ChE views and opinions

AN IVORY TOWER MAN DINES IN THE REAL WORLD

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THE FAMINE

BECOMING A UNIVERSITY professor immediately after receiving a doctorate degree can be an uneasy experience. All those years in graduate school flood the mind with differential equations and FORTRAN programs. Boundary layers, laplace transforms and digital computers become a way of life. Little time is spent worrying about why pumps cavitate, why heat exchangers leak, why bearings fail, why pipelines corrode away or why reactors plug. Even less time is devoted to solutions to the above problems. The reason is simple. Popular text books rarely discuss them. Chemical engineers with bachelor's degrees are confronted with these problems daily. A useful education for them demands that their instructors know the answers to such questions and relate the importance of such "mundane" problems.

Graduate students on assistantships or fellowships seldom worry about financial red tape. Their advisers take care of that. The paycheck somehow gets home every month. The student researcher's mind can't be cluttered with priorities, justifications, budget estimates, transfer of funds and similar monetary considerations. In industry, making a profit for stockholders is the primary justification for existence. How money is handled determines whether it's a steak or hamburger year. Engineers must help decide how much and where money is spent. Instructors who don't know can't tell students.

The above paragraphs are not meant to unduly criticize the educational system per se. The point is that industrial experience is essential for any instructor who is preparing students for an engineering career outside reesarch. Getting this experience without giving up teaching altogether is a difficult task in many universities.

FOOD FOR THE HUNGRY

THE AMERICAN SOCIETY for Engineering Education (ASEE) sponsors a Resident Fellow Program just for engineering faculty wanting 12-15 months industrial employment. Research work is discouraged and "real-life" experiences are top priority. Industry pays the Fellow's wages, while ASEE picks up moving expenses from and to the university. Employment depends on company/faculty match of interests. Luckily, Standard Oil Company of California was willing to hire this writer.

Few of the problems discussed required extensive calculations for their solution. Some of the day-to-day problems, however, do require mathematical treatment.

THE MENU

WORKING IN A LARGE industry for one year (365 days in this case) can be handled in different ways. The Fellow can spend short periods of time in many different areas, thereby gaining lots of superficial knowledge about an entire complex operation. Benefits to the Fellow are many but the employer gets little return for his investment because time spent in any one area is too short. A second approach is to treat the Fellow as an ordinary employee and have him become intimately familiar with one or two plants. He may not see the entire manufacturing complex but should be quite valuable to the company before he leaves. Other options such as assignment to detailed design projects are also available. Personal preference of the Fellow and company needs determine the final choice.

HORS D'OEUVRES

Before an engineer can do meaningful work for a company, he must learn a few things about the firm or unit where he is employed:

Where is technical information located? (Don't underestimate the yellow pages!)
Who are the company experts in specialized areas?
How are equipment files organized?
What paper work is required to get work done in the field?
Who sets priorities on field work?
How are materials ordered and delivered?
How are contracts written, approved and executed?
What are the safety requirements set by the company?
How is money obtained for expensive maintenance projects?
What levels of approval are needed for capital expenditures?
What are the lines of communication, i.e., who is supposed to know what you're doing?

Answers to all these questions will vary from company to company, but they are facts which every engineer needs.

THE MAIN COURSE

MOST OF THE JOBS discussed below were problem types assigned to the author or any engineer in manufacturing. Some solutions are given. At times no solutions were found. None of the work items were textbook problems with answers in the appendix. They are discussed briefly in order to show future Fellows the variety of problems to which they can be exposed. Industrial readers should note that a Ph.D. doesn't immunize an engineer from dirt and grease. Student readers will guess that even professors can't solve all their problems.

Leaks around stems and bonnet gaskets of valves are never-ending problems. Replacing packing and gaskets is straightforward if the valves can temporarily be taken out of service. New sealing materials are often tried on repeaters. Grafoil (a patented Union Carbide form of graphite) is the latest wonder product in many applications. On occasion, a leaking valve can shut down an entire plant if it can't be isolated. Other times, special clamps must be designed so a heat-setting material (like Copaltite) can be pumped inside the clamp to surround the leak. As the Copaltite sets up it stops the leak. (This solution works only on valves handling hot stock . . . that should have been obvious).

Erosion/corrosion of trim in valves can be tough to stop. Deciding if corrosion is the primary factor often requires detailed metallurgical analyses. Materials selection is not a cut-and-dried procedure. Exotic materials are expensive (carbon steel is getting that way) and may not give appreciably longer life. Past experience can be the best guideline. When erosion is the real problem, hard-surfacing the wearing parts may be the answer. Other times, changing the style of trim will help. Really bad cases require replacing the entire valve with one of suitable trim and material.

A useful education for B.S. ChE's demands that their instructors know the answers to such practical questions and relate the importance of such "mundane" problems.

Piping flange leaks have many causes but no cheap solutions once they start. The most common cause is dirt on the sealing surfaces. Poorly made gaskets and improper bolt-up are other culprits. Short spools which don't line up perfectly in tight spaces can induce strains which prevent proper seating of the gasket. Also, designers sometimes follow codes too explicitly so that not enough extra "beef" is available. As a result flanged joints can't take the strain for a variety of reasons and leak. The unfortunate cure for many leaks is to shut down a large section of a plant until the gasket can be replaced or the seating surfaces remachined or the piping system modified. Once in a while a special clamp plus Copaltite will seal off the leak. If a particular flange leaks repeatedly after start-ups, it's time to consider a new-style gasket. In extreme cases, flanges may be welded or removed and replaced with a straight piece of pipe.

Seal and/or bearing failures in pumps, turbines or compressors are frequent headaches. Friday evening is the most common time for these occurrences. Improper type of lubricating oil is seldom the problem. Misalignment, inadequate flush to the seals or too little oil circulation to the bearings is the usual cause. Old age is another if a pump gets overlooked on the maintenance schedule. Cures range from in-kind replacement to complete modification of the seals and seal flush system and/or oil lubrication system.

Few of the problems discussed so far required extensive calculations for their solution. Some of the day-to-day problems, however, do require mathematical treatment. Sizing pipelines for vents or recycle streams is a familiar calculation. Calculating maximum operation temperatures for reaction vessels is done periodically, particularly if part of a refractory lining has been changed. Operating temperatures are normally limited by temperature limits on the shell as set by ASME code requirements. Changing ranges on flow meters and resizing control valves are among the most common calculations made.

Energy conservation is even more critical now than in the past. Seemingly small items like recovering condensate from steam traps add up to many dollars in a large plant. Critical evaluation of blowdown systems in plants with several steam boilers can show ways of generating more steam without consuming more fuel. Since furnaces are large consumers of fuel, careful control of fuel/air ratios (e.g., by installing stack dampers) is always economically attractive. Igniting a smoke bomb in furnaces (whose stacks can be sealed off) when they are shut down will show where leaks may exist in the stacks or other seams of the furnace. Unwanted air may leak through the openings during operation.

Noise pollution is a real concern, particularly if a plant is close to a residential area. Valves, compressors and furnaces are all contributors. For new systems, designs can incorporate "quiet" equipment. In existing plants, reducing noise by lagging pipe or adding burner mutes to furnaces is an expensive and marginally effective solution in most cases. In this relatively new field much work remains to be done.

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little time is spent worrying about
why pumps cavitate, why heat exchangers
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Major projects (those with budgets > $50,000) consume about one-third of an engineer's time the first year. Probably the most emotional of projects —and best learning experience—is being a shutdown engineer. Preparing a worklist and ordering materials begins two to three months in advance (or sooner now because of material problems). The actual time a plant is down while equipment is being dismantled depends on the size of the plant and the amount of work to be done. Meeting deadlines is a real challenge. Dealing with the unexpected is the most exciting aspect of the job. The success or failure of a shutdown engineer depends largely on his ability to deal with people on the spur of the moment. There is no time to look in a favorite reference book or cite famous literature articles. Getting critical materials to the plant site in a hurry is a fun task. Transportation costs often exceed the price of the material. Cannonball express is a very descriptive phrase. A truck can be hired to drive up to 100 miles from the plant to pick up something as small as a valve bonnet gasket. Justification for such delivery expenditures is simple. Every hour that the plant is shut down beyond the schedule costs hundreds or even thousands of dollars in lost production.

The educational (in a textbook sense) part of a shutdown is seeing internals of all the equipment discussed functionally in lectures. No picture can give the same effect as actually seeing it in person. It's a real eye-opening experience to see an exchanger bundle covered with carbon particles and then find out it was still operating satisfactorily. Equally amazing is seeing a pump impeller corroded so badly it begins to crumble when touched—and then verifying that it was still pumping sour water.

Materials availability and price spirals challenge the best cost estimators. Small amounts of rare metals like Incoloy 825 or Inconel 600 are located in very obscure places. Finding them gives Ma Bell a real shot in the arm. For large amounts, no price can get deliveries speeded up. Companies just wait their turn. Previously abundant things like refractories are being added to the scarce list. Even Tokyo can't supply some varieties in less than three months.

DESSERT

BESIDES DOING ENGINEERING work, Fellows are exposed to management philosophies and actions through informal luncheons (free!) or committee meetings. Safety, pollution and public relations are high-priority items. The dollars spent to modify equipment which offends nearby

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residents is nearly unbelievable. Such expenditures seldom show a return on investment.

Working for an oil company during the energy crisis and Arab embargo was prime time for observing management and publicity men in action. Statistics in newspapers can be very misleading unless they show the whole picture. Getting both sides of the story certainly cleared a lot of fog. Knowing the oil companies' views makes one a believer in energy conservation.

A LITTLE ALKA SELTZER

HEADACHES WERE FEW, but some helpful hints seem in order for future participants to make thinks even smoother.

Industry—forget the Fellow has a Ph.D. This can actually be a handicap. He probably hasn't had his hands dirtied by anything more than carbon paper on computer printout. Grafoil gaskets, John Crane 187-I packing, dum dum, Copaltite and Locktite are still Greek the first few weeks. Maintenance people are hard to convince that a doctor doesn't know everything. Bachelors are more easily forgiven for their "ignorance." Keep the man busy. Boredom quickly discourages even the most enthusiastic engineer.

Fellows—don't brag about having your doctorate. A 50-year-old machinist with 30 years experience knows a lot more about his plant than any book will tell you. Just because a man is old, don't assume he's senile. An experienced pipefitter can help you out of more piping problems than any Reynold's Number-Friction Factor Chart. On the other end, don't think a man your age without a college education must be dumb. Listen to what he has to say—in fact, ask his opinion, then *think* about it. The more people you ask the more apt you are to find the real problem and then its solution. Don't be afraid to admit you were wrong and a less educated person was right. Only God never makes mistakes. Don't fret if all your fancy calculations say something should work, but it doesn't. (Molecules sometimes refuse to be ideal gases). Quite often there is no substitute for "gut reaction" engineering. You did it because deep down inside it felt good. Very few equations have a symbol for common sense, even though it is the most important factor in many solutions.

Above all, don't expect to acquire a portfolio of problems which can be used as classroom exercises. Such is not the point of the program. The non-cookbook problems are most important for rounding out your education. Many will be interesting tales to relate during lectures but won't be amenable to solution with an HP-35.

Life in industry won't be a bed of roses. Some days are boring; others are frightfully frustrating. Most, however, can be quite enjoyable with the proper attitude.

MINTS ANYONE?

LITERATURE ON THE Resident Fellow Program seems to reach universities through engineering education magazines. Unfortunately, several large chemical companies were contacted by the author and had never heard of the idea or were not actively involved in it. Benefits to industry are not just the work a Fellow performs. Good relations can be established with a university and communication lines are opened to express criticism of graduates and suggest improvements in engineering curricula. These thoughts can be conveyed during, as well as after, the residency.

Future success of the Residency Program will depend on greater support by industry. A modification worth exploring would be to set up an exchange program whereby someone from industry replaces the faculty member at the university. Caution: University pay scales are significantly lower than industrial ones.

GRATUITIES

The author wishes to express his sincere and long-lasting thanks to the many employees of Standard Oil Company of California, who made life easier when he didn't yet know which fork to use. Thanks also goes to the American Society for Engineering Education for picking up part of the tab for this most worthwhile experience. □

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