

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Energetika v krožnem gospodarstvu
Course title:	Energy supply in circular economy
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski	Energetsko strojništvo (smer)	2. letnik	1. semester

Univerzitetna koda predmeta/University course code: 0566864

Koda učne enote na članici/UL Member course code: 6009-M

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30		30			65	5

Nosilec predmeta/Lecturer: Mihael Sekavčnik, Tine Seljak, Tomaž Katrašnik

Vrsta predmeta/Course type: Obvezni strokovni predmet na smeri Energetsko strojništvo, ki je izbirni strokovni predmet na ostalih smereh./Compulsory specialised course in the study of Energy engineering, which is an elective specialised course in other fields of study.

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: **Prerequisites:**

Izpolnjevanje pogojev za vpis v Magistrski študijski program II. stopnje Strojništvo - Razvojno raziskovalni program.	Meeting the enrollment conditions for the Master's study programme of Mechanical Engineering - Research and Development program.
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Vsebina: **Content (Syllabus outline):**

<p>1. Uvod</p> <p>1. Osnovni principi krožnega gospodarstva (kroženje snovi, energije in informacij)</p>	<p>1. Introduction</p> <p>1. Basic principles of circular economy (material, energy and information looping).</p>
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<ol style="list-style-type: none"> 2. Kriteriji, indikatorji: energijska, snovna in ekonomska učinkovitost 3. Vzorednice s klasičnimi pristopi 4. Strategije prehoda na krožno gospodarstvo 2. Energijski tokovi v krožnem gospodarstvu <ol style="list-style-type: none"> 1. Sistematizacija virov energije s primerjalno analizo tehnologij 2. Diagram energijskih tokov za posamezne vire in države: kronološki, urejeni 3. Časovno usklajevanje energijskih tokov 4. Razpoložljivost proizvodnih virov: energijska, časovna in močnostna 5. Praktični primeri 3. Gospodarnost ukrepov na prehodu v krožno gospodarstvo <ol style="list-style-type: none"> 1. Stroški, struktura specifičnih stroškov, lastna cena, izračun 2. Gospodarska upravičenost naložbe: neto denarni tokovi, neto sedanja vrednost, interna stopnja donosa 3. Praktični primeri 4. Energijski tokovi v proizvodnih procesih <ol style="list-style-type: none"> 1. Racionalno izkoriščanje energijskih virov 2. Ukrepi racionalne rabe energije v gospodarstvu (faktor obremenitve, regeneracija energije, izkoriščanje odpadnih toplot, zmanjševanje lastne rabe) 3. Energetski pregledi: izračun okoljskih in ekonomskih učinkov, energetsko knjigovodstvo 4. Praktični primeri z izračuni 5. Uvajanje obnovljivih virov energije v krožno gospodarstvo <ol style="list-style-type: none"> 1. Vprašanja izravnave energijskih tokov 2. Uvajanje ukrepov aktivnega odjema 3. Proizvajalci & Odjemalci = 'Prodjemalci' (Prosumers) 4. Elementi virtualnih elektrarn in pametnih energetskih omrežij 5. Praktični primeri z izračuni 6. Tehnologije za prehod med materialnim in energijskim krogom. <ol style="list-style-type: none"> 1. Razpoložljive tehnologije za konverzijo in rekonverzijo snovnih tokov v energijske tokove (termična in termokemična pretvorba, kemična reciklaža, tehnologije za pretvorbo CO₂), ključne značilnosti. 2. Področja uporabe posameznih tehnologij. 3. Omejitve tehnologij in fleksibilnost. 4. Okoljski učinki 5. Razvoj, snovanje in optimizacija tehnologij, ki omogočajo okoljsko sprejemljivo pridobivanje energije v krožnem gospodarstvu. 	<ol style="list-style-type: none"> 2. Criteria and indicators for circular economy: energy efficiency, material efficiency, economic efficiency. 3. Comparative analysis to linear economy. 4. Strategies for transition into circular economy 2. Energy flows in circular economy. <ol style="list-style-type: none"> 1. Classification of energy sources with comparative analysis of available technologies for energy conversion. 2. Energy flow charts for local, regional and global energy sources: chronological and load duration curve 3. Stability of power supply and system demand 4. Availability of power generation sources: energy-, time- and power- related availability. 5. Case studies. 3. Energy management during transition into circular economy. <ol style="list-style-type: none"> 1. Costs, structure of specific costs, least cost of energy, calculations. 2. Economic justification of investment: net cash flow, net present value, internal rate of return. 3. Case studies. 4. Energy flows in industrial processes. <ol style="list-style-type: none"> 1. Rational use of resources. 2. Measures for rational industrial energy use: load factor, regeneration, waste heat recovery, reduction of auxiliary energy consumption. 3. Energy audits: evaluation of environmental and economic impacts, energy accounting. 4. Case studies with calculations. 5. Introduction of renewable energy sources in circular economy <ol style="list-style-type: none"> 1. Grid stability challenges. 2. Employing demand side management techniques. 3. Multi-functional players in energy market: Producers & Consumers = Prosumers. 4. Elements of virtual power plants and smart grids. 5. Case studies with calculations. 6. Technologies for coupling material and energy cycles. <ol style="list-style-type: none"> 1. Available technologies for conversion and reconversion of material streams in energy streams (thermal and thermochemical conversion, chemical recycling, technologies for CO₂ conversion), key characteristics. 2. Applicable use areas for different conversion
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<p>7. Osnove snovanja energetskih tehnologij v krožnem gospodarstvu.</p> <ol style="list-style-type: none"> 1. Osnove reakcijskih poti pirolize, uplinjanja in plazemskih tehnologij. 2. Osnove sinteze novih energentov (surovin) 3. Metode vrednotenja lastnosti materialov, proces izbire ustreznih poti pretvorbe. 4. Valorizacija snovnih tokov. <p>8. Sektorsko sklapljanje</p> <ol style="list-style-type: none"> 1. Izraba presežnih energijskih tokov iz OVE za 'proizvodnjo' nizkoogljičnih nosilcev energije 2. Energijski vektorji, ki temeljijo na vodiku (energetika + transport) in njihova uporaba kot vstopne surovine za kemijsko industrijo 3. Hranilniki enegije 4. Praktični primeri <p>9. Tehnologije za shranjevanje in pretvorbo CO₂.</p> <ol style="list-style-type: none"> 1. Energijski vektorji, ki temeljijo na pretvorbi CO₂ (sintetični metan in sintetični metanol, sintetični ogljikovodiki) 2. Analiza energijskih ravni, procesi sinteze energentov, katalitični procesi. 3. Dimenzioniranje sistemov z ozirom na termodinamske parametre in kemijsko-fizikalno sestavo virov CO₂. 4. Energijska optimizacija tehnologij. 5. Umeščanje tehnologij v obstoječe sisteme in ponovna uporaba produktov pretvorbe v energetskih sistemih. <p>10. Termična obdelava odpadnih snovnih tokov za namene energetske rabe</p> <ol style="list-style-type: none"> 1. Določitev termodinamskih parametrov, dimenzioniranje, zagotavljanje fleksibilnosti glede na vstopne materiale, postopki predpriprave vstopnih materialov 2. Energijska in masna bilanca, upravljanje stranskih produktov, predikcija koncentracij v plinastih produktih in trdnih snoveh 3. Izbira materialov za gradnjo sistemov 4. Izbira procesov za naknadno obdelavo stranskih produktov 5. Presoja vplivov na okolje <p>11. Termokemične tehnologije za pretvorbo odpadnih snovnih tokov.</p> <ol style="list-style-type: none"> 1. Izbira ustreznih procesov pretvorbe z ozirom na kemijsko-fizikalne lastnosti vstopnih materialov. 2. Vodenje termičnega razpada. 3. Entalpijske ravni procesov, snovna in energetska učinkovitost, izbira materialov za gradnjo. 4. Pristopi dekontaminacije produktov naprednih termo-kemičnih tehnologij <p>12. Kemično recikliranje.</p>	<p>technologies.</p> <ol style="list-style-type: none"> 3. Limitations and flexibility of conversion technologies. 4. Environmental impact. 5. Development, design and optimization of technologies for environmentally acceptable power generation in circular economy. <p>7. Design fundamentals of energy technologies in circular economy.</p> <ol style="list-style-type: none"> 1. Reaction pathway fundamentals for pyrolysis, gasification and plasma technologies. 2. Fundamentals of energy carrier, fuel and basic chemical synthesis. 3. Characterization of feedstock, selection of suitable conversion pathways. 4. Waste stream valorisation. <p>8. Sector coupling</p> <ol style="list-style-type: none"> 1. Peak shaving and energy storage with low-carbon synthetic fuels. 2. Hydrogen based energy carriers (for energy sector and transport) and their use as basic chemicals. 3. Energy storage. 4. Case studies. <p>9. Technologies for carbon capture and utilization.</p> <ol style="list-style-type: none"> 1. CO₂ based synthetic energy carriers (methane, methanol, hydrocarbons). 2. Energy balance analysis, synthesis pathways, catalytic processes. 3. Design of conversion systems based on thermodynamic parameters and physical and chemical properties of CO₂ sources. 4. Energy optimization of conversion technologies. 5. Positioning of technologies in existing energy systems, reuse of CO₂ based energy carriers in existent infrastructure. <p>10. Thermal treatment of waste streams with energy recovery.</p> <ol style="list-style-type: none"> 1. Designing thermodynamic parameters, achieving flexibility according to input material properties, feedstock pre-processing. 2. Energy and mass balance, management of side streams, prediction of pollutant concentrations and composition. 3. Selection of build materials. 4. Selection of flue gas and side stream aftertreatment systems. 5. Impact on environment. <p>11. Thermochemical technologies for conversion of waste streams.</p> <ol style="list-style-type: none"> 1. Selection of suitable thermochemical
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<ol style="list-style-type: none"> 1. Dimenzioniranje procesa, vodenje razklopa polimernih materialov, optimizacija snovnih in energijskih izkoristkov. 2. Variacije termodinamskih parametrov z ozirom na kemijsko-fizikalne lastnosti vstopnih materialov. 3. Optimizacija procesa z ozirom na lastnosti produktov. 4. Karakterizacija produktov s poudarkom na energentih, izračuni končnih masnih in energijskih bilanc <ol style="list-style-type: none"> 13. Bio-osnovane tehnologije. <ol style="list-style-type: none"> 1. Tehnologije pridobivanja bioplina, biometana, izbor surovin, vodenje procesnih pogojev. 2. Viri in tehnologije za predpripravo in izboljšanje kemijsko-fizikalnih lastnosti bio-olj. 3. Postopki za neposredno uporabo tekočin in plinastih bio-osnovanih produktov v sistemih z visokim učinkovitim izkoristkom. 14. Metode vrednotenja <ol style="list-style-type: none"> 1. Inventarji življenjskih ciklov za proizvode in procese – LCI 2. Indikatorji vrednot 3. Analize življenjskih ciklov (celostne masne, energijske in okoljske bilance) – LCA 4. Analize življenjskih stroškov – LCC 5. Vračilo energijskega vložka – EROI 15. Krožni energetski sistemi prihodnosti <ol style="list-style-type: none"> 1. Refleksija in povezovanje vsebin 2. Primeri dobrih praks iz izračuni in primerjalnimi analizami 3. Učinkoviti krožni energetski sistemi prihodnosti 	<ol style="list-style-type: none"> pathways according to physical and chemical properties of input materials. 2. Controlling the process of thermal degradation. 3. Enthalpy levels, material and energy efficiency, selection of build materials. 4. Post processing of products. <ol style="list-style-type: none"> 12. Chemical recycling. <ol style="list-style-type: none"> 1. Process design, control of depolymerization process, optimization of material and energy efficiency. 2. Selection of thermodynamic parameters according to chemical and physical properties of input materials. 3. Process optimization according to desired properties of output products. 4. End product characterization with emphasis on energy carriers, final evaluation of mass and energy balance. 13. Bio-based technologies and utilization of bio-based products for energy use <ol style="list-style-type: none"> 1. Technologies for production of biogas, selection of input materials, control of process parameters. 2. Input materials and technologies for pre-treatment and improvement of chemical and physical properties of bio-oils. 3. Processes for direct use of liquid and gaseous bio-based products in systems with high effective efficiency. 14. Evaluation methods <ol style="list-style-type: none"> 1. Life cycle inventory for products and processes (LCI). 2. Value indicators. 3. Life cycle analysis (LCA), mass, energy and environmental balances. 4. Life cycle cost analysis (LCC). 5. Energy return over energy invested (EROI). 15. Future energy systems. <ol style="list-style-type: none"> 1. Cross-linking of acquired knowledge within the subject. 2. Case studies, best practice examples with comparative analysis. 3. Efficient energy systems for circular economy.
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Temeljna literatura in viri/Readings:

1. Weber G.: Sustainability and Energy Management, Springer, 2017
2. Ghosh S.H.: Waste Management as Economic Industry Towards Circular Economy, Springer 2020
3. Sillanpää M., Ncibi C.: The Circular Economy, Elsevier, 2019
4. Roosa A., Doty S., Turner W. C.: Energy Management Handbook, 9th Edition, CRC Press, 2018

5. [Paul T. Williams](#), 2005, Waste treatment and disposal. John Wiley & Sons, Ltd, DOI:10.1002/0470012668
6. [Anthony Dufour](#), 2016, Thermochemical Conversion of Biomass for the Production of Energy and Chemicals. John Wiley & Sons, Inc, DOI:10.1002/9781119137696.

Cilji in kompetence:

Cilji:

1. Uporabiti interdisciplinarna in transdisciplinarna znanja s področij tehnike, naravoslovja, okoljskih ved in ekonomije za kreiranje novih in inovativnih konceptov ravnanja s snovnimi in energijskimi tokovi
2. Razvoj in uporaba računalniško podprtih metod za simulacijo in procesov, značilnih za krožno gospodarstvo
3. Uporaba metod za celostno vrednotenje produktov in procesov ter snovanje novih strategij pri prehodu na paradigmo krožnega gospodarstva.
4. Vzpostavljane novih konceptov rabe energije s sektorskim povezovanjem in novimi poslovnimi modeli.
5. Spoznati metodolgijo in uporabo orodij za vrednotenje celovitih vplivov procesov za pretvorbo odpadnih snovnih tokov (termokemični in bio-osnovani procesi).

Kompetence:

1. Sposobnost povezovanja interdisciplinarnih in transdisciplinarnih znanj različnih področij strojništva, naravoslovja in ekonomije (S1-MAG + S7-MAG + S4-MAG + S10-MAG + P1-MAG + P2-MAG + P3-MAG + P4-MAG + P6-MAG + + P7-MAG)
2. Sposobnost načrtovanja in celostne presoje produktov in procesov v krožnem gospodarstvu (S7-MAG + S10-MAG + P2-MAG + P4-MAG)
3. Sposobnost modeliranja in celostnega vrednotenja sodobnih energetskih rešitev, ki temeljijo na izrabi razpršenih OVE, sektorskega sklapljanja in pametnih omrežij (energetika, promet, industrija) (S1-MAG + S7-MAG + S4-MAG + S10-MAG + P1-MAG + P2-MAG + P3-MAG + P4-MAG + P6-MAG + + P7-MAG)
4. Obvladanje optimizacije in izbire ustreznih termokemičnih in bio-osnovanih procesov glede na dano aplikacijo, vstopne surovine in zelene končne produkte. (S1-MAG + S2-MAG + S8-MAG + S9-MAG + P1-MAG + P2-MAG + P3-MAG + P7-MAG)

Objectives and competences:

Objectives:

1. Use of interdisciplinary and transdisciplinary engineering, natural sciences, environmental sciences and economics skills to create new and innovative concepts for material and energy flow management
2. Development and the use of computer-aided methods to simulate processes relevant to circular economy
3. Use of methods for holistic evaluation of products and processes and formulation of new strategies in the transition to the circular economy paradigm.
4. Establishing new energy use concepts through sector-coupling and new business models.
5. Obtain the knowledge on methods and tools for evaluation of overall impact of waste conversion processes. (thermochemical and bio-based processes).

Competences:

1. Ability to integrate interdisciplinary and transdisciplinary skills in various fields of mechanical engineering, natural science and economics (S1-MAG + S7-MAG + S4-MAG + S10-MAG + P1-MAG + P2-MAG + P3-MAG + P4-MAG + P6-MAG + + P7-MAG)
2. Ability to design and evaluate products and processes in a circular economy (S7-MAG + S10-MAG + P2-MAG + P4-MAG)
3. Ability to model and holistically evaluate modern energy solutions based on the use of disperse RES, sectoral coupling and smart grids (energy, transport, industry) (S1-MAG + S7-MAG + S4-MAG + S10-MAG + P1-MAG + P2-MAG + P3-MAG + P4-MAG + P6-MAG + + P7-MAG)
4. Mastering optimization and selection of thermochemical and bio-based processes according to the required application, input materials and output products. (S1-MAG + S2-MAG + S8-MAG + S9-MAG + P1-MAG + P2-MAG + P3-MAG + P7-MAG)

Predvideni študijski rezultati:

Intended learning outcomes:

<p>Znanja:</p> <p>Z2: Poglobljeno teoretično, metodološko in analitično znanje z elementi raziskovanja, ki je osnova za zelo zahtevno strokovno delo.</p> <p>Spretnosti:</p> <p>S2.1 Obvladovanje zelo zahtevnih, kompleksnih delovnih procesov in metodoloških orodij na specializiranih področjih.</p> <p>S2.2 Načrtovanje in vodenje delovnega procesa na podlagi ustvarjalnega reševanja problemov, povezanih s področjem izobraževanja in usposabljanja.</p> <p>S2.3 Sposobnost izvirnih dognanj/stvaritev in kritične refleksije.</p>	<p>Knowledge:</p> <p>Z2: Thorough theoretical, methodological and analytical knowledge with elements of a research work that form a basis for very demanding professional work</p> <p>Skills:</p> <p>S2.1 Mastering very demanding and complex work processes and methodological tools in specialised professional fields.</p> <p>S2.2 Planning and managing of the working process on the basis of creative solving of problems that are linked to the teaching and training content.</p> <p>S2.3 Ability of unique innovations and critical reflections.</p>
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Metode poučevanja in učenja:

Learning and teaching methods:

<p>Klasične oblike poučevanja:</p> <p>P1 Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov.</p> <p>P2 Obravnava snovi po urejeni in vnaprej razloženi sistematiki.</p> <p>P3 Avditorne vaje, kjer se teoretično znanje s predavanj podkrepi z računskimi primeri.</p> <p>P4 Laboratorijske vaje z namenski didaktičnimi pripomočki (opišite katerimi- maks. dve vrstici na en pripomoček).</p> <p>P5 Uporaba študijskega gradiva v obliki tiskane in e-verzije predstavitve.</p> <p>Moderne in prožne oblike poučevanja:</p> <p>P7 Študij literature in razprava</p> <p>P8 Izdelava in predstavitev aplikativnih seminarских nalog</p> <p>P9 Skupinsko delo: strukturirana diskusija, projektno delo.</p> <p>P10: Uporaba anket v realnem času.</p> <p>P12 Individualizirane domače naloge v spletni učilnici</p> <p>P14 Virtualni eksperimenti</p> <p>P15 Uporaba video vsebin kot priprava na predavanja in vaje</p>	<p>Conventional teaching methods:</p> <p>P1 Auditorial lectures with solving selected field-specific theoretical and applied use cases.</p> <p>P2 Presenting the content according to the explained system.</p> <p>P3 Auditorial exercises, in which theoretical content from the lectures is supplemented with practical examples.</p> <p>P4 Laboratory exercises with special-purpose didactic devices (description needs to be added, max. two lines per device).</p> <p>P5 Application of study material (description needs to be added, max. one line per material, e.g. textbook, e-book, printed lecture presentations, etc.).</p> <p>Contemporary and flexible teaching methods:</p> <p>P7 Literature study and discussion.</p> <p>P8 Making and presenting applied seminar exercises.</p> <p>P9 Team work: structured discussion, project work.</p> <p>P10: Use of real-time surveys</p> <p>P14 Virtual experiments.</p> <p>P15 Application of videos for preparations to the lectures and exercises.</p>
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Načini ocenjevanja:**Delež/Weight****Assessment:**

Teoretične vsebine (predavanja).	50,00 %	Theoretical contents (lectures).
Samostojno delo na vajah.	30,00 %	Coursework.
Delo na laboratorijskih vajah.	20,00 %	Laboratory exercises.

Reference nosilca/Lecturer's references:**Mihael Sekavčnik**

1. STROPNIK, Rok, LOTRIČ, Andrej, MONTENEGRO, Alfonso Bernad, SEKAVČNIK, Mihael, MORI, Mitja. Critical materials in PEMFC systems and a LCA analysis for the potential reduction of environmental impacts with EoL strategies. *Energy science & engineering*. Sep. 2019, f. 1-21, ilustr. ISSN 2050-0505. <https://onlinelibrary.wiley.com/doi/full/10.1002/ese3.441>, DOI: 10.1002/ese3.441. [COBISS.SI-ID 16811803]
2. STROPNIK, Rok, SEKAVČNIK, Mihael, FERRIZ, Ana María, MORI, Mitja. Reducing environmental impacts of the ups system based on PEM fuel cell with circular economy. *Energy*. [Print ed.]. 2018, vol. 165, part b, str. 824-835, ilustr. ISSN 0360-5442. <https://www.sciencedirect.com/science/article/pii/S0360544218319790?via%3Dihub>, DOI: 10.1016/j.energy.2018.09.201. [COBISS.SI-ID 16276763]
3. LOTRIČ, Andrej, SEKAVČNIK, Mihael, POHAR, Andrej, LIKOZAR, Blaž, HOČEVAR, Stanko. Conceptual design of an integrated thermally self-sustained methanol steam reformer : high-temperature PEM fuel cell stack manportable power generator. *International journal of hydrogen energy*. [Print ed.]. Jun. 2017, vol. 42, iss. 26, str. 16700-16713, ilustr. ISSN 0360-3199. <http://www.sciencedirect.com/science/article/pii/S0360319917319225>. [COBISS.SI-ID 15546139]
4. NAROBÉ, Miha, GOLOB, Janvit, MELE, Jernej, SEKAVČNIK, Mihael, SENEGAČNIK, Andrej, KLINAR, Dušan. Scale-up research in a dual fluidized bed gasification process. *Acta chimica slovenica*. [Tiskana izd.]. 2015, vol. 62, no. 2, str. 394-402. ISSN 1318-0207. <https://journals.matheo.si/index.php/ACSi/article/view/1060>, DOI: 10.17344/acsi.2014.1060. [COBISS.SI-ID 18783254]
5. GANTAR, Gašper, GLOJEK, Andrej, MORI, Mitja, NARDIN, Blaž, SEKAVČNIK, Mihael. Resource efficient injection moulding with low environmental impacts. *Strojniški vestnik*. Mar. 2013, vol. 59, no. 3, str. 193-200, si 35, ilustr. ISSN 0039-2480. DOI: [10.5545/sv-jme.2012.661](https://doi.org/10.5545/sv-jme.2012.661). [COBISS.SI-ID [12749083](https://doi.org/10.5545/sv-jme.2012.661)]

Tomaž Katrašnik

1. SELJAK, Tine, KATRAŠNIK, Tomaž. Designing the microturbine engine for waste-derived fuels. *Waste management*, ISSN 0956-053X. [Print ed.], Jan. 2016, vol. 47, pt. B, str. 299-310
2. SELJAK, Tine, RODMAN OPREŠNIK, Samuel, KATRAŠNIK, Tomaž. Microturbine combustion and emission characterisation of waste polymer-derived fuels. *Energy*, ISSN 0360-5442. [Print ed.], 2014, vol. 77, str. 226-234
3. BUFFI, Marco, SELJAK, Tine, CAPPELLETTI, Alessandro, BETTUCCI, Lorenzo, VALERA-MEDINA, Augustin, KATRAŠNIK, Tomaž, CHIARAMONTI, David. Performance and emissions of liquefied wood as fuel for a small scale gas turbine. *Applied energy*, ISSN 0306-2619, Nov. 2018, vol. 230, str. 1193-1204
4. ŽVAR BAŠKOVIČ, Urban, VIHAR, Rok, SELJAK, Tine, KATRAŠNIK, Tomaž. Feasibility analysis of 100% tire pyrolysis oil in a common rail Diesel engine. *Energy*, ISSN 0360-5442. [Print ed.], Oct. 2017, vol. 137, str. 980-990
5. VIHAR, Rok, SELJAK, Tine, RODMAN OPREŠNIK, Samuel, KATRAŠNIK, Tomaž. Combustion characteristics of tire pyrolysis oil in turbo charged compression ignition engine. *Fuel*, ISSN 0016-2361. [Print ed.], Jun. 2015, vol. 150, str. 226-235

Tine Seljak

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