

RC 207

Introduction to Biofuels

3 Credits

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RC 207 Version: 6



Introduction to Biofuels

Calendar Description

This course examines the basic principles and practices of current biofuel production. Topics include an overview of the production processes of biodiesel and ethanol. Quality, cost, and performance issues of these fuels are discussed as well as their benefits and challenges.

Rationale

This is a required course for the Sustainable Energy Technology program. The topic of biofuels is in the news daily. To fully understand the issues, one must first understand exactly what biofuels are, how they are made, what benefits they provide, and what challenges exist. Ethanol, biodiesel, and other biofuels will be part of our energy mix in the future as petroleum fuels become more difficult and expensive to acquire. The learner in this course will be able to sort fact from fiction and better understand how biofuels will find their place in our future. The course benefits people entering the biofuel industry by giving them the background necessary to communicate effectively with other industry professionals and to perform tasks such as troubleshooting production problems. This course provides basic background information to assist people wanting to start their own small to mid-scale production facilities.

Prerequisites

Co-Requisites

None

Course Learning Outcomes

Upon successful completion of this course, students will be able to

1. discuss the history and current status of biofuels in Canada and the United States.
2. explain the advantages and disadvantages associated with the use of biofuels when compared to conventional fuels to answer questions the public might have about biofuels and the biofuel industry.
3. describe how diesel and gasoline engines work and how combustion and engine operation are affected by the fuel used.

4. describe the basic production processes and quality control parameters, including how to troubleshoot basic production problems for first generation ethanol and biodiesel production.
5. compare feedstocks used for biodiesel and ethanol production.
6. describe methods used to extract oil from seeds and calculate oil extraction efficiency.
7. describe the uses of the byproducts of biodiesel and ethanol production.
8. recommend safe and appropriate strategies for the treatment and disposal of waste from biodiesel and ethanol plants.
9. interpret ASTM test results for biodiesel and ethanol, discussing the reasons a fuel might not meet specifications.
10. review home-brew biodiesel production practices.
11. perform a basic analysis of the cost of raw materials for a biodiesel plant.
12. describe methods used in second generation ethanol production and the challenges of implementing second-generation ethanol production on a commercial scale
13. use terminology correctly for the biofuels industry.

Resource Materials

Required Text(s):

The following textbook is available to the learners through Lakeland College's Library on-line databases. Registered students will receive a library bar code and password to gain access to this e-book. Instruction for accessing this information is provided in the course.

Knothe, G., J. Van Gerpen, and J. Krahl (Eds.). 2010. Biodiesel handbook. 2nd ed, AOCS Press, Urbana, IL.

http://www.library.ualberta.ca/permalink/opac/7814780/LAKELND_LLWEB

The following articles are required and can be downloaded from the Internet:

Van Gerpen, J., D. Clements, and G. Knothe. 2004. Biodiesel production technology. National Renewable Energy Lab (NREL).

Van Gerpen, J. 2004. Biodiesel analytical methods. National Renewable Energy Lab (NREL).

Love, J. and J. A. Bryant. 2017. Biofuels and bioenergy. John Wiley & Sons, Ltd.

Conduct of Course

This course consists of the equivalent of 45 hours of lecture delivered on-line using an online learning manager program. Course content modules and links to assigned readings are available on-line. A course facilitator is available to guide the learner through the course, answer any questions, and grade assignments. Learners are expected to participate in on-line discussion forums and synchronous conference discussions with other classmates and the course

facilitator. Participation in synchronous sessions is encouraged but not required. These sessions are recorded for learners unavailable to participate. Assignments are to be submitted electronically by e-mail or through the learning manager program. Unit exams are taken on-line. In order to complete the course on time, deadlines for assignments, exam, and projects are enforced.

Case Studies: Each student is expected to select a topic of intensive study from the field of biofuels preferably from within the course frame and notify the instructor for pre-approval. Upon approval, the student would gather additional information on the topic of interest and prepare a project report and presenting his/her finding in the virtual classroom at a pre-determined time. Through this exercise the students will find opportunities to share knowledge and seek friendly/constructive feedback from their peers as well as from the course instructor.

Evaluation Procedures

The student's final grade is an aggregate of the following components:

Lecture 1 Quiz	5%
Lecture 2 Quiz	5%
Lecture 3 Quiz	5%
Lecture 4 Quiz	5%
Lecture 5 Quiz	5%
Lecture 6 Quiz	5%
Project Case Study	50%
Final Exam	20%
Grand Total	100%

Grade Equivalents and Course Pass Requirements

A minimum grade of D (50%) (1.00) is required to pass this course.

Letter	F	D	D+	C-	C	C+	B-	B	B+	A-	A	A+
Percent Range	0-49	50-52	53-56	57-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100
Points	0.00	1.00	1.30	1.70	2.00	2.30	2.70	3.00	3.30	3.70	4.00	4.00

Students must maintain a cumulative grade of C (GPA - Grade Point Average of 2.00) in order to qualify to graduate.

Attendance

Attendance to the virtual class at the pre-designated time is not mandatory, however is highly recommended.

A recorded version of the lecture is made available for viewing at a later time. Pertinent lecture material associated with each topic will be uploaded on D2L, 5-days ahead of the scheduled virtual lecture.

The lecture test quiz is uploaded 2-days after each lecture and has a deadline.

Course Units/Topics

1 INTRODUCTION TO BIOFUELS

- 1.1 HISTORY OF BIOFUELS
- 1.2 CATEGORIES & CLASSIFICATION CRITERIA
- 1.3 GENERATIONS (1ST, 2ND, 3RD)
- 1.4 SOLID, LIQUID, GASEOUS BIOFUELS
- 1.5 BENEFITS AND CHALLENGES
- 1.6 CURRENT STATE OF THE ART

2 INTRODUCTION TO FEEDSTOCKS

- 2.1 CATEGORIES & CLASSIFICATION CRITERIA
- 2.2 TESTING METHODOLOGIES
- 2.3 QUALITY GRADES
- 2.4 AVAILABILITY & SUSTAINABILITY

3 PRE-PROCESSING TECHNOLOGIES

- 3.1 MECHANICAL
- 3.2 CHEMICAL
- 3.3 THERMAL
- 3.4 BIOLOGICAL
- 3.5 HYBRID

4 CONVERSION PATHWAYS

4.1. BIO-CHEMICAL CONVERSIONS

4.1.1 FERMENTATION

4.1.2 ANAEROBIC DIGESTION

4.2 THERMO-CHEMICAL CONVERSIONS

4.2.1 TRANS-ESTERIFICATION

4.2.2 TORREFACTION

4.2.3. PYROLYSIS

4.2.4 GASIFICATION

4.2.5 COMBUSTION

4.2.6 HYDROTHERMAL

5 REGULATORY LANDSCAPE, CARBON INTENSITY & SUSTAINABILITY

5.2 FEDERAL & PROVINCIAL REGULATIONS

5.3 CANADIAN CLEAN FUEL STANDARDS

5.4 CARBON INTENSITY / GHG OFFSET CALCULATIONS

5.5 ENVIRONMENTAL SUSTAINABILITY

6 CASE STUDIES



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