



ЦЕНТЪР ЗА ОБУЧЕНИЕ – БАН

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Basic Information

Course Title: **Catalysis for Environmental Protection and Energy Production**

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Total Teaching Hours 30 academic hours

Annotation (up to 150 words)

The aim of the course is to familiarize PhD students with the selection, preparation, characterization, and testing of catalysts for important processes related to environmental protection (removal of harmful pollutants from waste gases) and energy applications (hydrogen production and purification). The catalytic processes emphasized in the course include the catalytic combustion of volatile organic compounds (VOCs) and carbon monoxide. The course will cover the preparation and selection of novel active and stable catalysts for hydrocarbon reforming processes aimed at hydrogen production. PhD students will become acquainted with the reaction mechanisms, physicochemical and catalytic properties of catalysts, as well as the influence of various factors on coke formation and its removal from catalyst surfaces. The course will also examine catalyst types used in hydrogen-rich gas purification processes, including the water-gas shift reaction and the preferential oxidation of carbon monoxide in the presence of hydrogen.

Course Content (brief description by topics or modules)

Topic/Module 1: Catalysts for the Removal of Volatile Organic Compounds (VOCs). Volatile organic compounds, sources, environmental impact, removal technologies, noble metal catalysts, transition metal oxide catalysts, mixed oxide catalysts, perovskites and spinels.

Topic/Module 2: Mesoporous Materials as Catalyst Supports for VOC Oxidation. Classification and types of mesoporous materials, synthesis methods, structural and textural characteristics, advantages as catalyst supports, and applications in VOC oxidation.

Topic/Module 3: Zeolites as Catalyst Supports for VOC Oxidation. Definition, framework structure, ion-exchange and adsorption properties, and applications as catalysts, adsorbents and ion exchangers.

Topic/Module 4: Methods for Hydrogen Production. Electrolysis, photocatalytic methods, hydrogen production from biomass, steam reforming, and dry reforming of methane with CO₂.

Topic/Module 5: Hydrogen Purification. Hydrogen purification methods: water-gas shift



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reaction, preferential oxidation of CO in the presence of hydrogen. Catalyst types for these processes.

Competencies acquired as a result of training (3–5 points)

1. Fundamental knowledge of catalysts for VOC and CO removal.
2. Knowledge of catalyst supports used for VOC removal.
3. Understanding of catalytic mechanisms.
4. Knowledge of hydrogen production and purification methods.

References

1. Ronald A. Bailey, Herbert M. Clark, James P. Ferris, Sonja Krause and Robert L. Strong, **Chemistry of the Environment** (Second Edition), 2002 Elsevier Inc.
<http://www.sciencedirect.com/science/book/9780120734610>
2. Roberto Fiorenza, Bimetallic Catalysts for Volatile Organic Compound Oxidation, *Catalysts* 2020, 10, 661; doi:10.3390/catal10060661
3. Benzhen Lou, Noman Shakoor, Muhammad Adeel, Peng Zhang, Lili Huang, Yongwen Zhao, Weichen Zhao, Yaqi Jiang, Yukui Rui, “Catalytic oxidation of volatile organic compounds by non-noble metal catalyst: Current advancement and future perspectives”, *Journal of Cleaner Production* 363 (2022) 132523
4. Ying Zhou , Ruiying Li, Zexuan Lv, Jian Liu, Hongjun Zhou, Chunming Xu, Green hydrogen: A promising way to the carbon-free society; *Chinese Journal of Chemical Engineering* 43 (2022) 2–13
5. Apoorva M. Ranjekar, Ganapati D. Yadav; Dry reforming of methane for syngas production: A review and assessment of catalyst development and efficacy; *Journal of the Indian Chemical Society* 98 (2021) 100002