Open-Ended Problems: A Future Chemical Engineering Education Approach. J. Patrick Abulencia and Louis Theodore.

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Term Projects (4): Environmental Management

Term Project 31.1

Dissolve The USEPA

One of the authors of this book has offered the following comments regarding the US Environmental Protection Agency (USEPA) [1].

The problems associated with the regulatory framework of the federal environmental management program have always been questioned. As with any government-controlled operation, many steps must often be taken before anything meaningful can be accomplished (this appears to apply to many activities, with the exception of war, where the president can exclusively command the armed forces for immediate action).

To implement an environmental regulation, the problem must be first identified (often in an EPA report), then data must be collected and analyzed (usually in another EPA report), and a goal has to be set, ultimately by congressional legislation. Once the law is in effect, it must be enforced by the EPA. The law has often been amended because of unreasonable goals and lax enforcement.

The present problem that exists with the EPA is an intricate one, consisting of primarily four main concerns:

1. Economically efficient measures are seldom, if ever, adopted, causing little progress in achieving environmental goals.
2. Data collection often has limitations, and when insufficient data is used for legislation, an ongoing string of amendments is attached.
3. The legal issues involving environmental problems have rocketed, brought on mainly by the complex legislation.
4. The EPA is presently primarily a legal organization that is serving the best interests of the law profession rather than the environment.

Consumer and political interest movements led earlier by Ralph Nader and growing groups of engineers, scientists, and other so called environmental experts, including some lawyers, influenced many of the new initiatives on the environmental legislation agenda. Events of the later 1960s, such as the oil burning on the Cuyahoga River in the center of Cleveland and the washing up of dead birds on the oil-slicked shores of Santa Barbara, reflected a sense of crisis and dissatisfaction within society.

The EPA was formed by bringing together 15 components from 5 executive departments and independent agencies. Air pollution control, solid waste management, radiation control, and the drinking water program were transferred from the Department of Health, Education, and Welfare (now the Department of Health and Human Services). The federal water pollution control program was taken from the Department of the Interior, as was part of a pesticide research program. EPA acquired authority to register pesticides and to regulate their use from the Department of Agriculture, and inherited the responsibility to set tolerance levels for pesticides in food from the Food and Drug Administration. EPA was assigned some responsibility for setting environmental radiation protection standards from the Atomic Energy Commission, and absorbed the duties of the Federal Radiation Council. Unfortunately, these groups were, and today essentially remain, compartmentalized [1]. The EPA was set up where each office dealt with a specific problem, and new offices were often created sequentially as individual environmental problems were identified and responded to by legislation.

The EPA's first administrator, William Ruckelshaus, initially sought to convey the impression that his agency would aggressively enforce the new policies, and adopted a systems approach by forming two primary program offices to handle the variety of issue areas and legislative mandates under its jurisdiction. Several function-oriented divisions were designed to be more responsive to White House concerns, as well as fulfill certain agency wide objectives, such as enforcement and research. The new agency, however, was quickly overwhelmed by its rapidly expanding regulatory responsibilities, the conflicting signals from the Nixon, and later Ford Administrations on how aggressively it should pursue such regulations, and effective industry maneuvering, which used scientific uncertainty in the regulation process to delay or counter the establishment and enforcement of standards [1].

A major criticism of the present regulatory approach to solving environmental problems (and pollution) is its economic inefficiency. The EPA's Annual Performance Plan and Congressional Justification request budget for 2013 is approximately $10 billion in discretionary budget authority and nearly 29,000 Full Time Employees (FTE) [2].

The problems of the environment need to be examined from an engineering perspective,. If an environmental concern arises, passing regulations before a good scientific basis and peer review are achieved can result in enormous expenditures in legalities, something that this country is presently burdened with. When environmental legislation is passed, it is often so ambiguous that an array of lawyers is needed to translate them. The main reason for this problem is that amendments are made based on premature or simply ill-defined findings. As mentioned previously, scientific data is not always featured predominantly when politics and emotion flare.

Complicated legislation passed based on insufficient data is by no means a solution to the environmental problem. Costly control measures are taken, and in some cases, the public's risk is increased. Constant amendments are needed, often doing little to alleviate problems. As noted, regulations can only help if they are based on sound scientific data. When the legislation is unclear, lawyers are often brought in to "clarify" it. Instead, they usually complicate the problems further.

The predictable bureaucratic tendency which feeds on the professional ambitions of "dedicated" staff and inevitably generates calls for larger budgets, is reinforced by the high costs of litigation and the long delays associated with the process. This centralizing effect feeds the political machinery to Congress. EPA is the whipping boy, never meeting the impossible deadlines and not doing enough to satisfy the politicians. Industry is the villain, and the flaming emotions of innocent people are fanned by the rhetoric that ensues. Heating hearings, more proposed laws, larger budgets, more lawyers, and limited progress is the result. Political demand continues to outstrip political supply [3].

When the EPA was formed in 1970, it was—in a very real sense—a technical organization. The Agency was manned primarily with engineers and scientists. Most of these individuals were dedicated to a common cause: correcting the environmental problems facing the nation and improving the environment. The problems these individuals tackled were technical, and there were little or no legal complications or constraints. The EPA was indeed a technical organization, run and operated by technical people, attempting to solve technical problems. Much was accomplished during these early years … but something happened on the way to the forum [4].

Over 40 years later, the EPA is no longer a technical organization—it is now a legal organization. The EPA is no longer run by engineers and scientists. It is run and operated by lawyers. And, the EPA is no longer attempting to solve technical problem; it is now stalled in a legal malaise [5].

How in the world did this occur? It happened because it served the best interest of the career bureaucrats, in and out of Congress, most of whom are lawyers, and it happened because the technical community did nothing to stop it. The result is that this nation is now paying the price for an environmental organization with 20,000 employees and a monstrous annual budget that is not serving the best interests of either the nation or the environment [5].

Interestingly, all of the administrators to the EPA have been lawyers. Though lawyers are required in every industry for helping to settle disputes over legalities, protecting the environment is generally beyond their scope. In the EPA today, for every three engineers there is one lawyer; it is indeed (as described above) a legal organization, serving the legal profession and not the environment. Actual proposals for regulations and control, based on good scientific data, should be designed by scientists and engineers, or those who have come to be defined as problem solvers. They can analytically break down a problem, initially assess the damages, then fix them [4].

Creating problems and not solving them has become the mode of operation for the EPA. One need only look at Superfund (see earlier discussion in Part II Chapter 14 and 15) for an example of what the professional bureaucrats have accomplished. When one talks about wasting tax dollars, Superfund is at the top of the list, with nearly $10 billion down the drain.

Something has gone afoul. In this society, engineers are the problem solvers, but rarely the decision makers. Although the world known today has been called a product of engineering, engineers play a minor role in important decision making.

The environmental problem is one that developed over many years of civilization by many different sources. To think that the EPA, with its present mode of operation, can solve this problem is ludicrous. However, there is a solution. *Dissolve the EPA now*! No reorganization will work, since the lawyers and career bureaucrats have a stronghold in the Agency with their ties to Congress and the White House. What is needed is to make the present EPA disappear and start anew. The nation needs an environmental administration that will solve, not create problems [4]. The nation needs technically competent people who can lead an organization in making cost-effective decisions based on the public well-being, not on politicians whose goal is to get reelected or lawyers who cost the nation billions of dollars annually proposing and enforcing ill-defined legislation.

Based on the above comments, draft and propose a bill to Congress that would accomplish the following:

1. Dissolve the present EPA.
2. Form another environmental organization with another name (of your choice) that will be directed to serve the best interests of the environment, society, and the nation.

Term Project 31.2

Solving Your Town's Sludge Problem

Most waste water treatment plants use primary sedimentation to remove readily settleable solids from raw wastewater. In a typical plant, the dry weight of *primary sludge* solids (those removed by filtration, settling or other physical means) is roughly 50% of that for the total sludge solids. Primary sludge is usually easier to manage than *biological and chemical sludges*—which are produced in the advanced or secondary stages of treatment—for several reasons. First, primary sludge is readily thickened by gravity, either within a primary sedimentation tank or within a separate gravity thickener. In comparison with many biological and chemical sludges, primary sludge with low requirements can rapidly be mechanically dewatered. Furthermore, the dewatering device will produce a drier cake and give better solids capture than it would for most biological and chemical sludges.

Primary sludge always contains some grit, even when the wastewater has been processed through degritting. Typically, it also contains different anaerobic and facultative species of bacteria, such as sulfate-reducing and oxidizing bacteria. Primary sludge production is typically within the range of 800 – 2500 lbs per million gallons (100 – 300 mg/L) of wastewater. A basic approach to estimating primary sludge production for a particular plant is to compute the quantity of total suspended solids (TSS) entering the primary sedimentation tanks.

Biological sludges are produced by secondary treatment processes such as activated sludge, trickling filters, and rotating biological contactors. Quantities and characteristics of biological sludges vary with the metabolic and growth rates of the various microorganisms present in the sludge. Biological sludge that contains debris such as grit, plastics, paper, and fibers is produced at plants lacking primary treatment. Plants with primary sedimentation normally produce a fairly pure biological sludge. Biological sludges are generally more difficult to thicken and dewater than are primary sludge and most chemical sludges.

Ensuring the safe disposal of municipal sludge and other residues, such as grits, and skimmings, is considered an integral part of good planning, design, and management of municipal wastewater treatment facilities. Acceptable sludge disposal practices include conversion processes such as: incineration; wet oxidation; pyrolysis and composting, and land disposal by *land application* and *landfilling*.

Landfilling is probably the most popular disposal method and is generally used on wastes in the form of sludges. There are two types of landfilling: *area fill* and *trenching*. Area fill is essentially accomplished above ground, whereas trenching involves burying the waste. Trenching is the better-established and more popular form of the two. Yet, since trenching requires excavation, area fill has the advantage that is requires less manpower and machinery. Area fill is also less likely to contaminate groundwater since the filling is above ground. Trenching, however, may be used for both stabilized and unstabilized sludges and makes more efficient use of the land. Both techniques require the use of lime and other chemicals to control odors, and cold and wet weather can cause problems with either. Both methods also produce gas, which can cause explosions or harm vegetation, and leachate, which can contaminate ground and surface water [6].

Most wastes must be subjected to one or more pretreatments such as solidification, degradation, volume reduction, and detoxification before being landfilled. This practice stabilizes the waste and helps decrease the amount of gas and leachate produced from the landfill. Landfilling is similar to *landfarming* in that both ultimate disposal methods combine wastes and soil. Landfarming, as described above, involves the biochemical reaction between solid nutrients and wastes to degrade and stabilize the waste; as a result, only specific types of wastes can be landfarmed. A larger variety of waste may be handled by landfilling [6].

Determine the sludge disposal practices of your home town, village, or city. Write a report describing your findings. The report should include a discussion of the following items [7]:

1. The quantity of sludge produced as well as seasonal variations, if any.
2. On-site temporary storage. If the entity does provide for temporary storage describe the capacity, whether it is covered or not, and any management techniques that are utilized to control drainage from the sludge storage areas, used to treat the drainage, and used to control odor problems. Also discuss whether the capacity varies with seasons.
3. Discuss sludge disposal options. Where is the sludge disposed of and how? What quantity of sludge is disposed of? What regulations control its disposal? What are the costs of disposal?

Term Project 31.3

Benzene Underground Storage Tank Leak

One topic not reviewed in any detail earlier is underground storage tanks (USTs). Environmental contamination from leaking USTs poses a significant threat to human health and the environment. These leaking USTs contaminate the nation's groundwater, which a major source of drinking water. Nationally, there are over 500,000 USTs. Originally placed underground as a fire prevention measure, these tanks have substantially reduced the damage from stored flammable liquids. However, underground tanks are thought to be leaking now, and many more will begin to leak in the near future. Products released from these leaking tanks can threaten groundwater supplies, damage sewer lines and buried cables, poison crops, and lead to fires and explosion [9].

The primary reason for regulating underground storage tanks is to protect water, especially groundwater that is used for drinking water. This is one of the nation's greatest natural resources and one which is extremely difficult to remediate once it is contaminated. Approximately fifty percent of the U.S. population depends on groundwater for drinking water. Rural areas would be seriously affected if their groundwater were contaminated since it provides 95% of their total water supplies. Groundwater drawn for large-scale agricultural and industrial uses also can be adversely affected by contamination from leaking underground tanks [10].

Owners and operators of petroleum and hazardous substance UST systems must respond to a leak or spill within 24 hours of release or within another reasonable period of time as determined by the implementing agency. The responses to releases from USTs depend on several different factors, most of which is site-specific. Owners and operators can comply with the financial responsibility requirements in a number of ways that can include: self-insurance (which requires a financial test), guarantees, insurance and risk-retention group coverage, surety bonds, letter of credit, use of state-required mechanisms, state funds, or other state assurances, trust funds, and standby trust funds. Owners and operators can use a single means or a combination of methods to satisfy the required coverage of financial requirements [9].

A total of 400 L of pure benzene leaks from an underground storage tank before the leak is discovered. The water table lies a few feet below the tank. Discuss the following items related to this release [11]:

1. What is the possibility of recovering some of the pure product benzene, and how might this product recovery be accomplished.
2. What is the maximum benzene concentration expected in the groundwater?
3. What is the dissolved benzene retardation factor assuming that the soil organic carbon fraction (f_{oc}) = 0.5%?
4. What is the rate of biodegradation expected for this benzene?
5. Propose your solution to this problem.

Comment: The retardation factor R is given by

$$R = 1 + f_{oc}\,(K_{oc})\,(\rho_B)/n$$

where f_{oc} = the fraction of organic carbon in the soil
K_{oc} = the organic carbon normalized soil/water partition coefficient
ρ_B = the bulk density of the aquifer solids
n = the aquifer solid total porosity.

For benzene, K_{oc} is reasonably approximated by its octanol/water partition coefficient, $K_{ow} \approx 100$ (mL water/g octanol). Typical values of ρ_B and n for aquifer solids are 2 g/mL and 0.3, respectively.

Term Project 31.4

An Improved MSDS Sheet

As noted in the Overview in Part II, Chapter 15, the following information is generally provided on a typical MSDS sheet [12–14].

1. Product or chemical identity used on the label
2. Manufacturer's name and address
3. Chemical and common names of each hazardous ingredient
4. Name, address, and phone number for hazard and emergency information
5. The hazardous chemical's physical and chemical characteristics, such as vapor pressure and flashpoint
6. Physical hazards, including potential for fire, explosion, and reactivity
7. Known health hazard
8. Exposure limits
9. Emergency and first-aid procedure
10. Toxicological information
11. Precautions for safe handling and use
12. Control measures such as engineering controls, work practices, hygienic practices or personal protective equipment required
13. Procedures for spills, leaks, and clean-up

Develop an outline for a new and improved MSDS sheet. Provide specific details and information. In effect, improve on the above MSDS writeup.

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