A New Chemical Engineering Senior Elective Course: Principles of Food Engineering

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Background

Food industry has drawn increasing attention with headlines of megamergers and joint ventures, and aggressive, innovative marketing campaigns. The industry currently enjoys rapid growth, with the top 100 companies posting an average sales gain of 6.7% last year and topping a total of $684 billion[1]. The industry's recent growth has demanded a new focus on process improvement and automation, which has resulted in a shortage of employees with technical skills [2]. Engineers, thus, play an important and expanding role in this exciting field, yet undergraduate chemical engineering students are rarely exposed to food engineering. This course developed and integrated applied food engineering coursework and food chemistry experiments to provide students with the skills directly relevant to the evolving needs of the food processing industry.

Rowan University is pioneering a progressive engineering program that uses innovative methods of teaching and learning to prepare students for a rapidly changing and highly competitive marketplace, as recommended by ASEE [3]. Rowan Engineering is committed to being a major technological resource for the area, preparing students for engineering careers in regionally important industries such as food processing. The New Jersey Economic Development Authority has targeted food processing as one of the state's key industries, and has arranged for over $50 million in financing to attract new food processors to the state [2]. The state is home to Campbell Soup Co. (in neighboring Camden, NJ), and has major manufacturing operations of top companies such as Coca Cola, Anheuser Busch, General Mills, and Kellogg's. The immediate Vineland area is the hub of Southern New Jersey's food processing industry, home to about thirty

companies employing 3,000 people and producing $700 million in shipments [4]. The abundance of food processing companies in New Jersey demands a steady pipeline of well-prepared engineering graduates.

Rowan Engineering students respond to the regional emphasis on food processing with a tremendous interest in the industry. In their senior exit interviews, an overwhelming number of graduating seniors strongly indicated a need for more exposure to food-oriented projects and courses. To respond to student demand and regional industrial needs, Chemical Engineering faculty have secured support in recent years for undergraduate Clinic research projects with General Mills, Campbell Soup, Pepperidge Farm, and C. W. Brown. Food experiments have been introduced to all engineering students in the Freshman Engineering Clinic, a multidisciplinary, introductory course required of all freshmen.

Goals and Objectives of this Course

The broad goals of this course are:

(1) To provide chemical engineering students with the necessary food science/chemistry background.

(2) To introduce unit operations and processes that are relevant to food industry, and that are not traditionally covered in the chemical engineering curriculum.

Introduction

Food Engineering involves most of the classical chemical engineering principles, such as thermodynamics, fluid flow, and heat and mass transfer. This course is typically taught in programs other than engineering to provide basic knowledge of these engineering principles to biochemists, microbiologists, nutritionists, flavor chemists and toxicologists. As a senior elective chemical engineering class, the audience would have had a good background in the engineering principles but an almost complete lack of food science and food chemistry background. Therefore the course was based on two textbooks. One was "Introduction to Food Engineering", 3rd. Edition, written by R.P. Singh and D.R. Heldman. This textbook provided the necessary

information to address the engineering principles relevant to the chemical engineering profession and its link to food industry. A second one, "Introductory Foods" by M. Bennion and B. Scheule, was used to cover the material on food composition and its properties.

Class format

This class was taught for the first time in the fall semester of 2002. The class is a senior elective/graduate student course this means that it is opened to senior chemical engineering undergraduates and graduate students in the program as well. The total enrollment for the course was 20 with 12 of them being undergraduates. The class met once a week for two and a half hours and the class activities were then clearly divided in two segments. During the first part of the class a brief introductory lecture to the topic was presented usually followed by a laboratory experiment. The brief lectures focus on background only to allow for an inductive learning environment. There were few occasions in which the entire period was devoted to a lecture followed by a problem solving activity or to a more extensive laboratory activity. The food engineering textbook is designed to be used in a sequence of two courses, therefore, we covered only the part of the book that we felt best complemented the preexisting engineering knowledge of our chemical engineering seniors. The engineering topics covered were: Theory and Design of Dehydration processes, Diffusion Mass transfer in Food and Packaging Materials, Evaporation, Food Freezing modeling and Preservation Processes. Complementing the engineering topics, the students learn about food composition, beverages, sugars, starches and other carbohydrates (bulking agents and sugar substitutes), sugar cookery, frozen desserts (water crystallization), gelatinization and gelation processes (modified starches concepts were introduced in this section as well), fats, frying and emulsions, cakes and cookies (non yeast batters), yeast dough, and milk and milk products.

There were a total of seven labs adapted from either a food science manual [5] or from a food engineering laboratory manual [6]. The first laboratory experiment was on Sensory Analysis, followed by experiments in Beverages, Sugar Cookery, Frozen Desserts, Starches, Osmotic

Dehydration and a final experiment on different food preservation processes for meat. The students also have a semester-long project. The class was divided into groups of three or four students and each team was given the opportunity to pick a project out of a given list. All these projects focus on the design of food science/engineering experiments and the written delivery was a self-contained laboratory procedure to introduce into the chemical engineering curriculum.

The topics chosen by the student teams were: chocolate rheology, chocolate coating, microbial presence in milk, hard cheese manufacturing, batch concentration of milk and instrumentation of an old-fashion ice cream maker. The students also had to present their work to the class and in some cases some groups decided to have the rest of their classmates perform the lab that they had designed.

The course grading was split as follows:

Exams (3) 50 %

Homework and laboratories 20%

Project 30 %

Results

Student comments about the course were quite positive with an overall rating of the course of 4.73 (in a scale from 1-poor to 5-excellent).

Some of the relevant students comments are transcribed below

"It is more interesting to do labs with something that you can relate to in real life as opposed to some obscure chemical process"

"Great course! a) I learned a lot; b) It was fun; c) Interesting topic; d) Good break from the rigor of normal boring classes. Thanks"

"One of my favorite classes due to the different subject matter than (sp.) other engineering material"

Biographical Information

Mariano J. Savelski received a Chemical Engineering degree from the University of Buenos Aires, Argentina in 1991, a M.E. from the University of Tulsa in 1994 and a Ph.D. from the University of Oklahoma in 1999. Dr. Savelski has seven years of industrial experience working first as process engineer for SADE Skanka and later on as quality and technology engineer for Kellogg. He joined the Chemical Engineering Department at Rowan University as Assistant Professor in 1999.

References

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