

## Izvirni znanstveni članek *Original Scientific Paper*

Branko Neral<sup>1</sup>, Sonja Šostar-Turk<sup>2</sup>, Sabina Fijan<sup>1,2</sup>

<sup>1</sup> Univerza v Mariboru, Fakulteta za strojništvo, Inštitut za inženirske materiale in oblikovanje, Smetanova 17, 2000 Maribor/  
*University of Maribor, Faculty of Mechanical Engineering, Institut for Engineering Materials and Design, Smetanova 17, 2000 SI – Maribor, Slovenia*

<sup>2</sup> Univerza v Mariboru, Fakulteta za zdravstvene vede, Žitna ulica 15, 2000 Maribor/  
*University of Maribor, College of Nursing Studies, Žitna ulica 15, SI – 2000 Maribor, Slovenia*

### Okoljski vplivi različnih razkuževalnih postopkov nege tekstilij

*Environmental Impacts of Various Disinfection Procedures during Laundering*

Od postopkov nege tekstilij za zdravstvene ustanove in živilsko industrijo se zahteva razen odstranjevanja nečistoč tudi zagotavljanje ustrezne stopnje higijene. Ob klasičnem kombiniranem kemijsko-termičnem postopku razkuževanja se čedalje bolj uveljavlja tudi postopek nege tekstilij, ki ima osnovo v tehnologiji tekočega CO<sub>2</sub> (LCO<sub>2</sub>). V dosedanjih raziskavah postopkov nege je bilo v središču zanimanja predvsem vrednotenje razkuževalnih učinkov, medtem ko so bili vplivi na okolje nekoliko potisnjeni v ozadje.

Raziskava je bila osredotočena na primerjavo okoljskih vplivov, ki jih povzročata kemijsko-termičen in CO<sub>2</sub> postopek nege medicinskih tekstilij. Za vrednotenje razkuževalnega učinka so bili uporabljeni bioindikatorji, klasična in prototipna LCO<sub>2</sub> oprema za nego tekstilij, pralna, razkuževalna in pomožna sredstva ter oprema in metode za preskušanje.

Opravljene so bile ekološke analize odpadnih pralnih vod kemijsko-termičnega razkuževalnega procesa v skladu z Uredbo o emisiji snovi pri odvajanju odpadne vode iz naprav za pranje in kemično čiščenje tekstilij (UL RS 41/2007). Izdelane so bile energetske in okoljske bilance za oba negovalna postopka, pri čemer je bila upoštevana metodologija ocene življenjskega cikla izdelka/storitve LCA, popisa stanja LCI ter ocena vplivov na okolje v času življenjskega cikla LCIA.

Rezultati raziskave kažejo, da je porabljena energija za 1 kg opranih tekstilij pri enokopelnem postopku LCO<sub>2</sub> za 2800 kJ manjša kot pri kemijsko-termičnem. Ugotovljeno je bilo tudi, da klasičen kemijsko-termični postopek daje štirikrat višji indeks globalnega segrevanja (GWP<sub>100</sub>) in indeks zakisljevanja (AP), torej sprošča tudi štirikrat več emisij toplogrednih plinov in plinov zakisljevanja kot enokopeljni LCO<sub>2</sub> razkuževalni postopek nege tekstilij.

**Ključne besede:** nega tekstilij, obdelava LCO<sub>2</sub>, odpadne vode, LCA, ekologija

*The laundering procedures for health institutions and the food-processing industry must ensure the elimination of impurities and ap-*

*propriate levels of hygiene. In addition to the classical combination of chemo-thermal disinfection procedures, the laundering procedure based on the liquid carbon dioxide (LCO) technology is becoming more and more assertive. In the previous studies on laundry care processes, the evaluations of disinfection effects have become prominent, while sadly the environmental impacts have remained in the background.*

*The research focused on comparing the environment impacts caused by chemical-thermal and CO<sub>2</sub> laundering procedures regarding medical textiles. Bioindicators, classical and prototype LCO<sub>2</sub> equipment for the textile laundry, detergents, disinfectants and auxiliary agents, as well as the sampling equipment and sampling methods were used for the evaluation of disinfection effects.*

*This paper introduces performed wastewater ecological analyses using a chemo-thermal procedure in accordance with the Slovenian regulation on the substance emission during the removal of wastewater from laundries and dry-cleaner's (Slovenian Official Gazette 41/2007). Energy and environmental balances for both laundering procedures were prepared. Life cycle assessment (LCA), life cycle inventories (LCI) and life cycle impact assessment (LCIA) methodologies were taken into account.*

*The results of our investigation point to the fact that the energy used for 1 kg of textiles during one-bath LCO<sub>2</sub> procedure is in comparison with the chemo-thermal procedure lower by 2,800 kJ. It was also discovered that a classical chemo-thermal procedure has four times higher global warming potential (GWP<sub>TGP</sub>) and acidification potential (AP) than the one-bath LCO<sub>2</sub> laundering procedure, regarding disinfection.*

**Keywords:** textile care, LCO<sub>2</sub> procedure, wastewaters, LCA, ecology.

## Izvirni znanstveni članek *Original Scientific Paper*

Aleš Doliška<sup>1,2</sup>

<sup>1</sup> Univerza v Mariboru, Fakulteta za strojništvo, Laboratorij za obdelavo in preskušanje polimernih materialov, Smetanova 17, 2000 Maribor/  
*University of Maribor, Faculty of Mechanical Engineering, Laboratory for Characterisation and Processing of Polymers, Smetanova 17, SI – 2000 Maribor, Slovenia*

<sup>2</sup> Center odličnosti za polimerne materiale in tehnologije, Tehnološki park 24, 1000 Ljubljana/  
*Centre of Excellence for Polymer Materials and Technologies, Tehnološki park 24, 1000 Ljubljana, Slovenia*

### Uporaba kremenove mikrotehnice za spremljanje adsorpcije biopolimerov

*Use of Quartz Crystal Microbalance (QCM) for Biopolymers Adsorption Studies*

Uporaba polimerov naravnega izvora oziroma biopolimerov se v zadnjih letih povečuje, posebno na področju biorafinerije. Najobetavnejši biopolimeri so rastlinski polisaharidi, ki so potencialni materiali tudi za hidrokoloide in nove napredne narav-

ne materiale. Velika količina potencialno uporabnih hemiceluloz se zavrže med proizvodnjo termomehانيčne pulpe (TMP) z odpadnimi procesnimi vodami. Hemiceluloze iz mehkega lesa, kot je smrekovina, so bile testirane kot material za proizvodnjo biorazgradljivih filmov in hidrokolidov.

Adsorpcija in stabilnost teh adsorbiranih hemiceluloznih filmov sta pomembna dejavnika v koloidni in prehranski kemiji. Ena od tehnik, s katerimi lahko spremljamo adsorpcijo v realnem času, je kremenova mikrotehnica (QCM-D). V našem prispevku smo uporabili kremenovo mikrotehniko za adsorpcijo hemiceluloz iz smrekovine na modelno površino polietilentereftalata (PET). Dodana sol je povečala stopnjo adsorpcije hemiceluloz na površino PET zaradi omiljenja odbojnih sil med negativno nabito površino PET in negativnimi skupinami v hemicelulozah.

**Ključne besede:** QCM-D, hemiceluloze, PET, termomehانيčna pulpa (TMP), galaktoglucomanan

*The importance of biomaterials has been on the increase during the last years, especially in the field of biorefineries. The most abundant biopolymers are plant polysaccharides, which are potential materials for hydrocolloids and novel advanced natural materials. During the thermomechanical pulp (TMP) production, a huge amount of hemicelluloses with a great application potential are disposed with process waters. Hemicelluloses from spruce wood were tested as the material for the production of biodegradable films and as hydrocolloids.*

*Therefore, the adsorption process and stability of adsorbed hemicellulose films are important in the colloid and food chemistry. One of the techniques which can be used for the in situ adsorption studies is quartz crystal microbalance with dissipation unit (QCM-D). In our study, QCM-D was used for monitoring the adsorption of hemicellulose from spruce wood onto model poly(ethyleneterephthalate) (PET) surface. The added salt increased the adsorption of hemicelluloses from softwood due to the shielding of repulsive forces between the negative charges of the PET surface and negative charge groups in hemicelluloses.*

**Keywords:** QCM-D, hemicellulose, PET, thermomechanical pulp (TMP), galactoglucomanan

## Strokovni članek *Professional Paper*

Urška Vrabič Brodnjak

Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za tekstilstvo, Snežniška 5, 1000 Ljubljana/University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Snežniška 5, SI – 1000 Ljubljana, Slovenia

## Oznaka CE

### CE Marking

Oznaka CE je glavni kazalec skladnosti izdelka in potrjuje, da izdelek izpolnjuje bistvene zahteve glede varnosti potrošnikov, zdravja, varovanja okolja, kot jih določa zakonodaja Evropske unije. Z označevanjem izdelkov v skladu z zakonodajo se varuje javni interes z zahtevami po varnih izdelkih, saj se s pomočjo zakonodajnih mehanizmov podpira in omogoča prost pretok blaga znotraj EU. Področje, ki ga vključuje označevanje z oznako CE, je obsežno in zahtevno. Velikokrat prihaja do nejasnih in nerazumljivih razlag opisa oznake, kot so „China Export“ (izvoz iz Kitajske) ali „China Electronics“ (kitajska elektronika) itd. Treba je vedeti, da oznaka ne razkriva izvora izdelka.

**Ključne besede:** oznaka CE, skladnost izdelka, zakonodaja EU, evropski gospodarski prostor

*The CE marking is the main indicator of product compliance, confirming whether a product meets the essential requirements for consumer safety, health and environmental protection, as defined by the law of the European Union. The labelling of products in accordance with law protects the public interest by requiring safe products through legislative mechanisms to support and facilitate the free movement of goods within the EU. The area covered by the CE Marking is extensive and demanding.*

*Frequently, there is an incomprehensible explanation of the description tag, e.g. “China Export” or “China Electronics” etc. It should be noted that the marking does not reveal the origin of the product.*

**Keywords:** CE marking, product compliance, EU law, European Economic Area