ENVIRONMENTAL COURSES

G. E. KLINZING
University of Pittsburgh
Pittsburgh, Pennsylvania 15261

DURING THE PAST THREE years at the University of Pittsburgh the Chemical Engineering Department has developed two courses dealing with the environment for advanced undergraduates and graduate students. One is entitled, "Atmospheric Pollution" and the other, "Industrial Waste Treatment." These courses developed from joint student-faculty-industry interest and cooperation. Not only have chemical engineering students participated in the program, but other science and engineering students have also taken these courses.

The University's location in a heavily industrialized city has been a particular advantage for the study of the environment in these courses. Cooperation with industrial and government organizations has given the courses a unique quality of seeing and being involved in the most immediate and relevant problems of an industrial city.

In the atmospheric pollution course, the Pittsburgh problem was stressed and used as a basis for analysis. The sulfur dioxide and suspended particulate matter problems were presented more than the nitrogen oxides or any other pollutant problems. The course ran 15 weeks, which is one trimester having three hours of class time per week. This course was held on one evening in order to accommodate the large number of part-time graduate students from the industrial community of the area.

The final part of the course looked at equipment, design and economics. Process treatments, scrubbers, bag houses, cyclones, electrostatic precipitators, etc., were handled. The cost of these units as well as a treatment of cost-benefit analysis of air pollution control in general was presented.

George Klinzing received his BS degree in Chemical Engineering from the University of Pittsburgh and his MS and PhD from Carnegie-Mellon University. He spent three years teaching and consulting in chemical engineering at Central University in Quito, Ecuador. His interests are transport phenomena and engineering education in and technology transfer to developing countries.

The first week was devoted to an introduction to air pollution both on a global and local basis. Definition of terms and identification of sources were detailed. Chapters 1-5 of McCormac [1] and Chapter 1 of Strauss [2] were required readings. The next two weeks were dedicated to atmospheric transport by dispersion models. Comparison between models and evaluation of coefficients of dispersion were treated. The effects of inversions, chemical reactions and finite absorption of the pollutants at ground level was studied in the modeling. The many plume rise equation were viewed and controversy aired on the various analyses. The book by Ledbetter [3] was also used as reference material.

Sampling and analysis were next scrutinized. The EPA sampling train and other EPA regulations on sampling were covered. At this point, an industrial representative from a local power com-

pany discussed the practical aspects of sampling commenting heavily on the regulations specified by EPA in the Federal Register. Considerable class interaction took place at this point and an appreciation of the industrial problem was realized. These topics took two weeks to study.

LEGAL ASPECT

THE LEGAL ASPECTS of air pollution are indeed complex. Some of the more famous cases were viewed and the pending legal situation of cases in Allegheny County (Pittsburgh being the County Seat) were discussed. A representation of the State of Pennsylvania's Department of Environmental Resources gave a lecture discussing some specific cases and showing the legal process that needs to be followed in prosecuting a violator. Routine inspections and testing were explained and problem areas mentioned as to enforcement of the law. Two weeks were spent in total on the legal topic.

The next three to four weeks were spent on sulfur dioxide and suspended particulate matter analysis. Detection techniques, sources and abatement procedures were treated. Chapters 3-10 of Strauss were utilized as a basis with government publication assisting in the treatment. [4] The various types of equipment for analysis and sampling were brought into class when possible, and the advantages and disadvantages of the units explained in detail.

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In addition to quizzes and a final exam, the students in groups of 2 or 3 worked on a project during the term related to the air pollution area. Some topics were suggested and others were originated by the students. Some of the topics for analyses were:

- CO Concentrations in Oakland (University Area)
- Pressure Swing Adsorption Cycle on Auto Emissions
- Infra-Red, Gas Chromatographic Analysis of Pollutants
- Indoor Level of Pollutants (Engineering Hall, Student Dormitories)
- Multiple Stack Analysis
- Plume Rise Calculations (Comparison and Analysis)
- Flow Patterns Around Buildings

WASTE TREATMENT COURSE

THE SECOND COURSE in the environmental area was "Industrial Waste Treatment." This course met for the same length of time and same time slot as the "Atmospheric Pollution" course. The base text for the course was Nemerow. [5] The first four to five weeks of the course were dedicated to understanding the basics of industrial waste treatment and roughly Chapter 1-20 in Nemerow were covered. Here again, definitions are essential such as BOD, COD, and TOD. The basic operation of neutralization, sedimentation flotation, activated sludge, and trickle filters were handled showing the basis for analyses from mass and heat transfer approaches. Detailed designs of a base case for each one of these units were presented. [6] This preface was used as a basis for industrial representatives to present lectures on specific industrial waste problems concerning mostly the Pittsburgh area. To begin the special lectures a professor of Environmental Law talked in general and specific on industrial waste problems stressing changes in legal interpretation and sentiment. A consultant in the Pittsburgh area spoke on wastes in the tanning industry showing that as the laws are presently written and considering the small size of such tanning operations the industry would probably die in the United States in the next few years.

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Wastes in the food industry was given by an engineer from the H. J. Heinz Co. and another consultant in the environmental area spoke on waste water parameters and measurement for treatment control. Both speakers stressed high costs with the Heinz representative giving detailed information on financing of an industrial waste treatment. The pitfalls of waste water measurement were mentioned by the consultant showing you can rely very little on most measurement in the waste water analysis field including the

stadard pH measurement.

Radioactive waste disposal was handled by Westinghouse and a representative of United States Steel Corporation gave an excellent treatment of the steel industries problems and programs. The municipal waste and their ability and willingness to handle industrial discharge was presented by the county's municipal disposal facility, ALCOSAN. Jones and Laughlin Steel Corporation presented the coal mining waste problem and treatment. Effective treatment can be inacted on new mines; but old abandoned ones are the areas most difficult to clean-up.

THERMAL POLLUTION

DURING THE LAST WEEK of the course, the thermal pollution area was treated with consideration from power plants both coal fired and atomic. Much of the atomic power plant material tied in with the radioactive waste treatment lecture.

In short, reliance on industry for up-to-date information and a special viewpoint was very successful both in the atmospheric and industrial wastes courses offered. Our area indeed is rich in capable, knowledgeable engineers willing to assist in the preparation of meaningful courses on the environment for the students of our engineering schools. □

REFERENCES

1. Mc Cormac, B. M., *Introduction to the Scientific Study of Atmospheric Pollution*, D. Reidel Publishing Co., Dordrecht-Holland (1971).
2. Strauss, W., *Industrial Gas Cleaning*, Pergamon Press, London, (1966).
3. Ledbetter, J. E., *Air Pollution Part A: Analysis*, Marcel Dekker, Inc., New York (1972).
4. National Air Pollution Control Administration Publications AP-49, 50, 51, 52, 62, 63, 66, 67, 68, 84.
5. Nemerow, N. L., *Liquid Waste of Industry*, Addison-Wesley Publishing Co., Reading, Mass. (1971).
6. Eckenfelder, W. W., *Industrial Water Pollution Control*, McGraw-Hill Book Co., New York (1966).

BOOK REVIEW: Multivariable Computer Control

Continued from page 154

publish these together in a single volume. The result is the present book.

The authors have been able to present a coherent view of their work by appending introductory discussion to previously published papers and organizing this by topic. It may be useful to summarize briefly the scope of the material. Section 1 presents an overall view of the book, while Section 2 treats several different approaches to modelling the process. Of particular interest is a comparison of model reduction procedures and a study of several approximate low order models of the process. Section 3 demonstrates the dynamic performance to be expected under conventional control while Sections 4-6 discuss more modern computer control techniques. These sections present a detailed comparative study of techniques such a multivariable feedback control, combined feedforward-feedback control, time optimal control, optimal linear-quadratic feedback control, model reference adaptive control, etc. Section 7 presents experimental testing of on-line state estimation (using Kalman Filters) and the incorporation of the state estimator into a stochastic feedback control scheme. Finally Section 8 describes the overall educational aspects of such computer control facilities.

The case study would be of interest to anyone wanting to evaluate the experimental performance of a number of modern process control techniques. However, as one who has used this case study (in manuscript form) with good results in a graduate process control course, this writer feels the greatest value of the book is as a supplementary text in such a graduate course. The availability of a single process from which to draw experimental examples of model linearization, model reduction, single loop feedback control, multivariable feedback control, multivariable optimal feedback control, state estimation, etc., allows the student to study a new method on an already familiar process and to compare with methods already discussed. As a supplement to lectures over the fundamental mathematical methods, we found the case study extraordinarily helpful.

BOOK RECEIVED

Organic Electronic Spectral Data. Vol. II, 1969.
Edited by J. P. Phillips, H. Feuer, P. M. Laughton and B. S. Thyagarajan.
John Wiley & Sons, Inc. New York, 1975.
1075 pages.
This is volume II in a continuing compilation of ultraviolet-visible spectra of organic compounds presented in the journal literature.