Chemical Engineering 733 Coal Combustion

Thomas H. Fletcher, Andrew R. Fry Spring 2022 9:00 – 10:50 am 383 CB MWF

Catalog Description:

Fundamentals of coal combustion and gasification processes, including particle mechanics, devolatilization, heterogeneous oxidation, radiative heat transfer, and combustion of coal in practical flames.

Course Objective:

The objective of this course is to help students develop a background in important aspects of coal and biomass combustion. Many graduate students specialize in a narrow area of coal combustion (or a related field), but never gain much knowledge of other areas of coal and biomass combustion. This broader knowledge is often useful in writing proposals, theses, and research papers, and often helps put a better perspective on your chosen research emphasis. We will discuss some aspects of biomass, since it is closely related. Biomass reference material has been placed on the ChEn 733 class web page.

Topics:

- 1. Processes and Properties of Coal (4)
- 2. Devolatilization (4)
- 3. Heterogeneous Oxidation (3)
- 4. Mineral Matter & Deposition (2)
- 5. Practical Flames (1)
- 6. NO_x/SO_x Formation (1)
- 7. Lab Tours (3)

Required Text:

Smith, K. L., L. D. Smoot, T. H. Fletcher, and R. J. Pugmire, <u>The Structure and Reaction</u> <u>Processes of Coal</u>, Plenum, 1994. (You can borrow this, or order a copy through me at author discount pricing)

Secondary Sources:

- 1. L. D. Smoot and P. J. Smith, <u>Coal Combustion and Gasification</u>, Plenum, 1985.
- 2. L. D. Smoot and D. T. Pratt, editors, <u>Pulverized-Coal Combustion and Gasification</u>, Plenum, 1979.
- 3. Coal Science and Technology Series. -by Elsevier Scientific Publishing Company, Volumes 1 through 10.
- 4. H.H. Lowry (editor), <u>Chemistry of Coal Utilization</u>, Vol. 1 and Supplementary Volume, Wiley, New York (1945 & 1963).
- 5. L. D. Smoot (editor), <u>Fundamentals of Coal Combustion for Clean and Efficient Use</u>, (Coal Science and Technology 20), Elsevier, Amsterdam, 1993.
- 6. Van Krevelyn, D. W., <u>Coal</u>, Elsevier, 1993.
- 7. S. van Loo and J. Koppejan, editors, <u>Biomass Handbook</u>, Twente University Press, 2002.

Prerequisites:

The course involves the development of qualitative and quantitative descriptions of the physical processes involved in coal combustion and gasification. The fundamental tools used to describe these processes include turbulent fluid mechanics, heat transfer, mass transfer, thermodynamics, and reaction kinetics. It is expected that each student be well founded in these subjects before beginning this course. Additionally, the description of these processes usually involves differential equations that often require numerical methods to solve. It is expected that students be comfortable in the use of the computer to solve these problems.

Courses in Transport Phenomena, Partial Differential Equations and Combustion Fundamentals would be helpful, but are not required.

Class Discussion:

This is an advanced graduate level course. It is expected that students will come to class having prepared themselves thoroughly on the topic to be discussed that day. Originally, this class was heavily lecture-oriented, with the students feeling like a fire hose has been attached to their head. Overheads full of information were passed before the class, hoping for learning to take place. A different philosophy is currently employed in this course, where student learning is emphasized, rather than mere presentation by the instructor. This is especially true of this year (2020) due to online nature of the class due to the COVID-19 outbreak. Class will be organized in the following manner:

- 1. Students will be divided into groups (of 3 in this case).
- 2. Reading questions are placed on the class web page. Please be sure to check for updates the day before class.
- 3. Students are expected to read the assigned material, and then meet as a group to discuss the reading material.
- 3. Student groups will each prepare one set of responses to the reading questions that will be suitable for presentation to the class. PowerPoint or PDF files are acceptable, but please do not make the format too fancy. Focus on content rather than graphics and style. Email the files before class to Dr. Fletcher, and have them available on your computer.
- 4. One student will be randomly selected and asked to present their group answers to the class.
- 5. The student presentation will not be graded right or wrong, but only prepared or unprepared. The entire group will receive a demerit if one member of their group is unprepared.
- 6. A printed copy of your group's PowerPoint slides will help you take notes. Your answers may differ from other students. You may print these in handout mode, 6 slides to a page, in order to save paper costs.
- Additional slides from Dr. Fletcher are posted on the web page, along with a video from previous classes. Please look at these resources <u>AFTER</u> preparing your group PowerPoint slides.

This format is a little different than the usual 100% lecture format, and is written up in the engineering education literature. This method is intended to promote student learning, and has been successfully used by several faculty in our college. 30% of the grade will be given for classroom participation (25% for answers to reading questions and 5% for general participation). The goal is for you to LEARN and SHARE.

Since most of the graduate students in this class have specialized in an area of combustion research, each student will be asked to contribute to the discussion in class in that area. For those

students that are not directly in the coal or biomass combustion area, appropriate discussions and questions are expected.

Homework:

The preparation for the class discussion takes the place of homework in this class. Only a few of the "reading questions" will be of the problem-solving type.

Trip Reports:

I hope to one field trip in this class to the IPP or Hunter power plant. A one-page trip report is required of the field trip, describing what significant things you learned. We will discuss alternatives in class if travel restrictions due to the COVID-19 virus are still in place.

Exams:

Two exams will be given during the semester, one midterm and one final. Exams will be normalized so that the high score is 100%. Both exams will be <u>oral exams</u>, given individually to each student. These are generally 30 minute exams, and will be conducted on the in my office.

Grading:

Since the focus of this class is not problem solving, a large portion of the grade will be assigned to classroom participation and the answers to the reading questions. The final grade will be based on the following:

Reading Questions	25%
Class Participation	5%
Trip Reports	5%
Midterm	30%
Final	35%

<u>Advice</u>: You can get an A in this class by preparing 8+ hrs per class or 4 hrs per class. Please optimize your time by skim reading, deciding what is important, and not making the PowerPoint too fancy.

Office Hours:

I am always available to answer questions and pursue discussions on coal combustion whenever I am not in any other meeting. When the buildings are reopened, I am available in 330Q EB. My office phone is 801-422-6236, and this phone is transferred to my cell phone when I am not in the office. Ad hoc discussions on these topics are encouraged using zoom or other means.

University Mission:

The following is quoted from the General Catalog. "The mission of Brigham Young University - founded, supported, and guided by The Church of Jesus Christ of Latter-day Saints - is to assist individuals in their quest for perfection and eternal life. That assistance should provide a period of intensive learning in a stimulating setting where a commitment to excellence is expected and the full realization of human potential is pursued. To succeed in this mission the university must provide an environment enlightened by living prophets and sustained by those moral virtues which characterize the life and teachings of the Son of God."

BYU Environment:

BYU is owned and sponsored by the Church of Jesus Christ of Latter-day Saints, and BYU

students and faculty are required to abide the BYU honor code and the dress and grooming standards. Visitors are also expected to abide by these standards while on the BYU campus. This generally means to be honest, dress conservatively, refrain from foul language, and abstain from tobacco, alcohol, coffee, and tea. Copies of the BYU standards are available at https://policy.byu.edu/view/index.php?p=26.

Preventing Sexual Misconduct:

As required by Title IX of the Education Amendments of 1972, the university prohibits sex discrimination against any participant in its education programs or activities. Title IX also prohibits sexual harassment-including sexual violence-committed by or against students, university employees, and visitors to campus. As outlined in university policy, sexual harassment, dating violence, domestic violence, sexual assault, and stalking are considered forms of "Sexual Misconduct" prohibited by the university.

University policy requires any university employee in a teaching, managerial, or supervisory role to report incidents of sexual misconduct that come to their attention through various forms including face-to-face conversation, a written class assignment or paper, class discussion, email, text, or social media post. If you encounter Sexual Misconduct, please contact the Title IX Coordinator at t9coordinator@byu.edu or 801-422-2130 or Ethics Point at https://titleix.byu.edu/report or 1-888-238-1062 (24-hours). Additional information about Title IX and resources available to you can be found at http://titleix.byu.edu.

Students with Disabilities:

BYU is committed to providing a working and learning atmosphere that Brigham Young University is committed to providing a working and learning atmosphere that reasonably accommodates qualified persons with disabilities. If you have any disability which may impair your ability to complete this course successfully, please contact the University Accessibility Center (UAC), 2170 WSC or 422-2767. Reasonable academic accommodations are reviewed for all students who have qualified, documented disabilities. The UAC can also assess students for learning, attention, and emotional concerns. Services are coordinated with the student and instructor by the UAC. If you need assistance or if you feel you have been unlawfully discriminated against on the basis of disability, you may seek resolution through established grievance policy and procedures by contacting the Equal Employment Office at 422-5895, D-285 ASB.