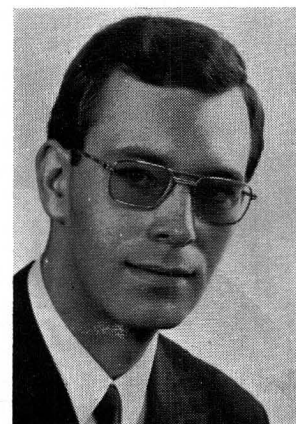


FOOD ENGINEERING



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The dramatic changes in the world population activated intensive interest in food problems all over the world.

As a result, our department began offering a selected topics type of course dealing with some aspects of food engineering; indeed, the volume of information available in the field is enormous and a one semester course can never cover more than a small fraction of the material.

TABLE I: FOOD ENGINEERING COURSE OUTLINE

PART I: BIOCHEMISTRY AND MICROBIOLOGY

- A. Amino acids
- B. Proteins
- C. Bacteria
- D. Yeasts
- E. Microbial growth curve

PART II: OIL SEED TECHNOLOGY

- A. Preparation of beans
- B. Extraction
- C. Desolventizing
- D. Lecithin separation
- E. Alkali refining
- F. Bleaching
- G. Hydrogenation
- H. Deodorization
- I. Mixing
- J. Rheology

PART III: BIOCHEMICAL ENGINEERING

- A. Sterilization
- B. Fermentation Kinetics
- C. Batch and CSTR reactors
- D. Application to the brewing industry

PART IV: STUDENT PRESENTATION OF TERM PAPERS

1. Food from petroleum
2. Food additives
3. Food processing by microwaves
4. Protein from grasses

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The course was offered for the first time to fourth year students and to first level graduate students in chemical engineering. Chemists and microbiologists also took the course but were somewhat disappointed due to their lack of knowledge in kinetics, transport phenomena, unit operations and mathematics.

Active student participation was promoted by including assignments in which judgement and ingenuity were to be exercised and alternative solutions considered, followed by oral presentation of a term paper, movie projections and a final quiz.

We hope that the program of the course will captive one's intellectual interest and indicate important ways in which chemical engineers can broaden their services to humanity.

DISCUSSION OF COURSE MATERIAL

TABLE I OUTLINES the course material. The first two sections of the first part introduced the student to biochemistry. Properties of amino acids and protein structures were discussed in detail. The effect of processing factors such as heat, storage, etc . . . on the structure of protein was dealt with and some of the analysis methods (chromatography X-Ray diffraction) were introduced. Then followed some notion of microbiology. In addition to a general discussion about the cell, some properties of bacteria and yeasts were focussed upon. References [1-7] were very helpful in this context. The second part of the course

switched the student back into the engineering world of material balances, mass transfer and transport phenomena. As an example, the production of margarine was discussed in detail. Attention was given to equipment selection (cracking mills, extraction apparatus etc.), calculations were made on extraction, mixing and hydrogenation. With regard to those subjects, references [8-9, 13-14, and 15] were of particular interest.

Some time was spent on the problems encountered with the choice of solvent(s) and on efficiency calculations based on film theory and on diffusion theory [12]. Due to time limitation, the previous part was followed by a too brief introduction to the rheology of non-Newtonian liquids [16-17]. This second part was then concluded by a projection of the two following movies:

- Raw materials and refining vegetable oils and fats.
- What is margarine, vegetable oils and fats.

These movies were produced for the Lever (British) Company by Worldwide Incorporated and rented from the Canadian Film Institute, Ottawa, Canada. References [10-11] proved also to be of interest in the preparation of this material.

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At various appropriate points in the third part of the course, several aspects of the beer brewing industry were introduced. Sterilization was looked upon from an engineering point of view. In addition to presenting the classical Michaelis-Menten kinetic model, we attempted to develop more sophisticated ones such as the Aiyar and Luedeking [21] and Kono-Asai [25] models.

Material and energy balances were then used to predict the performance of batch reactors. Continuous systems were next studied; here a variety of situations was looked into, such as the case of a series of vessels, a single vessel with recycling and the washout problem [18-19] other fermentations were presented, dealing with the given models [22, 24]. In addition to the above mentioned references the following publications

proved to be useful in connections with this design part: [20, 23, 26]. The course was concluded by the presentation of the term papers. Table II shows the chosen topics. □

TABLE II: TERM PAPER TOPICS

1. Food from petroleum
2. Food additives
3. Food processing by microwaves
4. Protein from grasses
5. Protein from algae
6. Enzymes and the tenderization of meat
7. Gibberellin fermentation
8. Control of fermentation processes
9. Sugar refining
10. Sorbitol utilization
11. Liquorice in food
12. Yeast as an animal food
13. Ethanol from wood
14. Protein from spent sulphite liquor
15. Furfural production from bagasse
16. Products from molasses
17. Starch

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strong collections of publications on fusion technology maintained by the Engineering Library and also by a satellite library at the Plasma Physics Laboratory on the Forrestal Campus. Many of these publications are in the form of proceedings of international symposia and workshops on specialized aspects of fusion technology sponsored by various agencies like Energy Research and Development Administration (ERDA) and technical societies like the American Nuclear Society and the Institute of Electrical and Electronics Engineers (IEEE).

The graduate course was designed primarily for first-year graduate students in the fusion reactor technology program but a number of other students elect it as well. A principal objective is to provide an up-to-date perspective on the major problems and current researches in the technological aspects of fusion power development.

Because of the rapid growth of knowledge in many aspects of fusion technology and shifting emphases as new constraints arise and old ones change, the content of the course will vary from year to year. Last fall the formal coverage included a brief overview of the world energy problem to show what contributions might be expected of fusion power, a detailed review of the Princeton Reference Design to identify the major problems and some possible solutions, a treatment of the problems of plasma physics as a basis for setting the scale of realistic machines and fixing many of their properties, and an examination of the environmental problems arising from power plants generally and from fusion power plants in particular.

Although some problems had to be treated cursorily, either for lack of time or because current understanding is uncertain, every major problem was addressed in the formal part of the course. Some like the use of molten salts as tritium breeding media the permeation of hydrogen isotopes in metals were addressed in greater detail because of the special interests of particular faculty members.

During the term eight seminars were conducted in the course on the following subjects:

1. Low Concentration Permeation
2. Ion Bombardment of Metals
3. Fission-Fusion Hybrids

4. Parametric Systems Analysis
5. Laser Fusion
6. Alternate Fuel Cycles
7. Non-Power Uses of Fusion
8. Fuel Injection

Concurrently with the graduate course in fusion reactor technology a series of ten seminars on vacuum technology and engineering was offered by a physicist from the Plasma Physics Laboratory as part of the program in fusion reactor technology. A similar seminar series on neutronics was offered during the preceding term. As a consequence neither of these topics was discussed in any detail in the graduate course.

Although we have offered the course only once, our assessment, arrived at in consultation with our students, is that we have fairly met our objectives. We anticipate that we will follow essentially the same format when we offer the course again this fall. In contrast with the first offering we shall probably include some homework problems and examinations to provide a better feedback on our teaching. □

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