

Biofuels

Calendar: 5th day semester

Contact Hours: T 22,5h; TP 30,0h; OT 7,50h

Scientific Area: Processes in Chemical and Biological Engineering

Learning outcomes of the curricular unit:

The aim of the curricular unit is to supply the students with a general panoramic of the biofuels field, namely, of solid, liquid and gaseous biofuels, giving also a perspective on the present and future of bioenergies. It is intended that the students learn the sources and main properties of biomasses used as raw materials to produce the different biofuels in relation with the technologies used. Finally students must be able to perform simple calculations related with the unit operations involved in the production of the biofuels studied.

Syllabus:

1. Introduction to the basic concepts related to bioenergies. The context of the present development of bioenergies and social and environmental questions of biofuels production; Concept of biorefinery and the possibility of combining environmental remediation with energetic recovery of bioresidues. Problems related to the seasonality of the availability of biomasses and the storage of bioenergy; Portuguese, european and world biofuels market.
2. Solid biofuels: Thermochemical processment of biomasses: combustion; pirolisis and gasification; biochar; Fisher-Tropsch process and reforming of the "syngas" obtained from biomass gasification to produce liquid biofuels; pelletization of forestry and agricultural residues; Main unit operations and equipments.
3. Liquid biofuels: bioethanol and alcoholic fermentation; biodiesel and esterification and transesterification of vegetable oils and fats; the "green diesel" and the hydrogenation and cracking of vegetable oils; main raw materials and processing technologies; main unit operations and equipments.
4. Gaseous biofuels: biogas, biomethane and e bio-hydrogen; biochemical processing of biomasses, anaerobic digestion; technologies used in the purification of biogas; processing of agro industrial residues, municipal solid wastes and WWTP slurries by anaerobic digestion and

co-digestion; Introduction to the electrochemical processing of residual biomasses; main raw materials and processing technologies; main unit operations and equipments.

Evidence of the syllabus coherence with the curricular unit's intended learning outcomes:

In this curricular unit some of the major biomasses processing technologies for the production of solid, liquid and gaseous biofuels are addressed. In a first topic basic concepts related with the production of bioenergy are treated, and some social and environmental implications of this production are discussed. In this chapter the concept of biorefinary is introduced, as a holistic concept of biomass residues recovery, allowing simultaneous reduction of environmental loads and energetic and economic valorization of those residues.

In the following 3 topics, technologies, raw materials, unit operations for the obtain of the main solid, liquid and gaseous biofuels with commercial significance or potential are presented separately. The fundamentals of the thermochemical and biochemical processing technologies are discussed in some details, with relation with the types of biomasses used as feed stocks. Some mechanical, chemical and electrochemical technologies involved in the pre and post processing of raw materials and end products are also addressed. There is a conviction that this approach may contribute to achieve the proposed learning objectives: "supply the students with a general panoramic of the biofuels field, namely, of solid, liquid and gaseous biofuels, giving also a perspective on the present and future of bioenergies".

References:

1. R. Farias, "Introdução aos Biocombustíveis", Editora Ciência Moderna, Brasil, 1ª ed. 2010, ISBN: 857-3-939-486;
2. E.E.S. Lora, O.J. Venturini, "Biocombustíveis" (2 volumes), Editora Interciência, Brasil, 2012, ISBN 857-1-93228;
3. L.A. Barbosa, E.E.S. Lora, E.O. Gomez (org.), "Biomassa para energia", Unicamp, Brasil, 2008, ISBN 852 6 807838;
4. G. Knothe, J. von Kerpen, J. Krahl, L.P. Ramos, "Manual do Biodiesel", Editora Blucher, Brasil, 2006, 852 1 294051;
5. D.M. Mousdale, Biofuels - Biotechnology, Chemistry and Sustainable Development, CRC Press, Taylor and Francis Group, 2008, ISBN-13:978-1-4200-5124-7
6. A. Scragg, Biofuels - Production, Application and Development, CABI, ISBN 978-1-84593-592