SUMMARY REPORT

TEACHING OF UNDERGRADUATE THERMODYNAMICS

A Mini-session presented at the

Annual Meeting

American Institute of Chemical Engineers

Philadelphia, Pa.

November 13, 1973

Dr. Edwin O. Eisen, Chairman

Lamar University

Beaumont, Texas

INTRODUCTION

The attached questionnaire was sent in May, 1973 to the chairman of each chemical engineering department in the United States and Canada, together with a cover letter asking that the appropriate faculty member complete and return the questionnaire. A follow-up letter was sent on September 15 to those departments (over 100) who had not responded by then. Out of about 155 universities (these included all the U.S. and Canadian universities listed in Chemical Engineering Faculties), 59 questionnaires were returned. The mini-session on Mass and Energy Balances held last year during the New York A.I.Ch.E. Meeting drew 71 responses, so this year's response is certainly good.

LEVEL OF THERMODYNAMICS COURSES

The class level of the thermodynamics courses are shown in Table I. Thirty of the 55 schools returning completed questionnaires offer all their thermodynamics courses in the junior year. An additional eighteen schools offer at least one thermodynamics course in the junior year. Nineteen schools offer at least one thermodynamics course in the sophomore year. Of schools offering a two course sequence, one offers two sophomore courses, eleven offer sophomore and junior courses, twelve offer two junior courses, and two offer junior and senior courses. One concludes that thermodynamics is essentially a junior course, with a significant tendency toward sophomore level courses.

TABLE 1

CLASS LEVEL OF THERMODYNAMICS COURSES

YEAR(s) COURSES ARE TAKEN	NUMBER OF SCHOOLS
SOPHOMORE	5
SOPHOMORE/SOPHOMORE	1
SOPHOMORE/SOPHOMORE/JUNIOR	2
SOPHOMORE/JUNIOR	11
SOPHOMORE/JUNIOR/SENIOR	2
JUNIOR	16
JUNIOR/JUNIOR	12
JUNIOR/JUNIOR/JUNIOR	2
JUNIOR/JUNIOR/SENIOR	1
JUNIOR/SENIOR	2
SENIOR	1

TEXTS

The questionnaires from 57 schools mentioned textbooks seventy three times. The distribution is as follows:

Smith and Van Ness (1959)	27
Balzhiser, Samuels and Eliassen (1971)	13
Van Wylen and Sonntag (1965)	9
Hougen, Watson and Ragatz (1959)	5

Other texts were mentioned less than 5 times each. All texts mentioned are listed in the bibliography. Usually, different texts are used when a school offers two courses in thermodynamics. The "durability" of Smith and Van Ness is worth noting. Almost half of the schools responding use this fourteen-year old text. The text by Balzhiser, et al, only two years old, is currently used by about one-fourth of the schools responding.

BIBLIOGRAPHY

Hougen, O.A., Watson, K.M. and Ragatz, R.A., "Chemical Process Principles," Volume II, 2nd ed. Wiley, New York, 1959.

Zemansky, M.W. and Van Ness, H.C., "Basic Engineering Thermodynamics." McGraw-Hill, New York, 1966.

Balzhiser, R.E., Samuels, M.R. and Eliassen, J.D., "Chemical Engineering Thermodynamics," Prentice-Hall, Englewood Cliffs, N.J. 1972.

Smith, J.M. and Van Ness, H.C., "Introduction to Chemical Engineering Thermodynamics," 2nd ed, McGraw-Hill, New York, 1959.

Denbigh, K., "The Principles of Chemical Equilibrium," 3rd ed., Cambridge University Press, Cambridge, 1971.

Van Wylen, G.J. and Sonntag, R.E., "Fundamentals of Classical Thermodynamics," Wiley, New York, 1965.

Abbott, M.M. and Van Ness, H.C., "Thermodynamics," (Schaum Outline Series) McGraw-Hill, New York, 1972.

R.L. Robinson, "Audio Tutorial Notes," Oklahoma State University.

H.F. Silver, "Introduction to Engineering Thermodynamics," (University of Wyoming).

Alan J. Brainard, "A Course in Thermodynamics," Mono Book Corporation (University of Pittsburgh).

REPLIES TO QUESTIONNAIRES

The replies from each school are summarized on the following pages. The following form is used.

NAME OF UNIVERSITY

Authors of Text used in courses. (When one or more numbers appear before the name of the text, this indicates the course for which the text is used. 1, 2 Balzhiser means the text is used for both the first and second courses.)

Level of Course(s) (listed to the right of the text)

The following words refer to replies to specific sections of the questionnaire.

EXPLANATIONS ("Some explanations of concepts I have found particularly effective are ......")

FEATURES ("Distinctive features of the course are:")

CHALLENGES ("Some particular challenges in teaching thermodynamics are:")

TEXT Any comments on the tests being used.

Instructions for Completing the Questionnaire

We invite you to share with others those presentations, analogies, explanations, etc. which you have found affective in teaching undergraduate Thermodynamics. It is expected that much of the originality in teaching Thermodynamics is directed toward EXPLAINING CONCEPTS, rather than substituting into equations and solving equations. Such concepts as entropy, internal energy fugacity, chemical potential, partial molalvolume, and activity, are difficult to "get a feel" although the mathematical aspects are presented adequately by most texts. Even with an explanation of less than one minute, you can help your colleagues to explain something which may have taken them the better part of a class period to get across. Please don't be modest and assume that because something is clear to you it's clear to everybody. Share your thoughts with us.

We would also be interested in your use of the computer in your Thermodynamics courses. Your coverage of equations of state, activity coefficient correlations, and any other matters you feel distinctive and valuable about your course.

Please return this questionnaire before August 15, 1973 to

Edwin O. Eisen
Lamar University
P.O. Box 10053
Beaumont, TX 77710

Thank you for your help.

QUESTIONNAIRE ON THE TEACHING OF UNDERGRADUATE THERMODYNAMICS

Instructor: ______________________________

University: ______________________________

Distinctive features of the course as I give it are:

Some explanations of concepts which I have found particularly effective are... (Use another sheet if necessary. I would like to give as many people as possible the opportunity to present these at the session.)

Some particular challenges in teaching Thermodynamics are:

_____ I (do, do not) plan to attend the New York meeting.

_____ I don't know yet.

QUESTIONNAIRE ON THE TEACHING OF UNDERGRADUATE THERMODYNAMICS

I. IDENTIFICATION

Instructor________________________________

University________________________________

II. COURSE TITLE(S)

1. ________________________________

2. ________________________________

3. ________________________________

III. TIME AVAILABLE

	Course 1	Course 2	Course 3
Hrs lecture / week	______	______	______
Hrs tutorial / week	______	______	______
Hrs lab / week	______	______	______

IV. TEXT(S) AND RESOURCES (AUTHOR, TITLE)

Course 1: ________________________________

Course 2: ________________________________

Course 3: ________________________________

V. STUDENTS

	Course 1	Course 2	Course 3
A. Year of Students e.g. soph	______	______	______
B. Class Size	______	______	______
C. Major (ChE, ME)	______	______	______

VI. MAIN OBJECTIVES

____

____

____

____

____

____

____

____

____

VII. Does your university operate on quarters or semesters?

Quarters of _______ weeks Semesters of _______ weeks

VIII. I would like a copy of the summary report. Yes No

Please attach a copy of your course outline.

XI. Do you feel there is a need for a better textbook for Chemical Engineering Thermodynamics? In what topic areas can the text you now use be improved?

____

____

____

____

____

ARIZONA STATE UNIVERSITY

1. Smith & Van Ness 2. Reynolds Jr/Jr
CHALLENGES
Difficulty of working with concepts rather than visible physical effects.

UNIVERSITY OF ARIZONA

1. Hougen, Watson & Ragatz plus Smith & Van Ness Jr/Jr
FEATURES
Derivation of key fundamentals; Drilling on basic fundamentals; theory and problems
CHALLENGES
Keep students interested; show how to use thermodynamics in chemical engineering work.

UNIVERSITY OF ARKANSAS

1. 2. Balzhiser Jr/Jr
EXPLANATIONS
Relation of entropy to free energy. Relation of free energy to "mechanical energy" in purely mechanical systems and processes. Statistical, microscopic description of entropy.
CHALLENGES
Appreciation, in student, of power and usefulness of thermodynamic methods.

AUBURN UNIVERSITY

1. Smith & Van Ness 2. Zemansky & Van Ness 3. Balzhiser Jr/Jr/Sr (Quarters)
FEATURES
Temperature derived from physical measurements and the Second Law, rather than intuition. Heat defined from First Law, rather than intuition. Stress calculation of heat and work since these involve capital and operating expenditures. Evaluation of theoretical efficiency as limit on practical processing.
EXPLANATIONS
Irreversible heat transfer to explain entropy increase. Heat and work are path functions, but thermodynamic state changes may be evaluated along any convenient path.
CHALLENGES
No good meaningful treatments of statistical methods at undergraduate level. Getting students to appreciate intricacies and reasoning involved in the subject.
TEXT
Zemansky & Van Ness: Use of equations of state to solve practical problems needs emphasis.

BUCKNELL UNIVERSITY

1. Smith and Van Ness Jr
FEATURES
Modified self-paced course consisting of twenty-seven modules based on Smith and Van Ness. The student's grade is based on the number of perfectly finished modules.
EXPLANATIONS
Use of H-S diagram for illustrating the limiting velocity of fluid flowing in a pipe. Use of a tennis ball for the concept of equilibrium.
CHALLENGES
1. Explain the fundamental concepts of irreversible thermodynamics 2. Limiting velocity of fluid in a pipe.
OBJECTIVES
A modified self-paced thermodynamics couse was developed from Smith and Van Ness. Twenty seven modules were used, each with specific subobjectives. Application of the computer and experimental procedures were stressed. Application of thermodynamic data and the estimation of data were used to solve engineering problems.
TEXT
Smith & Van Ness is excellent but needs up-dating. Balzhiser is current but harder for the students.

UNIVERSITY OF CALIFORNIA (BERKELEY)

F. Wall: Chemical Thermodynamics Soph
[One of three quarter-long courses in chemical engineering thermodynamics]
EXPLANATIONS
Lecture table experiments seem to be effective and helpful to students. Experiments illustrating: 1. partial molal volumes and other quantities 2. adiabitic reversible expansion of gases to measure cp/cv 3. rubber band engine to convert heat into work.
CHALLENGES
To achieve real understanding of principles as opposed to memorizing formulas.
TEXT
Should be more closely related to chemistry; should not be so concerned with elementary introduction if it is to follow elementary courses given in chemistry; should do a better job about thermodynamics of solutions.

UNIVERSITY OF CALIFORNIA (DAVIS)

1,2: Smith & Van Ness Jr/Jr
CHALLENGES
Molecular approach to First Law to distinguish Internal Energy from other Energy. Statistical approach to entrapy gives students a physical feeling for the Second Law.
TEXT
Smith & Van Ness - need statistical use of Second Law.

CITY COLLEGE OF NEW YORK

1. Zemansky & Van Ness Jr/Jr
2. Denbigh plus Hougen & Watson

EXPLANATION
Irreversibility in gas expansion and compression-so called "internal friction" -is the result of the inability of the fluid to keep up with the piston during expansion (pressure on piston less than equilibrium pressure) and to get away from piston during compression (pressure on piston greater than equilibrium pressure).
CHALLENGES
To make the student comfortable with the subject so that he is not afraid to use it.
COMMENT
Several years ago we gave consideration to the statistical mechanics approach and rejected it for the following reasons. 1. The approach gives the student the false wmpression that thermodynamics rests on molecular theory. 2. Too much class time is required to develop the subject to the point where the student could make effective use of the subject.
TEXT
Consolidation of texts: Explanation level of Zemansky and Van Ness. Sty[illegible] and clarity of Denbigh-2nd Law and chemical reactions. Applications & data from Hougen & Watson.

CLARKSON COLLEGE OF TECHNOLOGY

1. Abbott & Van Ness Jr/Sr-Grad
2. Lee, Sears, Tonottle
FEATURES
Problem oriented course. Short lectures (5-15 minutes) are given as needed to introduce and extend upon homework problems
CHALLENGES
Getting students to setup a problem of a type they have not seen before.
TEXT
Could be better with phase equilibria @ chemical reactions equilibria.

CLEVELAND STATE UNIVERSITY

1. Van Wylen & Sonntag Soph/Jr
2. Smith & Van Ness
One quarter course for all engineers, one quarter for CHE's.
TEXT
Van Wylers & Sountay: Lacks solution theory and chemical equilibrium. Smith & Van Ness: Poor on compressible flow.

COLORADO SCHOOL OF MINES

1. Smith & Van Ness plus Jr
Abbott & Van Ness (4 hour course)
TEXT
Better textbook needed.

UNIVERSITY OF COLORADO

1. Smith & Van Ness Jr
EXPLANATIONS
Explanation of concepts is weakness of most texts.

COLUMBIA UNIVERSITY

1,2. "Applied Chem", Soph/Soph/Jr
Daniels & Alberty 3. Hougen Watson plus Denbigh
EXPLANTIONS
1. The symmetry in the expressions T,S, P V, U,N (intensive/extensive) 2. Chemical potential in melting dissolving reading systems. 3. Although not required texts, I find Denbigh and Caldin's texts outstanding.
CHALLENGES:
Understanding the physical meaning of the rather simple mathematics.
TEXT
Needed is an applied thermodynamics text which concentrates on chemical systems, non-ideal behavior and includes at a relatively simple level some molecular interpretation of what is going on. Should include thermodynamics of new separation processes (e. g. desalination cycles nuclear topping cycles) rather than refrigeration cycles.

DARTMOUTH COLLEGE

Unable to reply to questionnaire; inapplicable to the college.

DREXEL UNIVERSITY

1. Smith & Van Ness Soph
FEATURES
Regular homework problems, numerous illustrative examples during lectures, plus simple laboratory experiments. Presentation of problem solutions by means of an overhead projector had proved to be beneficial both qualitatively and quantitatively.
EXPLANATIONS
Demonstrating necessity of interaction with the surroundings when an irreversible process in an isolated system is carried out revercibly, and hence that the entropy change is positive for the irreversible process. Showing that "lost work" is a valid measure of irreversibility.
CHALLENGES
Conveying an understanding of the entropy concept; Explaining the significance of activity and sugacity.
TEXT
Chapters on phase & chemical equilibria could be clearer and better organized. Statistical approach to Second Law shoul be included. Application of statistical mechanics to the predictions of thermodynamic properties should be reviewed briefly.

UNIVERSITY OF HOUSTON

1. Van Wylen & Sonntag Soph/Jr
2. Balzhiser
Course 1-Concepts & 1 component systems
Course 2-Multicomponent systems & applications.

ILLINOIS INSTITUE OF TECHNOLOGY

1. Hougen, Watson, Ragatz, V. III Jr

FEATURES

New problems formulated each year. Sfresson short, practical problems which illustrate basic concepts.

TEXT

Problems too long; many areas not covered by problems.

UNIVERSITY OF ILLINOIS

1. Zemansky-Van Ness Jr

EXPLANATIONS

More emphasis on new techniques of phase equilibria than most present texts.

CHALLENGES

Teaching students who have or have not had physical chemistry when taking thermodynamics.

TEXT

Better one needed.

IOWA STATE UNIVERSITY

1,2 Balzhiser Jr/Jr

FEATURES

Use of 3-dimensional phase diagrams to convey the ideas of behavior within a phase, phase changes, critical phenomena and property prediction from equations of state. These diagrams are constructed from computer programs using a calcomp plotter.

EXPLANATIONS

Use of geometrical interpretation e.g. enthalpy and entropy deviations from ideal gas behavior are shown by non-horizontal isotherms on an H-S-P diagram; binary partial molar volumes are given by the intercepts of a tangent to the mixing curve on an isothermal V-x diagram.

CHALLENGE

Make thermodynamic concepts physically meaningful so that our students can use thermo.

TEXT

There is always a need for a better textbook. But if our goal is really teaching students to understand thermodynamics, then it seems that we should do the teaching and rely less on the "best of all textbooks" to do it for us.

UNIVERSITY OF KENTUCKY

1. Smith & Van Ness Soph-Jr

CHALLENGES

Concept of Reduced Parameters; Concepts of Solution Thermodynamics

TEXT

Need for more modern text on sophomore level with emphasis on chemical thermodynamics & metric system and thermodynamics at reactions.

LAFAYETTE COLLEGE

1. Smith & Van Ness 2. To be decided. Jr/Soph

FEATURES

Fundamentals & Concepts. Calculate Process heat & work requirements. Equilibrium and their importance in establishing chemical reaction behavior.

TEXT

Text weakness. Compressible Flow; Eqn's of State; Phase Equilibria-Computer Calciny. Irreversible Processes.

LAMAR UNIVERSITY

1. Reynolds 2. Hougen, Watson, Ragatz Soph/Jr

FEATURES
First course taken by all engineers; Second Law developed from 3 premises: 1. Entropy is a measure of molecular disorder. 2. An increase in disorder results in an increase in entropy. 3. The most probable state of system is the one having the greatest disorder and, hence, entropy. By using alphabet blocks and brightly painted cheese boxes to represent particles and energy levels, the probability of the system transferring from one energy level distribution to another can be calculated. By postulating a sequence of several steps, which take the system from order to disorder, and then from disorder to order along the same steps, the probability of the former occuring is about 8 times as great per stop as the probability of the latter. Since entropy is a measure of disorder. The entropy of an isolated system will (probably) increase or remain constant (Second Law).
TEXT
H & W is outdated-poor in number of illustrations, modern equations of state, vapor-liquid equilibria.

LEHIGH UNIVERSITY

1. Smith & Van Ness Jr
EXPLANATIONS
Development of limiting velocity in a pipe by showing properties on a p-H diagram.
CHALLENGES
Student needs to develop relationships from First and Second Laws, rather than from specialized equations.

MICHIGAN TECHNOLOGY UNIVERSITY

1,2 Smith & Van Ness Jr/Jr
TEXT
Problems & Examples of most texts are stale.

UNIVERSITY OF MISSOURI (COLUMBIA)

1. Sliepevich-Powers & Eubanks Jr

UNIVERSITY OF MISSOURI (ROLLA)

1,2 Smith & Van Ness Soph/Jr
FEATURES
Use videotaped lectures. Use computer programs for correlating data. Videotaped lectures are used outside of class time for two-way discussions of concepts and problems. Videotape lecture closely follow text material. Computer programs free students from routine calculations.
CHALLENGES
Over coming time-consuming calculations.
TEXT
Better discussion of general energy balance. More text and problems dealing with CHE thermodynamics, particularly high pressure thermodynamics.

UNIVERSITY OF NEW HAMPSHIRE

1. Balzhiser Jr
FEATURES
Students are assigned individual laboratory demonstration projects to prepare present to the class. For example, a student might show how to measure specific heat, or apply the first law to an internal combustion or steam engine, or measure the heat of reaction. In each case he is required to assemble equipment, make measurements, and analyze the results. In the oral presentation, he operates the equipment before the other students, describes his analysis and analyzes the results. This approach promotes creativity, gives each student detailed knowledge of one concept and developes ability in oral presentations.
TEXT
Balzhiser is the best treatment so far of mechanical thermodynamics, but it is confusing complicated and poorly organized in the treatment of chemical thermodynamics.

NEWARK COLLEGE OF ENGINEERING

1,2 Smith & Van Ness — Jr/Jr
CHALLENGES
Too many concepts to be understood and remembered by the students. Even with two semesters, understanding is limited.
TEXT
Could be updated.

NEW MEXICO STATE UNIVERSITY

1. Abbott & Van Ness plus Denbigh — Jr
CHALLENGES
To show the beauty of its formalism yet retain the pragmatism of its use. To dispel the sense of mystery about entropy.

UNIVERSITY OF NEW MEXICO

1. Van Wylen & Sonntag — Jr/Jr
2. Balzhiser
First course: common core course for all engineering students. Second course is CHE exclusively.
EXPLANATIONS
Entropy explained from "random" as well as mathematical or Carnot treatment. Meaning of Equilibrium constant, as well as activities, fugacities, etc.
TEXT
Balzhiser is good for computer problems, but text needs to be augmented with personal notes. There is no really good book for a graduate course in thermodynamics.

NEW YORK STATE UNIVERSITY (BUFFALO)

1. Van Wylen & Sontagg — Soph/Jr
"Fund. of Class. Thermo. 2. Denbigh
First course, for ME, CHE, & CE covers 1st & 2nd Laws, applicaton to power cycles & refrigeration.
TEXT
Denbigh is well-written; lacks pictures & diagrams; requires considerable explanation in class.

NORTH DAKOTA UNIVERSITY

1. Balzhiser et al. — Sr
TEXT
Best present book for CHE's, although it could be improved.

OHIO STATE UNIVERSITY

1,2 Smith & Van Ness — Jr/Jr
CHALLENGES
Difficult concepts are fugacity; vapor liquid equilibria.
TEXT
Smith & Van Ness can be covered in a fast paced 2 quarter course.

OKLAHOMA STATE UNIVERSITY

1. Van Wylen & R. L. Robinson, "Audio Tutorial Notes" — Soph/Jr/Sr
FEATURES
Core course required of all engineers. Modified self-study approach with au[illegible] tutorial tapes optional. Required c[illegible]s attendance at one meeting per week, which is devoted to discussion of problems, questions and answers, and review.
EXPLANATIONS
Course taught as a skills course-teach students to use thermodynamics-rather than dwelling at length on such things as the nuances of the philosophy of entropy.
CHALLENGES
Student motivation. Most students enroll because they are required to, and feel they will never want, use, or need the subject matter of the course.

OHIO UNIVERSITY

1,2 Smith & Van Ness — Jr/Jr
3 Quarter sequence of thermodynamics and kinetics.

OREGON STATE UNIVERSITY

1,2 Van Wylen & Sonntag Jr/Jr/Jr
3. Smith & Van Ness
FEATURES:
3 quarter course: EE take 1 term, AgE & IE take 2 terms, ChE & ME take 3 terms
EXPLANATIONS
Proper choice of system or control volume before analysis; relation of entropy to reality.
TEXT
Need better book for a core course; now use 2 texts plus supplementary notes.

UNIVERSITY OF PENNSYLVANIA

1. Denbigh Jr
FEATURES
Use of computer to do more realistic problems than can be done analytically. Estimation of physical properties.
CHALLENGES
Effectively communicating the concepts and teaching student to translate these concepts into approaches to solutions of problems.
TEXT
Most texts have shortcomings of one sort or another.

PRINCETON UNIVERSITY

1,2 Smith & Van Ness Jr/Jr
FEATURES
First course develops first and second laws and other relationships and applies these to power generation and refrigeration. Begin study of ideal gases. Second course deals with non-ideal gases, phase equilibria and chemical equilibria.

PENNSYLVANIA STATE UNIVERSITY

1. Himmelblau; 2. Smith and Van Ness ; 3. Balzhiser SOPH/JR/SR
FEATURES
Emphasize Computer Solutions to problems. Students are provided with a data file containing data from Tables in Smith & Van Ness. They are asked to write their own programs for PVT, ΔM*, ΔS* and lu f/f° calculations. with the Beattie-Bridgenian Equation, and other programs for VLE calculations. Lecture time is kept short by using the overhead projector and handout sheets. Most class time is used discussing homework problems.
EXPLANATIONS
Concept of entropy from simple piston experiments asdescribed by Van Ness in his paperback "Understanding Thermodynamics. Activity equations are "sophisticated fudge factors."
CHALLENGES
Help students overcome prejudices and find that thermodynamics can be fun and a bit exciting.

UNIVERSITY OF PITTSBURGH

1. "A Course in Thermodynamics" Soph/Jr
A. J. ~~Balzhiser~~ Brainard
FEATURES
Use of self-study examples to provide student problem solving wastery.
EXPLANATIONS
Original experiments of Joule, while serving to establish the experimental basis of the First Law also provide very graphic evidence of the Second Law. Everyday examples of irreversibility are introduced to provide a foundation for the Second Law.
CHALLENGES
Students seem to feel that the various mathematical operations used in thermodynamics are a great mystery. They have trouble seeing the broad picture.

TEXT
Balzhiser follows current trends to introduce entropy using the statistical approach this adds additional concepts to the already heavy load that must be mastered in learning thermodynamics. The approach to chemical equilibrium (Ch11) is unnecessarily complicated.

UNIVERSITY OF PUERTO RICO

1,2 Balzhiser, et al. Jr/Sr
CHALLENGES
Need to unify the subject into a few clear ideas. Second course deals with chemical and phase equilibria.

UNIVERSITY OF SOUTH FLORIDA

1,2,3 Sonntag & Van Wylen Soph/Soph/Jr
FEATURES
Set of questions & answers and set of example problems didtributed to supplement text. Quizzes include questions similar to those provides. Students retain more than if only required to solve problems.
CHALLENGES
Understanding of simple, fundamental concepts.
TEXT
Greater stress on practical problems & simple theory concepts.

UNIVERSITY OF SOUTHWESTERN LOUISIANA

1. Smith & Van Ness Jr
FEATURES
Follows core thermodynamics course. Deals with deviations of ideal gas conditions and on chemical equilibria reactions applicable to process industries.
CHALLENGES
Explanation of entropy, lugacity, and activities and their applications to actual processes.
TEXT
Lacks sufficient thermodynamic data, needs up-dating; concentrate more on ChE thermodynamics.

UNIVERSITY OF TEXAS, AUSTIN

No contribution

TEXAS TECH UNIVERSITY

1, Smith & Van Ness

UNIVERSITY OF TOLEDO

1,2,3 Smith & Van Ness Jr/Jr/Jr
FEATURES
Develop understanding and thermodynamic reasoning and concepts. Develop skill in estimating interphase equilibria calculation of chemical equilibria, use of thermodynamic tables and charts, thermodynamic analysis.

TRI-STATE COLLEGE

1,2 Smith & Van Ness Jr/Jr
FEATURES
Laboratory expermint in refrigeration
TEXT
Need to moderize Smith & Van Ness

UNIVERSITY OF TULSA

1. Sussman Soph/Jr
2. Smith & Van Ness
(Hougen, Watson, Ragatz for graduate course)
1. Wales - Programmed Learning Text is uses alternatively for course 1. First course is core course for several disciplines of engineers.
TEXT
Smith could use improvement in vapor-liquid equilibria, reaction equilibria.

UNIVERSITY OF UTAH

1. Sonntag & Van Wylen Soph
FEATURES
1. Emphasize problem solving 2. Introduce computers for equations of state (Beattie-Bridgeman and others)
EXPLANATIONS
1. Use of 3-dimensional surface models to explain vapor-liquid solid phase equilibrium. 2. Use of a summary describing the first and second law equations to enable a student to recognize what terms are important under certain circumstances. 3. A special assignment in discussing power and refrigeration cycles created more interest in the topic.
CHALLENGES
Explaining the first law in flow systems, particularly those problems which involve an accumulation of mass and/or energy. Explaining the significance of the second law and its application to common problems.
TEXT
Introduce a section on compressors, single and multistage to help relate thermodynamics to engineering equipment.

VANDERBILT UNIVERSITY

1. Balzhiser, et al Jr
CHALLENGES
Application of princ*ples of thermodynamics to chemical engineering problems with particular emphasis on phase and chemical equilibria.

VILLANOVA UNIVERSITY

Balzhiser Soph
FEATURES
Problem oriented rather than theory oriented. Emphasis is on developing a feel for concepts, an understanding of basic principles, and an ability to apply the more formalized concepts.
EXPLANATIONS
To present the concept of Entropy (and the Second Law) and to develop an understanding of energy degradation, a model universe is defined (on the blackboard). Using the more or less intuitive concepts of a) hot and cold heat reservoirs (constant temperature 2 phase bath) b) mechanical energy stored in a weight pulley system c) a heat engine and d) frictional reversibilities, it is demonstrated that energy is conserved but the universe still runs down. This concept is extended to other types of irreversibilities.
CHALLENGE
Getting students to recognize what thermodynamics concepts are involved in the analysis of a particular problem.

UNIVERSITY OF WASHINGTON

1. Reynolds Jr/Jr
2. Balzhiser et al
EXPLANATIONS
Concepts of system and surroundings use of generalized force - generalized coordinate concepts for generalization o: interactions, whether heat or work.
TEXT
Balzhiser, et al. is good.

ST VIRGINIA UNIVERSITY

1. Wales "Programmed Thermodynamics" JR/JR
plus Smith & Van Ness

FEATURES

Programmed instruction uncluding fill in practice problems. Small project applications.

EXPLANATIONS

Need variety of problems , especially sample problems. Small project reports are helpful.

CHALLENGES

Creating interest in students excellently done by projects.

TEXT

Needs more practice problems.

WORCESTER POLYTECHNIC INSTITUTE

1. Van Wylen Soph/Soph
2. Van Wylen & Smith, Shipman's Notes, Denbigh

FEATURES

Class participation in problem solving.

UNIVERSITY OF WYONING

1. Silver "Introduction to Engineering Thermodynamics" Soph/Jr

FEATURES

Principles of thermodynamics are introduced in the form of generalized balance or conservation equations. Emphasis on working as many problems as possible through to numerical answers.

CHALLENGES

Developing meaningful laboratory demonstrations; finding satisfactory visualaids, such as films and slides to supplement the lectures.

YOUNGSTOWN STATE UNIVERSITY

1. Smith & Van Ness Jr

FEATURES

Concept of accountability and reversibility as it relates to the forst law. Concept of probability, physical and social changes as related to the Second Law.

CHALLENGES

Keeping interest of student in every class period.

UNIVERSITY OF MASSACHUSETTS

1. Smith and Van Ness Soph/Jr
2. Balzhiser

FEATURES

Application of phase equilibria and chemical reaction equilibria to industrial applications.

CHALLENGES

Idea of standard states for fugacity- to be sure that students understand that the composition for an equilibrium calculation is independent of standard states, but the values of activity coefficient are not.

TEXT

There is no good book which deals adequately with the first and second laws as well as with phase and reaction equilibria.