLANT IN
 BLAGOEVGRAD TOWN, BULGARIA
 (Анализа на тињата од отпадните води од општинската пречистителна станица во Благоевград,
 Бугарија) 225–232
- 537 – Ekaterina Serafimova, Silvia Milenkova, Vilma Petkova, Yoncho Pelovski**
 INTEGRATED WASTES TREATMENT AS A BASIC FOR PRODUCTION NEW MATERIALS
 (Интегрирана обработка на отпадот како основа за производство на нови материјали) 233–239
- 538 – Goran Demboski, Vineta Srebrenkoska, Silvana Žežova, Sonja Čortoševa**
 UTILIZATION OF GARMENT INDUSTRY TEXTILE WASTE
 (Употреба на текстилниот отпад од конфекциската индустрија) 241–146
- 539 – Karmina Miteva, Slavčo Aleksovski, Gordana Bogoeva-Gaceva**
 EFFICIENCY OF DIFFERENT CATALYSTS IN PYROLYSIS OF WASTE POLYOLEFIN MIXTURE
 (Ефикасност на различни катализатори во пиролиза на отпадна полиолефинска смеса)..... 247–252

- 540 – Slavčo Aleksovski, Igor Aleksovski, Zagorka Koneska**
 PYROLYSIS OF WASTE ENGINE OIL TO GASOLINE AND DIESEL FUEL
 (Пиролиза на отпадно моторно масло до бензин и дизелско гориво пиролиза на отпадно моторно
 масло до бензин и дизелско гориво) 253–256
- GREDIT – Section 6**
Climate change, Biodiversity, Energy efficiency
 (Климатски промени, биодиверзитет, енергетска ефикасност)
- 541 – Dimitar Dimitrov, Goran Čogelja, Vasilija Šarac**
 RULES FOR ELECTRICITY EXCHANGE FOR PHOTOVOLTAIC RESIDENTIAL SYSTEMS
 (Правила за размена на електрична енергија за домаќинства со инсталиран фотоволтаичен
 систем) 257–263
- 542 – Goce Kalevski, Vladimir Vaskov**
 EFFICIENT USAGE OF ENERGY IN MODERN BUILDINGS
 (Ефикасно користење на енергија во модерните згради) 265–270
- 543 – Lidija Joleska Bureska**
 INFLUENCE OF COAL QUALITY ON THE BOILER EFFICIENCY AND OPPORTUNITY FOR
 IMPROVEMENT
 (Влијанието на квалитетот на јагленот врз ефикасноста на котлите и можност за подобрување) 271–276
- 544 – Suzana Kasovska-Georgieva, Martina Blinkova**
 CLIMATE CHANGE IMPACT ASSESSMENT OF CULTURAL AND NATURAL HERITAGE IN OHRID
 REGION
 (Процена на влијанието на климатските промени врз културното и природното наследство
 во охридскиот регион) 277–284
- 545 – Taško Rizov, Petrika Janeku, Atanas Kočov**
 IMPLEMENTATION OF LOW CARBON TECHNOLOGIES IN THE MACEDONIAN AGRO INDUSTRY
 (Примена на технологии за намалување на емисиите на стакленички гасови во компании од агро
 индустријата во Македонија) 285–292
- 546 – Yoncho Pelovski, Ekaterina Serafimova, Nikolay Kozarev, Anton Petrov, Vilma Petkova**
 INFLUENCE OF SOME FACTORS ON THE GLOBAL CLIMATE SYSTEM AND NEEDED MEASURES
 (Влијанието на некои фактори врз глобалниот климатски систем и потребни мерки) 293–302
- 547 – Alper Sezer, Turkan Goksal Ozbalta, Yusuf Yildiz**
 ESTIMATION OF INDOOR RELATIVE HUMIDITY USING ANFIS AND BPNN: A CASE STUDY FROM
 ESKISEHIR, TURKEY
 (Процена на релативна влажност на внатрешен простор со употреба на моделите ANFIS и BPNN:
 Студија на случај од Eskisehir, Турција) 303–309
- 548 – Biljana Petrevska, Vlatko Čingoski**
 CAN MACEDONIAN HOTELS BE GREEN: THE EVIDENCE OF HOTEL “FLAMINGO” – GEVGELIJA,
 MACEDONIA
 (Дали македонските хотели можат да бидат „зелени“: Докази за хотел "Фламинго" – Гевгелија,
 Македонија) 311–321
- 549 – Atanas Kočov, Stevan Kjosevski, Marina Malish Sazdovska, Latif Latifi**
 CHALLENGES OF INTRODUCING ELECTRIC VEHICLES IN REPUBLIC OF MACEDONIA
 (Предизвици во воведувањето на електрични возила во Република Македонија) 323–328
- 550 – Arsim Maloku, Liridon S. Berisha, Ardita Thaqi, Eduard Andoni, Tahir Arbneshi**
 VOLTAMMETRIC SENSOR FOR CHLOROPHENOLS BASED ON SCREEN PRINTED ELECTRODES
 MODIFIED WITH REDUCED GRAPHENE OXIDE
 (Волтаметриски сензор за хлорофеноли базиран на сито-печатени електроди модифицирани
 со редуциран графит оксид) 329–335

GREDIT – Section 7**Agriculture, Agroecology, Food quality safety**
(Агрокултура, агроекологија, квалитет на храна)

- 551 – Erjola Reufi, Jozefita Marku, Thomas Bier**
ULTRASONIC PULSE VELOCITY INVESTIGATION OF POLYPROPYLENE AND STEEL FIBER
REINFORCED CONCRETE
(Определување на брзината на ултразвучниот импулс на полипропиленот и фибер-армираниот
бетон) 337–341
- 552 – Milica Igić, Petar Mitković, Jelena Đekić, Milena Dinić Branković, Mihailo Mitković**
SUSTAINABLE URBAN MOBILITY – PROBLEMS OF SUSTAINABLE BICYCLE TRAFFIC
IN CITY OF NIŠ
(Одржлива урбана мобилност – Проблеми во одржлив велосипедски сообраќај во градот Ниш) 343–351

GREDIT – Section 8**Agriculture, Agroecology, Food quality safety**
(Агрокултура, агроекологија, квалитет на храна)

- 553 – Ilir Hebovija, Ildjona Malollari**
THE ALBANIAN CRIMINAL LAW PROTECTION OF THE ENVIRONMENT AND THE CHALLENGES
FACING THE CURRENT LEGISLATION IN THE FRAMEWORK OF EUROPEAN UNION INTEGRATION
(Албанското казнено право во делот на заштита на животната средина и предизвиците на
сегашното законодавство во рамките на интеграцијата во Европската Унија)..... 353–357
- INSTRUCTIONS FOR AUTHORS** 359–360

UTILIZATION OF GARMENT INDUSTRY TEXTILE WASTE

Goran Demboski¹, Vineta Srebrenkoska², Silvana Žežova², Sonja Čortoševa¹

¹Faculty of Technology and Metallurgy, "Ss Cyril and Methodius" University in Skopje,
P.O. Box 580, MK-1001 Skopje, Republic of Macedonia

²Faculty of Technology, Goce Delčev University,
"Krstе Misirkov" b.b. P. O. Box 201, 2000 Štip, Republic of Macedonia
goran@tmf.ukim.edu.mk

Abstract: Because of increasing environmental demands, especially on dealing with product life phase end, manufacturers and designers must consider future disposal of their products. In recent years, an increased emphasis on developing recycling techniques for industrial waste products has been placed, with the goals of protecting the environment. The aim of the work is investigation of the possibilities of reusing of cotton textile waste, generated during the manufacture in garment industry, as reinforcement in production of composite materials. The main focus has been put on the preparation and characterization of composites based on cut waste from garment industry. The materials have been cotton fabric and cotton textile waste as reinforcements and phenol phormaldehyde resin as matrix. The composites containing 60 % wt. reinforcement were manufactured by compression molding. For the composites, the mechanical and thermal properties were analyzed and compared to those of commonly used continuous fiber reinforced composites based on cotton fabric and phenolic resin. It was found that the composites based on cotton textile waste are more sensitive to processing cycles with respect to continuous fiber reinforced composites. The mechanical properties for composites based on cotton textile waste are lower for about 25% compared to continuous one. The thermal stability, investigated by Martens method for both composites reinforced with cotton fabric and with cotton textile waste is very similar. The obtained results have shown that cotton textile waste could be reused for production of composite with acceptable mechanical properties and they can be successfully used in various industries as construction material.

Key words: textile waste; cotton fabric; reinforcement; composite material, garment industry

УПОТРЕБА НА ТЕКСТИЛНИОТ ОТПАД ОД КОНФЕКЦИСКАТА ИНДУСТРИЈА

Апстракт: Поради повисоките еколошки норми, особено за справувањето со крајот на животната фаза на производот, производителите и дизајнерите мора да го имаат во предвид идното депонирање на нивните производи. Во последните години, се става зголемен акцент на развојот на техники за рециклирање на индустрискиот отпад, со цел да се заштити животната средина. Целта на овој труд е да се истражат можностите за повторна употреба на памучниот текстилен отпад создаден за време на производството во конфекциската индустрија како зајакнувач во производството на композитни материјали. Главниот фокус е ставен на подготовката и карактеризацијата на композитите на база на отпадот при кроеење од текстилната индустрија. За производство на композитите беа користени памучна ткаенина и текстилен памучен отпад како зајакнувачи и фенолформалдехид како матрица. Композитните материјали кои содржеа 60 % мас. зајакнувачи беа произведени со техниката обликување под притисок. Механичките и термичките својства на композитите зајакнати со текстилен отпад беа анализирани и споредени со конвенционални композити зајакнати со континуирани влакна базирани на памучна ткаенина и фенолна смола. Произлеже дека композитите базирани на отпад од памучен текстил се почувствителни на циклусите на обработка во однос на композитите зајакнати со континуирани влакна. Механичките својства на композитите базирани на отпад од памучен текстил се за 25% пониски во споредба со континуираните. Термичката стабилност, испитувана со Мартенс методот, и на композитите зајакнати со памучна ткаенина и со отпадот од памучен текстил е многу слична. Добиените резултати покажаа дека отпадот од памучен текстил може повторно да се употреби за производство на композитни материјали со прифатливи механички својства и можат успешно да се употребуваат во различни индустрии како конструкциски материјал.

Клучни зборови: текстилен отпад; памучна ткаенина; зајакнувач; композитен материјал; конфекциска индустрија

INTRODUCTION

As result of the development in industrial production, the level of waste of different type and background has been significantly increased becoming worrying problem for today's civilization. Although in the last two to three decades progress in technological processes has been reported, the amounts of various waste materials represents huge problem in today's modern lifestyle.

The quantities of textile wastes that increase on daily basis, the energy used in the process of waste disposal or incineration, whether performed correctly or not, impose a need for creating sustainable waste management practices. Sustainable management of textile waste will contribute to reducing waste generation, more efficient use of raw materials and decreasing the cost of disposal. This inevitably implies the necessity of restructuring of the garment companies and raising the environmental awareness of all generators of waste.

Usually the company's modernization is the first step for an effective implementation of the integrated system for managing textile waste, effective in terms of cost. Modernization is usually associated with technological and operational changes. This is further accompanied by changes of equipment, operational settings, and exploring the possibilities for reuse of the generated textile waste as potential raw material. On one hand, this will ensure reduction of costs for the disposal. On other hand, the sale or reuse of the textile waste will lead to increasing the profitability and competitiveness of the company. One of the potential applications of the generated textile waste is the production of a composite material.

Preparation of composite materials using textile waste as a reinforcement is a research challenge, which involves solving multiple problems, such as:

- appropriate choice of textile waste as a reinforcement regarding polymer matrix;
- achieving their compatibility with the application of various accessories;
- establishing suitable technology for their interference;
- determination of optimal process parameters for manufacturing composites of required properties.

Acquiring these prerequisites will depend on the features of the resulting composite material.

The purpose of this study is to investigate sustainable technology for production of composite materials based on textile waste, in order to achieve additional profits and reduce the costs for the disposal of the textile waste.

EXPERIMENTAL

For preparation of the composite materials the following constituents were used:

– 60% wt. of cotton textile waste as a reinforcements

Different and irregular shapes and sizes of cotton waste fabric from (25 × 50) mm to (50 × 500) mm and larger, purified from various admixtures and impurities.

– 40% wt. of phenol Formaldehyde resin as matrices.

Phenol Formaldehyde resin was modified with thermoplastic polyvinylbutiral (PVB) and diluted with alcohol in relation 1:0.2–0.5.

The preparation of composites has been performed by mixing the resin and cotton textile waste into a universal mixer Werner Pfliderer with two S-fins, which can rotate in two majors.

The regime of mixing was as follows:

Half of the quantity of cotton textile waste and half of the amount of resin was mixed first. It was mixed for 2–3 minutes and then the other half of the cotton textile waste and resin was added. The total time of mixing was 60 minutes: 10 minutes movement of the fins of a mixer one versus another, and five minutes movements in the opposite direction. The mode of mixing was based on the previous experience of industrial practice of the company “Eurokompozit”. The mixed mass was evenly divided in a layer with about 50 mm height. The resulting mass was dried in a dryer at a temperature of 80 °C. The total drying time was 90 minutes: 60 minutes on the one side and 30 minutes on the other side. Presence of impurities, ingredients, fibers, fabric pieces and other substances in cotton waste fabric were not allowed, which were visual controlled in the early stage.

Thermal pressing of all samples was performed on polyindustrial press under the following conditions:

$$P = 75 \text{ bar};$$

$$T = 160 \text{ }^{\circ}\text{C};$$

$$t = 20 \text{ minutes.}$$

From the composite mass test samples were fabricated and certain physical, thermal and mechanical properties of composite materials were examined.

For testing the physical and mechanical properties of composite based on cotton textile waste and phenolic formaldehyde resin standard methods and procedure were used. Flexural strength and modulus of elasticity was tested according ASTM D 790 standard, impact strength according ASTM D 256, and the compression strength according ASTM D 695 standard. Thermal degradation temperature was measured by the method of Martens, DIN 53462.

RESULTS AND DISCUSSION

Influence of the content of PVB on the characteristics of the polymer system and composites

The basic physical and chemical characteristics of polymer systems controlled in terms of industrial exploitation are: content of dry substance, density and viscosity by Ford (Table 1).

In order to assess the reactivity of produced resin systems, B-time at different temperatures is investigated (Figure 1).

Table 1

Physical-chemical characteristics of the polymer systems

Characteristics	PVB/phenolic formaldehyde resin					
	10/90	20/80	25/75	30/70	40/60	50/50
Content of dry substance, mas. %	15.2	14.8	14.6	15.2	16.3	16.1
Density at 20°C, g/cm ³	1.11	1.10	1.11	1.11	1.12	1.12
Viscosity at 20° C according to Ford (4 mm/20° C), s	220	210	215	225	195	210

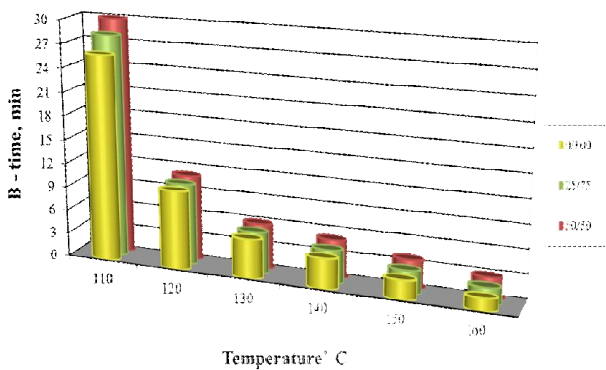


Fig. 1. B-time of phenol-formaldehyde resin modified with PVB at various temperatures

As shown in Figure 1, all B-time are in a narrow range, the pure phenol-formaldehyde resin has the shortest time and the modified resin with PVB (50/50) has the longest B-time. With increasing the content of PVB, B-time of resin systems slightly increases. The biggest change in the B-time occurs between 110°C and 120°C, where it is reduced about 60%, while from 120°C to 160°C, the decline is significantly lower.

Table 2 shows the summary of shear strength results for resin systems. From the statistical indi-

cators it can be concluded that there are many good clustering of results around the mean value (\bar{X}_{sr}), i.e. it has a good reproducibility of results (the standard deviation, S_d). It can be noted that PVB has great influence on the shear strength, i.e. adhesion properties of the resin systems: the lowest shear strength was showed the non-modified system-pure phenol-formaldehyde resin. With increasing the content of PVB, shear strength increases, so when only 10% of PVB is used in resin system, it increases about 28% (from 7.55 MPa to 9.64 MPa). The highest shear strength showed the resin system with the highest content (50%) of PVB and that more than 150% from non-modified resin system.

Mechanical properties of the polymer systems

The mechanical and thermal properties of composites based on cotton textile wastes were compared with conventional (laminated) composites based on continuous cotton fibers. Tables 3 and 4 show the summary of the obtained results from the testing of physical and mechanical properties of the laminated composites and the composites based on cotton textile wastes.

The properties of the composite reinforced with short fibers heavily depend on the content and distribution of fiber orientation, and on the adhesion between the fibers and matrix. The content of fibers is usually precisely controlled, although it may come to segregation of the fibres and resin during the production. The orientation of fibers changes when we change the conditions of press-

ing, but that it is too difficult to control. The properties of the thermoreactive composites reinforced with cotton textile waste is sensitive to processing conditions and particularly from the methods of processing, especially for composite based on phenol resin, and can greatly differ even for identical samples.

Table 2

Shear strength of resin systems (MPa)

Tube	PVB/phenolic formaldehyde resin						
	0/100	10/90	20/80	25/75	30/70	40/60	50/50
1	7.34	9.38	11.87	13.65	15.45	16.84	18.64
2	7.46	9.91	12.46	14.12	15.22	17.36	18.45
3	7.55	9.49	13.12	14.85	14.95	18.12	19.29
4	7.86	9.64	12.86	14.55	16.12	16.57	18.26
5	7.59	9.75	12.95	13.74	16.03	17.36	19.23
6	7.81	9.70	13.22	13.63	15.88	17.10	19.15
7	7.38	9.41	11.98	15.02	15.96	16.91	19.49
8	7.67	9.55	13.78	14.52	15.64	17.35	18.82
9	7.43	9.67	12.81	13.85	15.23	17.15	18.42
10	7.23	9.90	12.54	13.22	15.74	17.39	19.75
Statistical processing of results							
Xsr	7.55	9.64	12.76	14.12	15.77	17.22	18.95
Sd	0.2	0.2	0.6	0.6	0.4	0.4	0.5

Table 3

Physical and mechanical properties on the laminated composites

Physical properties	COMPOSITE	
	Cotton fabric/phenolic formaldehyde resin	
Specific weight, g/cm ³	1.3 – 1.4	
Water absorption, %	0.4 – 0.8	
Mechanical properties	Test method	
Flexural strength, MPa	DIN 53457	> 150
Modulus of elasticity at flexural GPa	DIN 53457	7
Impact strength, kJ/m ²	DIN 53453	> 30
Compression strength, MPa	DIN 53454	> 170

The results from the comparison of physical-mechanical properties of conventional (laminated) composites and composites based on cotton textile wastes, with respect to the constituents matrix /

Table 4

Physical and mechanical properties on the composites based on cotton textile wastes

Physical properties	COMPOSITE	
	Cotton textile waste/phenolic formaldehyde resin	
Specific weight, g/cm ³	1.3 – 1.4	
Water absorption, %	0.4 – 0.8	
Mechanical properties	Test method	
Flexural strength, MPa	DIN 53457	128±8.8
Modulus of elasticity at flexural, GPa	DIN 53457	5±0.5
Impact strength, kJ/m ²	DIN 53453	20±6.4
Compression strength, MPa	DIN 53454	140±9.6

fiber of 40/60 are shown as diagram (Figures 2, 3 and 4).

From the obtained results we can see that there is a difference in mechanical properties between the composites. The mechanical properties

for composites based on cotton textile waste are lower for about 25%, but the thermal stability investigated by Martens method for both composites reinforced with cotton fabric and with cotton textile waste is very similar. It is obvious that for all the same parameters: ratio of the constituents and conditions of production, the main reason for the difference in mechanical properties is different reinforcing of the textile product. The fibers are processed differently in various textile products. In the fabric, fibers are with a continuous length, crossed or tangled around each other, while the fibres from the cotton textile waste are short and chaotically distributed.

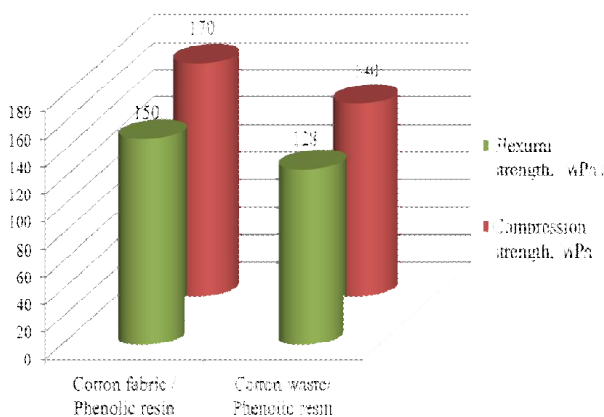


Fig. 2. Flexural and Compression strength, MPa

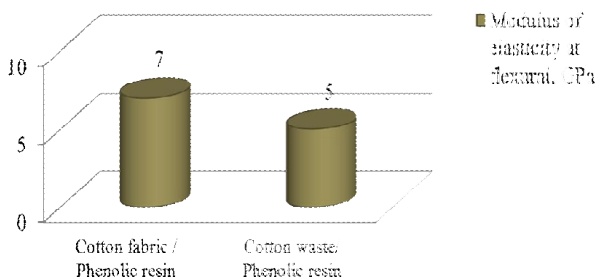


Fig. 3. Modulus of elasticity at flexural, GPa

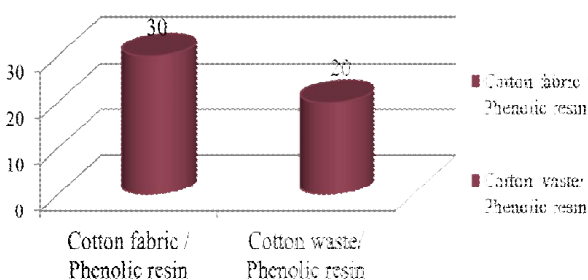


Fig. 4. Impact strength, kJ/m²

Thermoreactive composites reinforced with short fibers have the advantage of being able to offer a unique combination of properties. However, the differences in orientation and distribution of the fibers usually occur in the samples themselves, especially in thickness. It affects the optimal properties and can lead to imbalances of the mechanical properties of the material.

CONCLUSION

The composite materials have been produced from cotton textile waste, generated during the manufacture in textile industry, as a reinforcing phase and phenol-formaldehyde resin modified with thermoplastic polymer (PVB) as a matrix.

- The mechanical properties on composites based on cotton textile waste are about 25% lower compared to the composites based on continuous cotton fibers.
- The main reason for the difference in mechanical properties at all parameters being equal: ratio of the constituents and conditions of production, the difference is in configuration of reinforcing textile product. The lower properties of the composites are obtained where the reinforcement phase is cotton textile waste of fibers of various lengths and random orientation. On the opposite, the conventional composites have continuous reinforcement fiber.
- The thermal stability investigated by Martens method for both composites reinforced with cotton fabric and with cotton textile waste is very similar. All composites are thermo stable at temperature up to 200 °C.
- The obtained results have shown that the new produced composite material has relatively good properties and they can be successfully used in many industries as a construction and non construction material.
- The conventional composites are mostly used in applications where quality is a priority.
- The composites reinforced with textile waste are mostly used in applications where the cost is a priority.
- Generally, composites based on cotton waste are applying as non load construction elements.

REFERENCES

- [1] Lee S. M.: *International encyclopedia of composites*, Volume 2, VCH Publishers, New York, 1990, стр. 39000–401.
- [2] Chawla K. K., *Composite materials science and engineering*, Springer-Verlag, New York, 1985.
- [3] M.O.W. Richardson, *Polimer Engineering composites*, Applied science publishers ltd, London, 1977.
- [4] McCullough R. L.: *Concepts of fiber – resin composites*, Marcel Dekker, Inc., New York, 1971.
- [5] Lee S. M.: *International encyclopedia of composites*, Volume 4, VCH Publishers, New York, 1990, стр. 97–105.
- [6] Addabo H. E., Rojas A. J., Williams R. J. J., *Polym. Eng. Sci.*, 19, 835 (1979).
- [7] Lee S. M.: *International encyclopedia of composites*, Volume 1, VCH Publishers, New York, 1990, стр. 97–105.
- [8] Parratt N. J.: *Fibre-reinforced Materials technologi*, Van Nostrand/Reinhold, London, 1972.
- [9] Lee S. M.: *International encyclopedia of composites*, Volume 2, VCH Publishers, New York, 1990, стр. 390–401.
- [10] Indov J.: *Konstruiranje i sastav polimernih kompozita*, Savjetovanje polimerni kompoziti, Zagreb, 2001, стр. 1–6.
- [11] Cyras V., Iannace S., Kenny J., Vazquez A.: *Polym. Compos.*, 22, 104 (2001).
- [12] Mishra S., Misra M., Tripathy S. S., Nayak S. K. and Mohanty A. K.: *Polym. Compos.*, 23, 164 (2002).
- [13] Knop A., Scheib W.: *Chemistry and application of phenolic resins*, Springer-Verlag, Berlin, 1979.
- [14] Khan M. A., Hassan M. M., Brown T. K.: *Composites, Part A*, 36, 71–81 (2005);
- [15] De S. K., White J. R.: *Short fibre – polymer composites*, Woodhead publishing limited, Cambridge, 1996.
- [16] Keener T. J., Stuart R. K., Brown T. K.: *Compos. A*, 35, pp 357–374 (2004).
- [17] Mohanty A. K., Drzal L. T., Misra M.: *J. Adhes. Sci. Technol.*, 16, pp. 999–1013 (2002).
- [18] Mohanty A. K., Misra M., Drzal L. T.: *Compos. Interfaces*, 8, pp. 313 (2001).