

Engineering Ethics Cases with Numerical Problems

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Chemical Engineering Case 1

Superphosphates

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Suggested Courses:

Mass and Energy Balances, Fluids

Level:

Sophomore & Junior

I. Narrative

The Florida Institute for Fertilizer Technology, FIFT, is funded by a consortium of phosphate-based fertilizer producers. When Rebeca began her last co-op summer assignment, the Institute had already developed a very successful process for manufacturing highly concentrated "super-phosphoric" acid. Instead of evaporating the water by heating under vacuum in expensive multi-effect evaporators, Dr. Goldfinger, a clever chemist and Rebeca's boss-to-be, had developed an indirect and effective way to provide the heat. See Figure 1. He fed commercial-grade, 52% P_2O_5 , phosphoric acid, continuously into a three-necked one-liter flask. Simultaneously, he bubbled ammonia into the flask -- carefully monitoring temperature. The heat of reaction of the ammonia with any of the acid sites proved sufficient to raise the temperature and drive the steam out. Viscous ammonium superphosphate was withdrawn to maintain the level in the flask. The nitrogen content of the superphosphate was a plus. The new product, of more than 72% P_2O_5 , and the process of continuous ammoniation of commercial grade acid were granted a patent. That summer, Dr. Goldfinger was considering the idea of running his process in a pipe reactor. His experience suggested that gaseous ammonia would react upon contact with the acid and that the heat liberated would drive the water off. He explained his theory to his co-op student, sketched his idea of a pipe reactor, and asked her to assemble one.

She never completed assembling Dr Goldfinger's vision. In fact, She thought that he never had a clear idea of what he wanted. The next fall, Rebeca received her B.S. degree in Chemistry, with Honors, from Canonical University. She went to work with Chem-Tech and was assigned immediately to the ammonium nitrate fertilizer group. Soon after her experiences with real-plant equipment, an old idea became attractive: "The Pipe Reactor." She believed that she could manufacture ammonium poliphosphate with cooking times of much less than a second in a pipe reactor, instead of minutes in a CSTR, as taught by Dr. Goldfinger in his old patent. The reactor would be correspondingly smaller and could be transported. She thought it would be essential to disperse the acid in the gaseous ammonia by injecting them into opposite sides of a "T" ahead of the pipe.

Jim, Rebeca's boss, realized the economic advantages if the superphosphoric acid could be manufactured on the site of its use. However, he was aware of Rebeca's co-op experience and asked if the pipe reactor was her idea. She responded that Dr Goldfinger never had a clear idea of what he wanted. And besides, his 'disclosure' had been over a year ago. He asked Rebeca to contact Chem-Tech's legal department.

Given the prior art, the attorney's opinion was that unless the product and the reactor were significantly different the patent would not be granted. Rebeca showed them her preliminary calculations of the hold-up time for a small prototype. They convinced themselves that dispersing the acid in the "Mixing Tee" ahead of the pipe would guarantee a hold up time of less than a second. Scale up of pipe length and diameter would be a matter of engineering details. She was on her way. She needed that patent.

On developing the new process, she asked Ramon, a chemical engineer who had been to school with her, for his support, (see MEMO, 8/24/85). Upon checking her computations, he felt that her understanding of the average residence time was at odds with his, but failed to press the issue because he felt a loyalty to her as a fellow classmate.

Rebeca got a patent on her process. However, two defining restrictions were imposed: first, a hold up time of less than a second; and secondly, that the P_2O_5 content of the feed acid be less than that corresponding to 'pure acid.' Because of the patent and her management ability, Rebeca Ramirez was eventually promoted to Vice President of Chem-Tech. Meanwhile, Ramon left Chem-Tech and got a job with a small Mexican chemical firm, Mex-Chem. Still later, Ramon left Mex-Chem and joined a very large American firm, American Chemical.

Not to be outdone, Rebeca's original employer, FIFT Inc., developed and patented a process that was very similar to Rebeca's; except that the feed acid was 68% P_2O_5 , the hold-up time was apparently longer and there was no attempt to premix the acid and ammonia. Most superphosphate producers, members of FIFT, adopted its process free of charge.

Rebeca was furious! She believed that FIFT had illegitimately gained the patent and in fact had violated her patent rights.

Rebeca brought the issue to Jim, who was now inferior to her in the management chain. Still harboring doubts about Rebeca's claim regarding the time required for the ammonia and phosphoric acid to fly through, he asked his office neighbor, a Chem E., for a textbook discussing 'mist' flow. His suspicions were given further support. However, not being willing to challenge Rebeca, he simply sent copies of selected pages to her, copies provided in the Appendix.

Rebeca concluded that Jim's evidence was not conclusive, because he made no calculations. She then consulted the Chem-Tech legal department and they agreed to sue as many of the producers as possible. There could be millions of dollars in royalties--hundreds of millions if some larger producers were to be found guilty of violating Chem-Tech patent. The strategy was simple: to claim that they were violating the less-than-one-second-hold-up-time as computed by the method described in Chem-Tech patent. This was the same method described by Rebeca in her memo, of 8/24/85, to Ramon. The lawyers were aware of Jim's and Ramon's doubts; but after all, they had won their battle with the patent examiner of the US Patent Office. Now, it was up to the courts. And the burden to prove that they were outside the limits of Rebeca's patent would be on those sued. They decided to go after the smallest of the producers using the FIFT's process, Mex-Chem.

Rebeca remembered her friend Ramon and decided to call him with a proposal:

Would you be willing to testify on my behalf against Mex-Chem? Mex-Chem is using the new FIFT patent that is an infringement on my patent. I know that American Chemical also uses the FIFT process, but Chem-Tech lawyers tell me it would be best to challenge the FIFT patent by suing a small firm. You gave your blessing to my patent a number of years ago, so I am hoping you will help me defend it now. By the way, we will agree in writing not to sue American Chemical, even though they also use the FIFT process, whose patent I think is illegal.

Ramon was absolutely certain that the one-second claim which was crucial to Rebeca's patent was wrong because he had run a pilot plant using FIFT's new process while he was in Mexico. He got enough information to convince himself that the time must be at least three seconds, and he told her. He also talked to his supervisor, who told him plainly that he absolutely could not contact either Chem-Tech or Mex-Chem on this matter.

Chem-Tech's legal department decided to sue Mex-Chem, and won. Armed with the new finding, they sued Amer-Chem. However, Amer-Chem's lawyers and expert witnesses were up to the task. Amer-Chem proved to the courts that the hold-up time in the examples of both patents was in every case above one second. Legal fees, on both sides, including the cost of special pilot plants, exceeded four million dollars. However, had Amer-Chem lost, Chem-Tech would have collected an estimated two hundred million dollars on past royalties. It was too late for Mex-Chem. It went 'belly-up' after paying their lawyers.

II. Numerical and Design Problems

[See Appendix]

III. Ethical and Professional Questions.

1. When Rebeca approached Ramon and asked him to critique her new process, he failed to raise the issue of the possible error in her claim about the time required for the materials to pass through the pipe reactor. Did he carry out his obligation as a professional engineer satisfactorily?
2. Did Jim, a registered civil engineer, follow the Code of Ethics of these professional societies throughout these events? Discuss.
3. A patent is supposed to protect the intellectual property of one person from theft by another. To be awarded a patent, however, an applicant must show that her patent serves a "teaching" function. This education enables the public and other inventors to further the development of technology. Many cases in patent law involve a conflict between the need of society to protect the rights of individuals and the need to promote the advancement of technology. How could this conflict arise? Which of these two needs seems most important?
4. Amer-Chem told Ramon that he could not testify in court or contact Mex-Chem. Did Amer-Chem have a right to give him this order? Explain.
5. How would you evaluate Rebeca's actions as a professional?

Solutions to Ethical Problems:

1. Ramon was a chemical engineer. In failing to alert Rebeca to the defects in her patent application, he was probably violating two provisions of the "Code of Ethics" of the American Institute of Chemical Engineers (AIChE). First, the code requires members to "hold paramount the safety, health and welfare of the public in the performance of their professional duties." Second, the code requires members to "act in professional matters for each employer or client as faithful agents or trustees, and avoid conflicts of interest."

It is not in the public's interest to have applications for patents that are based on faulty data. Invalid patents are a kind of fraud on the public and do not contribute to the effective advancement of technology. Failing to warn an employer that a patent application is probably not valid is also not acting as a faithful agent of an employer. Although these are not serious violations of the code, Ramon was probably not acting in accord with the highest standards of his professional organization.

2. In failing to reveal the extent of his doubts about Rebeca's patent application, Jim was probably violating the same two provisions of the AIChE code.

3. The need to promote the overall good often conflicts with the need to protect the rights of individuals. This is in fact a familiar conflict within ethical theory itself, and it should come as no surprise that this theoretical conflict is often manifested in significant practical disputes.

One such practical dispute is society's need to protect the rights of individuals and its need to promote the advancement of technology. On the one hand, if patents too severely restrict the flow of technological information, they inhibit the development of technology and thus do not serve the interests of society. On the other hand, people have a right to control and benefit from the revenues from their own property, including intellectual property. To allow others to freely use another's intellectual property is to allow a kind of theft and to

violate the legitimate rights of the owners of intellectual property.

The issue is even more complicated than this. If people can freely use the intellectual property of others, there will be less incentive for the most creative members of society to produce that intellectual property in the first place. This will also hinder the development of technology and thus harm society. Thus, there are utilitarian reasons both for restricting and not restricting the use of intellectual property, as well as non-utilitarian reasons for protecting intellectual property rights.

When there are several value conflicts on both sides of an issue, the best approach is to find a "creative middle way" between the two extremes. Although the details of such a policy are difficult to work out, the overall ethical requirement is clear: intellectual property should be given protection, but not so much protection that the development of technology is crippled.

4. In telling Ramon, one of its own employees, that he could not testify in court or contact Mex-Chem, Amer-Chem did what it thought was in its best interest and what was necessary to protect itself in the face of impending litigation. Furthermore, there is no evidence that this restriction on Ramon was contrary to the public interest, since no threat to public health, safety or welfare was at stake. While organizations should be careful to respect the freedom of their professional employees, this restriction does not appear to be a curtailment of either Ramon's professional obligations and prerogatives, or of his personal rights. Therefore, it does not seem to be an illegitimate exercise of organizational power.

5. In addition to the AIChE code requirements mentioned earlier, the code also requires members to "be honest and realistic in stating claims or estimates based on available data" and to "seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of theirs."

Rebeca's desire to get the patent may have caused her to fail to give full credit to Dr. Goldfinger for the idea of the pipe reactor. It certainly caused her to be less than fully honest with herself and others about cooking times and to be less than fully open to criticisms of her claims. Her lack of interest in pursuing the criticisms made by others constituted a clear case of unprofessional behavior.

Appendix

