

**Department of Chemical Engineering
West Virginia University**

ChE 414 – Coal Utilization Engineering
Spring 2008

Monday, Wednesday 3:00 – 4:50
Room 209, Mineral Resources Building

Instructor: John W. Zondlo
Office: Room 415 ESB
Phone: 293-2111 x2409
Office Hours: Wednesday 2:00 – 3:00 or by Appointment

Required Text:

An Introduction to Coal Technology, 2nd Edition, N. Berkowitz, Academic Press, 1994.

Reference Texts:

- * Coal: The Energy Source of the Past and Future, Harold H. Schobert, American Chemical Society, Washington, DC, 1987.
- * Synthetic Fuels, R.F. Probst and R.E. Hicks, McGraw-Hill, 1982.
- * The Chemistry and Technology of Coal, James G. Speight, Marcel Dekker Inc., New York, 1983.
- * Coal Conversion Technology, C.Y. Wen and E.S. Lee, Addison-Wesley Pub. Co., 1979.
- Reaction Engineering in Direct Coal Liquefaction, Y.T. Shah, Addison-Wesley Pub. Co., 1981.
- Coal Conversion, E.J. Hoffman, The Energon Co., Laramie, Wyoming, 1978.
- * Chemistry of Coal Utilization, H.H. Lowry (Editor), J. Wiley & Sons, Vol. I & II (1945). Supplementary Vol. (1963); Second Supplementary Vol., M.A. Elliott (editor) (1981).
- * Coal Preparation, Fourth Edition, J.W. Leonard (Editor), American Institute of Mining, Metallurgical, and Petroleum Engineering, Inc., New York (1979).
- Energy and Society, An Introduction, Harold H. Schobert, Taylor and Francis, 2002.
- Sustainable Energy, Choosing Among Options, J.W. Tester, E.M. Drake, M.J. Driscoll, M.W. Golay and W.A. Peters, The MIT Press, 2005.

Handbook of Synfuels Technology, R.A. Meyers (Editor), McGraw-Hill, 1984.

Coal Gasification, L.G. Massey (Editor), Advances in Chemistry Series 131, American Chemical Society, Washington, DC, 1974.

Combustion, Second Edition, I. Glassman, Academic Press, 1987.

Coal Gasification, Existing Processes and New Developments, H.D. Schilling, B. Bonn and U. Krauss, Graham & Trotman Limited, London, 1979.

Production and Utilization of Synthetic Fuels, An Energy Economics Study, F.R. Benn, J.O. Edewor and C.A. McCauliffe, Applied Science Publishers, London, 1981.

The Beehive Coke Years, J.K. Gates, Uniontown, PA, 1990.

*Good References

Other Related References:

Chemical Reaction Engineering, 2nd Edition, O. Levenspiel, J. Wiley & Sons, 1972.

Energy Conversion Engineering, R.C. Bailie, Addison-Wesley Pub. Co., 1978.

Introduction to Chemical Engineering Thermodynamics, 3rd Edition, J.M. Smith and H.C. Van Ness, McGraw-Hill, 1975.

Unit Operations of Chemical Engineering, 6th Edition, W.L. McCabe, J.C. Smith and P. Harriott, McGraw-Hill, 2001.

Chemical Engineering Handbook, 7th Edition, J. Perry and D.W. Green (Editors), McGraw-Hill, 1998 (available in ChE Library).

Basis for Course Grade:

Mid Term Exam	30%
Final Exam	30%
Special Projects	30%
Homework	10%

Course Objectives:

- To integrate the discovery and use of coal into the development of energy generation, industrial growth and world history.
- To gain an appreciation for the physical and chemical properties of coal, coal structure and coal characterization.
- To survey the many possible chemical reactions and transformations of coal during its processing and use.

- To learn about the main technologies and processes associated with coal utilization, viz. Mining, combustion, pyrolysis, liquefaction and gasification.
- To address the significant economic and environmental issues related to fossil fuel combustion and utilization.
- To have fun learning about coal!

NOTE: During the semester we may have several field trips to view some current and past coal-processing facilities. We will also tour the coal-processing labs at WVU and the Beechurst Power Plant.

NOTE: In addition to the readings from the Recommended Text by Berkovitz, there will be numerous class handouts. It is suggested that you get a three-ring binder to keep the handouts in an orderly fashion!

NOTE: We will also have several films/slide shows on various aspects of coal utilization.

Course Outline
ChE 414 – Coal Utilization Engineering

Text: An Introduction to Coal Technology, N. Berkowitz

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| I. | <u>Introduction</u>
Sources of Energy, Reserves and Production
History of Coal Utilization
Coal Formation
Coal Mining
Overview of Coal Conversion Technologies | Chapters 1 and 2 |
| II. | <u>Analysis and Characterization of Coal</u>
Chemical and Physical Nature
Proximate analysis
Ultimate analysis
Coal Rank – ASTM Classification
Other Characteristic Tests
Petrography
Coal Cleaning | Chapters 3,4,5,8 & 9 |
| III. | <u>Coal Pyrolysis</u>
Coke Making
Mild Gasification
Chemicals From Coal
Kinetics | Chapters 6 and 11 |
| IV. | <u>Coal Gasification</u>
Basic Principles
Reactions
Gas Cleanup
Gasifier Reactors
Typical Processes
Methanation
Oxygen and Methane Production | Chapter 12 |
| V. | <u>Coal Liquefaction</u>
Basic Principles
Direct vs. Indirect Liquefaction
Upgrading of Products
Typical Processes | Chapter 13 |
| VI. | <u>Solvent Extraction</u>
Types of Solvents
Nature of Products
Some Processes
Problems | Chapter 7 |

VII.	<u>Coal Combustion</u>	Chapter 10
	Basic Principles	
	Combustion Products	
	Typical Combustion Systems	
	Environmental Problems	
VIII.	<u>Environmental Issues</u>	Chapter 14
	Mine Wastes	
	Land Reclamation	
	Ash and Char Disposition	
	Air Pollution	
	-- Fly Ash	
	-- Acid Rain	
	-- Greenhouse Effect and Global Warming	
IV.	<u>The Future of Coal Utilization</u>	
	Future Gen	
	Combined Cycle Processes	