

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Analizna kemija v industriji
Course title:	Industrial Analytical Chemistry

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Ekotehnologije, 2. stopnja		1	2
Ecotechnologies, 2 nd cycle		1	2

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: EKO2-867

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
15	15			15	105	5

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transferred to individual work.*

Nosilec predmeta / Lecturer: Prof. dr. Radmila Milačič
Prof. dr. Janez Ščančar
Prof. dr. Milena Horvat
Prof. dr. Ester Heath

Jeziki / Predavanja / Lectures: Slovenski ali angleški / Slovene or English
Languages: Seminar: Angleški / English

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

Zaključen študij prve stopnje naravoslovne ali tehniške smeri ali zaključen študij drugih smeri z dokazanim poznavanjem osnov področja predmeta (pisna dokazila, pogovor).

Prerequisites:

Completed first-cycle studies in natural sciences or engineering or completed second-cycle studies in other fields with proven knowledge of the fundamentals in the field of this course (certificates, interview).

Vsebina:

Predmet je usmerjen v poznavanje vloge analizne kemije v industriji, v povezavi s:

- Kontrolo industrijskih procesov in proizvodov.
- Zmanjševanjem izpustov kontaminantov v zrak, terestrično in vodno okolje.
- Reševanje okoljskih problemov, nastalih kot posledica industrijskih dejavnosti.
- Reševanje tehnoloških in okoljskih problemov v povezavi z zahtevami ustrezne zakonodaje.

Content (Syllabus outline):

The course is focused on the role of analytical chemistry in industry in relation to:

- Control of industrial processes and products.
- Minimization of contaminant releases into air, terrestrial and aquatic environment.
- Solutions to environmental problems as a consequence of industrial activities.
- Solutions to technological and environmental problems related to relevant legislative demands.

- Poznavanje naprednih tehnologij čiščenja v različnih industrijskih procesih z namenom zmanjševanja emisij.
- Recikliranje in ponovna uporaba odpadnih materialov in preučevanje vplivov novih materialov na okolje.

Seznanjanje z osnovami kemijske analize.

- Napredne analizne metodologije za analizo anorganskih in organskih kontaminantov.
- Masna spektrometrija z induktivno sklopljeno plazmo (ICP-MS) za določitev koncentracij elementov in sklopljene tehnike plinske ali tekočinske kromatografije (GC, HPLC) z ICP-MS za določitev koncentracij kemijskih zvrsti elementov (speciacijska analiza).
- Masno spektrometrične metode (tandemska masna spektrometrija (MS/MS, GC-MS, HPLC-MS) za določitev nizkih koncentracij organskih kontaminantov in njihovih metabolitov.
- Protokoli vzorčenja za plinaste, tekoče in trdne vzorce.
- Hranjenje vzorcev.
- Predpriprava vzorcev na analizo.
- Metrološki vidiki industrijske analizne kemije.

Izbrane študije

- Vloga speciacije kroma v industriji in gradbeništvu (speciacija kroma v usnjarski, avtomobilski in cementni industriji, jeklarstvu, speciacija kroma na delovnih mestih varilcev, varno odlaganje odpadkov, bogatih na kromu, ponovna uporaba odpadnih materialov, ki vsebujejo krom – okoljski vidiki).
- Vloga speciacije živega srebra v industriji (klor-alkalna, petrokemična, cementna in farmacevtska industrija).
- Kroženje bisfenola A in njegovih alternativ v okolju, hrani in bioloških matricah.

- Advanced clean-up technologies in different industrial processes for minimization of emissions.
- Recycling and re-use of waste materials and investigating environmental impacts of new materials.

Introduction into the fundamentals of chemical analysis.

- Advanced analytical methodologies for analysis of inorganic and organic contaminants.
- Inductively coupled plasma mass spectrometry (ICP-MS) for the determination of elemental concentrations and hyphenated techniques like gas or liquid chromatography (GC, HPLC) coupled to ICP-MS for the determination of concentrations of chemical species of elements (speciation analysis).
- Mass spectrometry analytical techniques (tandem mass spectrometry (MS/MS, GC-MS, HPLC-MS) for the determination of trace amounts of organic contaminants and their metabolites.
- Sampling protocols for gaseous, liquid and solid samples.
- Sample preservation.
- Sample pre-treatment prior to analysis.
- Metrological aspects related to industrial analytical chemistry.

Examples of selected case studies

- The role of chromium speciation in industry and civil engineering (speciation of chromium in leather, car, cement, and steel-making industries, speciation of chromium at the workplace of welders, safe disposal of chromium-rich waste materials, re-use of waste materials containing chromium – environmental concerns).
- The role of mercury speciation in industry (chlor-alkali, petrochemical, cement, and pharmaceutical industries).
- Cycling of bisphenol A and its alternatives in the environment, food and biological matrices.

Temeljni literatura in viri / Readings:

Knjige / Books:

- Pathak, H. 2013. Industrial pollution, Amazon.in, Amazon Asia-Pacific Holdings Private Limited, 31 pages.
- Carol, J. (Ed.). 2015. Advanced Analytical Chemistry, NY Research Press, 216 pages.

- Matusiewicz, H., Bulska, E. 2018. Inorganic Trace Analytics. Trace Element Analysis and Speciation, Walter de Gruyter GmbH, Berlin, 437 pages.

Revije / Periodicals:

- Journals related analytical chemistry / revije s področja analize kemije (Analytical Chemistry, Analytica Chimica Acta, Microchimica Acta, Journal of Chromatography A, Journal of Analytical Atomic Spectrometry, Talanta)
- Journals related to environmental sciences / revije s področja okoljskih znanosti (Environmental Science and Technology, Environmental Pollution, Water Research, Science of the Total Environment, Chemosphere, Environmental Research)
- Journals related to chemical engineering / revije s področja kemijskih tehnologij (Journal of Hazardous Materials, Journal of Environmental Management, Waste Management)
- Journals related to processing technologies / revije s področja tehnoloških procesov (Fuel, Fuel processing Technology)
- Pregledni članki, izbor v tekočem letu / Review articles, yearly selection

Cilji in kompetence:

Cilji:

Seznaniti študente z osnovami:

- Uporabe analiznih metodologij pri analitiki anorganskih in organskih kontaminantov, ki nastajajo pri različnih industrijskih procesih.
- Pridobiti osnovna znanja o vlogi analize kemije (elementna sestava, kemijske zvrsti elementov, organske spojine) pri kontroli različnih industrijskih procesov in kvalitete izdelkov.
- Pridobiti osnovna znanja o pretvorbah kemijskih zvrsti elementov in organskih spojin v različnih industrijskih procesih.
- Pridobiti osnovna znanja o emisijah različnih kontaminantov (anorganskih in organskih) v zrak, terestrično in vodno okolje.
- Pridobiti osnovna znanja o preprečevanju onesnaževanja okolja.
- Predstaviti študentom relevantno zakonodajo, povezano z različnimi industrijskimi procesi.
- Pridobiti informacijo o problemih, povezanih z industrijskimi odpadki in njihovim varnim odlaganjem.
- Pridobiti informacijo o možnosti recikliranja in ponovne uporabe različnih odpadnih materialov v gradbeništvu.
- Predlagati načine reševanja okoljskih problemov, nastalih zaradi specifičnih industrijskih dejavnosti.

Kompetence:

- Pridobiti osnovna znanja s področja analize kemije in njene uporabe v različnih

Objectives and competences:

Objectives:

To introduce the students to the fundamentals of

- The use of analytical methodologies for analysis of inorganic and organic contaminants resulting from different industrial processes.
- To gain basic knowledge on the role of analytical chemistry (elemental analysis, chemical speciation and organic analysis) in control of industrial processes and the quality of products.
- To gain basic knowledge on the transformation of chemical species of elements and organic compounds in different industrial processes.
- To gain the basic knowledge on emission of different contaminants (inorganic and organic) into the air, terrestrial and aquatic environment.
- To gain the basic knowledge on pollution prevention.
- To present to students the relevant legislation related to different industrial processes.
- To acquire information on problems related to industrial wastes and their safe disposal.
- To acquire information on the possibilities of recycling and re-use of different waste materials in civil engineering.
- To propose solutions of the environmental problems originating from specific industrial activities.

Competences:

- To gain knowledge on basic principles of analytical chemistry and its applications in

industrijskih procesih, pri kontroli kvalitete izdelkov in preprečevanju onesnaženosti okolja.

- Seznaniti se z ustrežno zakonodajo, povezano z različnimi industrijskimi procesi.
- Pridobiti zmožnost razumevanja in reševanja specifičnih industrijskih problemov.
- Vključevanje znanj pri reševanju problemov, ki so povezani z raziskovalnim delom magistrske naloge kandidata.

different fields of industrial processes, control of quality of products and pollution prevention.

- To be acquainted with the relevant legislation related to different industrial processes.
- To acquire the ability for understanding and solving the specific industrial problems.
- To integrate the knowledge for solving the problems related to the candidate's research on the master thesis.

Predvideni študijski rezultati:

- Poznavanje in razumevanje različnih industrijskih procesov.
- Poznavanje in razumevanje analize kemije in njene vloge pri študiju pretvorb kemijskih zvrsti elementov in organskih spojin v industrijskih procesih ter pri preučevanju vpliva različnih industrijskih procesov na okolje.
- Vključevanje pridobljenih znanj pri reševanju problemov, povezanih s temo magistrske naloge.

Intended learning outcomes:

- Knowledge and understanding of different industrial processes.
- Knowledge and understanding of analytical chemistry and its role in studying the transformation of chemical species of elements and organic compounds in industrial processes and in investigations of the impact of different industrial activities on the environment.
- Integration of the skills in solving of the problems related with the topic of the master thesis.

Metode poučevanja in učenja:

- Predavanja.
- Interaktivno delo s študentom pri reševanju specifičnih industrijskih problemov.
- Seminar.

Learning and teaching methods:

- Lectures.
- Interactive work with students to solve specific industrial problems.
- Seminar work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
• Seminar.	30 %	• Seminar.
• Ustni izpit.	30 %	• Oral examination.
• Predstavitev in reševanje specifičnega primera.	40 %	• Presentation and solving of a specific case.

Reference nosilca / Lecturer's references:

Radmila Milačič: No. of articles: 154, No. of EU patents 1, citations: 2243, h-index 27

- DRINČIČ, Ana, NIKOLIĆ, Irena, ZULIANI, Tea, MILAČIČ, Radmila, ŠČANČAR, Janez. Long-term environmental impacts of building composites containing waste materials: evaluation of the leaching protocols. *Waste Management*, 2017, 59, 340-349.
- ZALAR SERJUN, Vesna, MLADENOVIČ, Ana, MIRTIČ, Breda, MEDEN, Anton, ŠČANČAR, Janez, MILAČIČ, Radmila. Recycling of ladle slag in cement composites: environmental impacts. *Waste Management*, 2015, 43, 376-385.

Janez Ščančar: No. of articles: 127, No. of EU patents 1, citations: 1565, h-index 21

- ŠČANČAR, Janez, MILAČIČ, Radmila. A critical overview of Cr speciation analysis based on high performance liquid chromatography and spectrometric techniques. *Journal of Analytical Atomic*

Spectrometry, 2014, 29, 427-443.

- DRINČIĆ, Ana, ŠČANČAR, Janez, ZULIANI, Tea, NIKOLIĆ, Irena, MILAČIČ, Radmila. Simultaneous speciation of chromate, arsenate, molybdate and vanadate in alkaline samples by HPLC-ICP-MS at different concentration levels of vanadate. *Journal of Analytical Atomic Spectrometry*, 2017, 32, 2200-2209.

Milena Horvat: No. of articles: 250, citations: 6800, h-index 37

- STERGARŠEK, Andrej, HORVAT, Milena, FRKAL, Peter, RIBEIRO GUEVARA, Sergio, KOCJANČIČ, Robert. Removal of Hg⁰ in wet FGD by catalytic oxidation with air - A contribution to the development of a process chemical model. *Fuel*, 2013, 107, 183-191.
- SEDLAR, Matej, PAVLIN, Majda, JAČIMOVIĆ, Radojko, STERGARŠEK, Andrej, FRKAL, Peter, HORVAT, Milena. Temperature Fractionation (TF) of Hg compounds in gypsum from wet flue gas desulfurization system of the coal fired Thermal Power Plant (TPP). *American Journal of Analytical Chemistry* 2015, 6, 939-956.

Ester Heath: No. of articles: 65, citations: 1741, h-index 24

- ČESEN, Marjeta, LENARČIČ, Kaja, MISLEJ, Vesna, LEVSTEK, Meta, KOVAČIČ, Ana, CIMRMANČIČ, Bernardka, URANJEK ŽEVART, Nataša, KOSJEK, Tina, HEATH, David John, SOLLNER DOLENC, Marija, HEATH, Ester. The occurrence and source identification of bisphenol compounds in wastewaters. *Science of the Total Environment*, 2018, 616-617, 744-752.
- COVACI, A., HORVAT, M., HEATH, E., KOSJEK, T., MAZEJ, D., SNOJ TRATNIK, J., et al. Urinary BPA measurements in children and mothers from six European member states: overall results and determinants of exposure. *Environmental Research*, 2015, 141, 77-85.

Poglavja v knjigi/Book Chapters

- ŠČANČAR, Janez, MILAČIČ, Radmila. Safe disposal and re-use of chromium rich waste materials. V: BALART MURRIA, María José (ur.). *Management of hazardous residues containing Cr(VI)*, (Waste and waste management). New York: Nova Science Publishers, cop. 2011, 295-317.