Zero Emissions Discharge

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Introduction

Industrial Pollution Prevention courses are proliferating. At last count, three good textbooks and a workbook in homework problems were available. None of these materials deals with the ultimate goal of zero emissions discharge (ZED). Yet ZED is a goal for many industries. This paper defines the issues and problems of ZED, and how it could be integrated into environmental engineering coursework.

Status

Reducing emissions from industrial and manufacturing plants to zero is impossible; we all know that. It is an admirable goal, a target to shoot at, but not practical. The last remaining bits of pollution will cost too much to remove from discharges, according to conventional understanding. Is it really true zero emissions discharge (ZED) is an unattainable goal? Or can ZED be implemented reasonably and practically? These are the questions addressed in this paper.

ZED is already in place as policy in a number of environmental venues. For example, the ocean incineration of chlorinated organic chemical wastes has been totally banned in the United States and many European countries. There are also total prohibitions against the manufacture of ozone-depleting chloro-fluoro carbons, ocean dumping of radioactive wastes or sewage sludge, and the exportation of hazardous wastes from the United States[7].

In industry, the vocabularies of zero defects and zero inventory and zero emissions suggest a convergence of ideas and goals. ZED can be part of a strategy to maximize resource productivity to enhance industrial effectiveness and performance rather than the traditional view of it as impossible and costing great sums of money. It fits the recent shifts to new and innovative production systems such as lean and agile manufacturing and the high performance workplace.

In a recent industry survey, 16% of major companies in the US indicated they are actively pursuing zero emissions manufacturing. These firms reported that ZED is in its early stages of development and serves as a goal or target rather than an adopted practice or strategy. As a goal, ZED performs the essential function of focusing and motivating quality improvement efforts'.

ZED is the ultimate in sustainable development from an environmental standpoint, because its implementation results in no negative impacts. Buzzelli,' commenting on the business of environment, delineated six steps to sustainable industrial development:

1. Foster a company culture of sustainability
2. Initiate voluntary performance improvements
3. Apply eco-efficiency concepts
4. Seek opportunities for sustainable business growth
5. Invest in creativity and innovation for the future
6. Reward employer commitment and action

Eco-efficiency in terms of process redesign means scrap materials are collected and reused. Closed loop systems ease a plant's dependence on water and prevent process discharges into sewers.

Buzzelli perceives environmental sustainability as a potential competitive advantage through opportunities for manufacturers to achieve greater efficiency and productivity. However, it requires a significant paradigm shift from the environment as a cost of doing business to the

environment as a business strategy development process. The most efficient, most environmentally benign chemical plant of the future will be the most globally competitive'.

ZED is drawing interest from chemical producers because it will demand higher priced specialty chemicals. Water scarcity is generating interest in ZED in arid parts of the world as a critical resource and valuable raw material to recycle and reuse. The current market for specialty water treatment chemicals is estimated at $1.6 billion with a growth rate of 5.3%[2].

Government as an Obstacle

The implementation of ZED is impeded by government and regulations. Historically, state and local governmental entities promoted industrial emissions as signs of prosperity (smoke from stacks was a sign of strong economic activity), and promulgated weak to non-existent regulations to attract polluting industry. As pollution became regarded as a hazard, institutions emerged to restrict emissions, monitor, and punish violators. Yet, even today environmental regulations are a major factor in polluting industry relocation to avoid the areas under the greatest restrictions.

The current regulatory structure discourages ZED by "permitting" the discharges of emissions under the theory that pollution is defined as observable harm to the environment. As a result, the practice of "dilute and disperse" pollution was implemented with the use of sophisticated modeling techniques to predict impacts and acceptable levels. Unfortunately, the models have not predicted impacts with accuracy, given the complexity of ecosystems, the movement of pollutants across media, or long term bio-accumulative and synergistic impacts. These failures have not been readily acknowledged. Huge bureaucracies and support structures have prospered based on suspect science. ZED shifts the focus from modeling pollution impacts and enforcement to pollution elimination, and thereby reduces the need for surveillance and the ecoscience of impacts. A governmental paradigm shift from pollution cop to collaborator is required to make ZED work.

Some shifts are occurring. Recently, the Pennsylvania Department of Environmental Protection (DEP) adopted the goal of ZED. Governor Tom Ridge, in directing the DEP, stated that, "No pipe might be necessary if industry would figure out how to stop producing pollutants in the first place."[9]

Prescription for ZED

A working definition for ZED is, "no measurable emissions discharged into the environment." This definition can be connected to practical quantification units (PQL) which specify detectable limits of the various pollutants. As measurements improve over time the working definition becomes stricter. ZED can also be defined as no emissions of pollutants whatsoever, which is only achievable by plants not using or generating pollutants in the manufacturing process.

ZED can be applied to a single media such as liquid discharges. In this situation, care must be taken not to shift emissions to the other two media: air and land. Since matter cannot be created or destroyed, potential emissions must either be not used in the manufacturing processes, or transformed into useful by-products or raw materials. Inside this framework, the following tactics must be adopted:

1. Process Substitution
   This involves creating systems and using chemicals which do not form emissions in the first place.

2. Pollution Prevention (P2)
   This is the art of operating manufacturing processes to minimize emissions

3. Recycling
   Used and consumed materials plus by-products are reprocessed for use.

4. Industrial Ecology
   Industrial facilities in a given area develop an exchange network such that one plant's emissions are another plant's raw materials.

5. End of Pipe Treatment
   Emissions are captured in waste treatment facilities and either transformed into innocuous materials such as carbon dioxide and water, or converted into by-products for reuse.

The prescription isn't new. Ford[4] points out that the late Senator Edmund Muskie, the primary author of the 1972 Federal Clean Water Act which established zero discharge as a goal for industrial effluents, stated that "it was possible, through the development of new processes, modifications, replacement of obsolete plants, and other improvements in technology."

Liquid phase ZED is not new. Over two hundred cases are documented in the literature. Two states, California and Florida, have detailed regulations requiring certain industries to achieve ZED. Many western United States electric power generating plants are ZED. The liquid wastes are either discharged to solar evaporation ponds on site or processed in brine evaporator?. Industrial facilities reprocessing ultra-hazardous chemicals usually are required to go to ZED.

ZED technology is available. Significant advances in treatment technologies for these water/liquid phases have reduced costs and increased efficiencies. For liquid phase ZED, processes such as reverse osmosis, evaporators, crystallizers, carbon adsorption, biological processing, and solids handling can be designed in state of the art ZED systems Equipment manufacturers are advertising the advantages of their ZED systems. In the gas phase, ZED is less developed; nonetheless, processes such as thermal oxidizers and carbon adsorption with scrubbers and electrostatic precipitators are available. Solids handling and recycling systems equipment are in wide scale use. In summary, technology is not a barrier to ZED.

Political Reality

ZED has proven to be achievable when necessitated by geographical or political demands. Just as most environmental change has occurred after being legally mandated, so is ZED destined to be achieved after other publicly acceptable alternatives are removed.

The public is not to be underestimated. The symbiosis between industry and the consumer is responsive to tugs at both ends. In the 1970's the US consumer told the auto industry they wanted smaller, more fuel efficient cars by purchasing ever-greater numbers of smaller, fuel efficient Japanese cars -- with a concomitant decline in US-manufactured automobiles -- resulting in the massive restructuring and quality improvement of the US auto industry. So it is with ZED; technology improvements are not lacking, but public pressure and outrage is needed to give industry the will to achieve it.

Pollsters have found the American people increasingly supportive of tough environmental standards. Environmental issues were a powerful undercurrent in the recent political election, with both sides wanting to be green, and neither side willing to take a strong public stand. No wonder the public is confused. Mis-information abounds about the cost effectiveness of recycling, the "natural" occurrence of chlorinated hydrocarbons, the foolishness of protecting wetlands, and the economic hardships of meeting current environmental regulations.

Over the past 20 years, some members of industry have increasingly indulged in greenscam techniques, giving lip service to environmental concerns which were not borne out in action. DuPont, for example, spends millions of dollars publicizing their goal of "zero emissions", yet

recoils from any direct pressure to implement ZED. Their record of toxic releases (TRI) puts them at the bottom of a very dirty pile of polluters.

Industry is afraid to give up what they consider to be their God-given "right to pollute", manifested in the current permitting system which legalizes the pollution of our waterways, air, and land. Risk assessment experts are busy spinning a web of confusion and mis-information about the discharge of highly toxic chemicals. The same groups in the chemical industry that repressed news about chloro-fluoro carbons, are at work to obscure the impact of other substances. Yet the truth of the matter is that environmental damage is being done, and as the public recognizes the damage, change will be required. This is how the current prohibitions came into being against the exportation of hazardous wastes, ocean incineration, etc.

Environmental issues are relatively new in the political arena, and gaining in importance. The pendulum of environmental concern swung out towards protection through regulation in the 1970's and 1980's, and strongly back towards economic growth in the early 1990's; currently public concern about the environment is again on the rise. How can one tell? Despite financial incentives--which once were successful--communities now rise up to oppose the siting of landfills or incinerators in their backyard. Finding low-level radioactive waste disposal sites is a national crisis. Citizens living near industrial plants want to know--and stop--any potentially harmful emissions into their air and water. ZED is a topic of intense interest to grassroots organizations.

The first companies to realize the future requirement for ZED will be able to claim the moral high ground, no matter what their motivation. From a political perspective, the future of ZED is inevitable and unassailable. If the technology is proven and available, who can be against it without being a Bad Guy?

Sticking Points

A main sticking point from industry's viewpoint is cost. All the strategies to achieve ZED appear to cost much more than the current "permit to pollute" strategy. And in a world of cost consciousness and competitiveness, the argument for ZED seems difficult to make. However, if costs are looked at in a broader context, that is, not localized, in plant, but in a long range vision, unrecognized benefits appear. For example, ZED minimizes the cost of environmental compliance. It prevents environmental impact, reducing litigation costs and preserving the environment. A big cost saving is possible whenever a plant decides to expand. Citizen opposition is reduced, which usually results in more quickly receiving construction and operating permits. Thus, profits are realized quicker.

Another sticking point is that ZED is not pollution free. For example, more energy to power ZED technology may be needed, resulting in the burning of more fossil fuels at the power plant. These kinds of possibilities must be recognized and factored in. One rule of the thumb suggested by Ford is environmental superiority[4]. Is the proposed ZED system significantly environmentally superior to the current system? The laws of thermodynamics may in certain circumstances not allow ZED to be pollution-free due to energy needs and chemicals which may create indirect emissions.

The regulatory agencies are a sticking point. ZED is not a normal regulatory requirement and is rarely used. When ZED is proposed, it is brought to the table by a third party who then must concurrently negotiate with the industrial plant and the regulatory agency. In this manner, ZED has been achieved--after prolonged effort--using novel approaches like a contractual agreement between private citizens, environmental groups, and the company. Even then, the authorities are reluctant to put ZED provisions in permits. Also, more highly skilled and imaginative regulators are needed to implement ZED.

The final sticking point is societal inertia. With thousands of public relations professionals working full time to put a positive "spin" on any environmental news about their companies, normal information channels are slow to raise any alarm about everyday happenings'. The Average Joe and Josephine pretty much believe what they read in the newspapers and see on television, and thus are at a great disadvantage in discerning the need for change. Even so, environmental knowledge is growing, although the environmental consciousness of the average citizen is still sluggish. Even recycling is not practiced by a large fraction of the population. But make no mistake about it, a change in environmental perspective is underway in our society, a change which will prove to be as profound as anything we can remember in our collective lifetime. Unlike today, people over 60 years of age remember when racism was the law of the land; if you are more than 50 years old, you can remember when eating beef was on the rise; anyone over 40 years old can remember when people could smoke wherever they wanted; young adults over 30 years of age were alive when no one had to wear seat belts. Similarly, ZED will eventually be thought of as a reasonable goal for the individual and--for similar reasons--for an industrial facility. As consumers base purchases on the recycleability of the products and the greenness of the supplier, ZED will have the necessary mass appeal.

Coursework in ZED

At Penn State an existing course in industrial pollution control has been reengineered into a pollution prevention course. Students working in teams select a basic industry such as refining and steel making, research the prevailing technology and move up the pollution prevention ladder beginning with process substitution, to recycle, to end of the pipe treatment, to ZED. The students define what ZED means in the industry selected and determine the costs and benefits.

Interestingly, students find that ZED is both technologically achievable and not unreasonably costly. Students also figure out that there are multiple paths to ZED, depending on the mix of tactics. The process of conceptualizing sophisticated technologies as processes and systems integrates their knowledge base in environmental engineering, and provides a realistic basis for setting and achieving the highest goals. Lastly, the students are prepared to think creatively about the beneficial use of technology for achieving truly sustainable development.

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