

*Pollution*

WHAT'S AHEAD FOR PLASTIC WASTES IN THE 1970'S

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Last March I had the pleasure of addressing a RETEC in this same location sponsored by the Philadelphia Section, SPE. At that meeting, I pointed up the relationship of proper solid waste management to environmental pollution control--the threat posed by solid waste to our environment, our present facilities for coping with that threat, and what we were trying to do about it. In so doing, I indicated how plastics, specifically, fit into the picture.

Let me repeat a general statement I made rather early in my talk. I stated that all plastics combined, including the chlorinated organics, presently make up less than 3% by weight of the normal municipal solid waste load. Because of this small percentage, and its dilution in the total load, plastics have probably constituted an environmental hazard in only rare instances. However, they have been reported to be the source of problems in incinerators, where the acid gases formed have had severe corrosive effects on grates and metal parts.

Since then, the Bureau has been challenged several times to prove, beyond the shadow of a doubt, that hydrochloric acid resulting from incineration of PVC has been the specific cause of corrosion in municipal incinerators. Certain elements of the SPI, as well as other

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plastic groups, have taken the position that, until this is proven, they will take the stand that PVC causes no problems in incineration, and that the plastics industry is being falsely labeled as the "boogie man."

Our Bureau is not in the business of labeling "boogie men."

As stated by President Nixon in his Message on the Environment:

The fight against pollution . . . is not a search for villains. For the most part, the damage done to our environment has not been the work of evil men, nor has it been the inevitable by-product either of advancing technology or of growing population. It results not so much from choices made as from choices neglected; not from malign intention, but from failure to take into account the full consequences of our actions.

It is true that we have not been able to prove this causal relationship involving HCl by means of a "tagged" (radioactive or otherwise) sample of PVC, in which the tag material has been ultimately recovered from the corroded sections within the incinerators. However, the circumstantial evidence available suggests the relationship is valid so far as we are concerned. One, since HCl gas forms rapidly and is very stable, it is an inevitable product of combustion of PVC. Two, HCl in the presence of moisture is known to be a highly corrosive material which readily attacks metal surfaces. Three, corrosive effects on metal surfaces have been recorded from incinerators in which PVC wastes constitute a portion of the solid waste feed. It might be concluded, therefore, that HCl resulting from incineration of PVC corrodes metal surfaces in the incinerators.

SPI has supported work through the efforts of Battelle Memorial Institute to investigate potential problems due to plastics and to identify them. As a result of these efforts, Battelle published a report entitled "The Role of Plastics in Solid Wastes." I would like to quote briefly from this Report:

The presence of halogens (chlorine or bromine) in plastics, such as polyvinyl chloride, and in flame-retarding plasticizers and other additives presents three problems in the disposal of these materials by incineration:

- (1) Combustion is inhibited by the halogen gases; thus, more vigorous turbulence is needed to take care of the increased tendency for production of smoke.
- (2) The chlorine or bromine appears in the combustion products as gaseous hydrogen chloride (HCl) or hydrogen bromide (HBr) which can attack metals in the incinerator.
- (3) The emission of HCl and HBr contributes to air pollution.

It is acknowledged that the SPI, in a later report, says the effect of HCl in incinerator corrosion has been exaggerated, and that may be true. The point I am making is that, despite the fact incontrovertible proof of specific PVC-generated acid attack on specific incinerator parts is not readily available, a number of studies (including the one sponsored by the SPI) indicate recognition of a growing problem and an awareness that corrective action must be taken. We can no longer sympathize with the "ostrich" approach to the situation, but must move ahead to define the extent of the problem and its solution. Moving ahead requires responsible industry action.

Let's do a little "star-gazing" into the future and see what kinds of problems we might be facing in 1980, for instance, if plastics production continues to grow at its predicted rate in this country, and nothing is done to achieve plastic recyclability or disposability. Using the estimated average annual growth ranging from 11% for polystyrene to 16% for polypropylene (Chemical and Engineering News; Sept. 1, 1969 - "Facts and Figures"), and assuming the same percentage enters the waste stream then as now, we approach a plastics waste load of 25 million tons per year by 1980. Let's also assume that all metals and glass and 50% of the paper in solid waste is being reclaimed from the waste by that time, for there is certainly a major trend in that direction. The technologies for reclamation in these areas should be well developed by then, and the economic incentives clearly established and operating. Based on a 50% increase in solid waste generated from municipal sources by 1980, the total would amount to 375 million tons annually. Deducting 75 million tons of metals and glass and 95 million tons of paper through reclamation processes, the balance to be disposed would be 205 million tons. Plastics then, under these assumptions, would constitute 12% of the disposable portion of solid waste. Not only would the present-day problems connected with incineration be greatly aggravated, but environmental hazards of air pollution would likely be commonplace.

In early August, I met with a Japanese study team in our offices in Rockville. This team consisted of 15 Japanese scientists and engineers sent to this country to learn of advanced methods we may have

for solid waste handling and to exchange information on common problems. The spokesman for this team, Professor S. Iwai of Kyoto University, stated that plastic wastes represent 15% of the total waste load in Japan. He further stated that these wastes are causing severe problems in incineration, and that metal parts of the incinerators rapidly deteriorate as a result. He indicated there are measures under consideration in Japan to curtail plastics production in order to alleviate the problem.

If, indeed, circumstantial evidence is borne out by research now in progress, we too could greatly curtail plastics production in this country. For instance, is there any reason we couldn't legislate against the use of any plastic material in a beverage container--requiring that all such containers be either of glass, which is both reusable and recyclable, or of a metal which can be reclaimed? A bill (H.R. 15959) was introduced to the Congress in February 1970 by Congressman Scheuer of New York which would lead to this eventual result. This bill is still being considered by the House Ways and Means Committee.

Why not legislate against the use of plastics in any form of packaging materials? How would this affect us in our daily lives? We could go back to buying milk in glass bottles which would be returned to the store or be picked up by the dairy which delivers to our doors, rather than have the convenience of the plastic-impregnated paper cartons. We could get along without the plastic bottles and tubes containing shampoos, hair dressings, toothpaste, cosmetic items,

medicinals, etc. that we use so many of, and go back to the glass and metal containers that were previously used for this purpose. It might be less convenient, and perhaps more costly, but we could do it. We could dispense with plastic-impregnated paper for frozen foods; too, and either buy all such food products in cans or, in the cases of fruits and vegetables, in their fresh form when they are in season. There may be times of the year when we couldn't eat the things we like, and we may have to sacrifice a little taste quality here and there, but we could make out. Meat packaging may have to go down the drain, and the old-fashioned butcher may well be back in style, but we could live with that. Many children's toys would have to be done away with, or be made of more expensive materials, but kids have too many toys anyway and could get along with much less.

Everything I have suggested here says "go back"--go back to the old ways of doing things. It means giving up those many conveniences that have become so much a part of our way of life--those things that have been made possible by the great advances in the technology of plastics production. Is this what we want to do--to return to the technology of the 1930's? Is this the only alternative we have available? I say emphatically no! The technology that produced these conveniences can, I feel certain, likewise solve the environmental problems caused by them. I believe we can, in this case, "have our cake and eat it."

Referring again to the talk I gave in March, I made clear that, from the solid waste management point-of-view, the use of plastics

need not necessarily be limited or discouraged.

Synthetic fibers and plastics possess many desirable qualities which support their continued use in large quantities. It does mean, however, that increased attention must be given to improving the technology of plastics disposal, or to changing the physical and chemical characteristics of plastics themselves in order to reduce the problems they now present to the disposal plant operator.

I further suggested that, "to prevent these useful materials from becoming environmental problems, we believe that research is indicated in the following areas:

1. Development of new incinerator technology providing capability of incinerating these wastes while retaining, in a disposable form, the deleterious combustion by-products.
2. Development of additives to the material itself which would change its combustion by-products, thus eliminating threats to equipment and environment.
3. Development of separation and recycling techniques which will provide for economic reuse of the materials, thus removing them from the waste stream entirely.
4. Development of economic incentive systems which will help to insure optimum source reduction, reclamation, and reuse.

We are still of the opinion that these represent four valid areas for concentration of research activity.

The Bureau of Solid Waste Management, within the constraints provided by limited resources and breadth of responsibility, is pursuing several courses of action directly related to the problems caused by plastics. Through a contract with the Stanford Research Institute,

we are conducting a "Study and Evaluation of Technical and Economic Factors of Polymer Waste Disposal." The objectives of the study are to assess the disposal problem and evaluate alternative approaches to polymer waste utilization. Seven polymer producing plants, ranging in production capacity from 62.5 to 275 million tons per year, were contacted for this purpose.

Some interesting observations can be made as a result of the work thus far. The waste generation rates from these plants range from 0.5 to 4.0 percent, with the average being 1.75 percent. On this basis, the average resins producer generated 7.7 tons of polymer waste per day per plant in 1969. Of the seven plants, four use open dumping on company land, two use sanitary landfill, and one employs incineration. The weighted mean cost of disposal was calculated at \$26 per ton of production. The report states there was virtually a unanimous desire for development of improved reclamation methods in uses for low grade contaminated plastics.

Another phase of the study was related to the waste characteristics of the processing and fabrication enterprises. Of 47 plants studied, the total estimated polymer processing rate was 781 million pounds per year. The aggregate polymer waste generation was estimated at 17 million pounds per year, or 2.2 percent of the total production. The vast majority of the plants used off-site sanitary landfill as a principal waste disposal technique. The weighted mean disposal cost for all plants was estimated at \$23.50 per ton of production.

The study included an evaluation of all tentative disposal techniques for polymer wastes, and estimates were made of costs associated with various alternatives together with an assessment of their usefulness and acceptability in helping to solve the problem. The study recognizes the need for special design characteristics in incinerators planned for the combustion of plastics generated by polymer producers and plastic fabricators. Hopefully, a final report on this contract will be available for general distribution in early 1971.

Two projects supported by research grants should produce some findings of interest and value. The first is entitled "Incineration of Plastics Found in Municipal Refuse," and the project is being carried out at Syracuse University. The objectives are to systematically study the destruction of plastics and plastic-rich refuse by direct burning and by anaerobic heating followed by burning the volatile matter. Of particular interest are the chemical and toxicological nature of stack effluent and the interaction of the residue with water. This project is scheduled to be concluded early in 1972.

The second project is entitled "Combustion Products from the Incineration of Plastics," and it is being carried out at the University of Michigan. The objectives are to analyze the combustion products of various polymers under a variety of conditions of temperature and air supply. Some combustion runs will be performed with secondary burning so that both complete and incomplete incinerator conditions are approximated. This project is scheduled to be concluded in the latter part of 1972.

Another contract involves studying the concept of advanced incineration processes to generate electric power through the use of a fluidized bed combustion system and a gas turbine. It is significant that, in this study, it has been necessary to include in the design factors the need for removal of HCl gas in order to protect the steel of the turbine blades. Neutralizing agents incorporated in the bed will, hopefully, prevent the corrosive effects otherwise anticipated. The Bureau's contractor is also taking into consideration the possibility that sodium pyrosulfate or other sodium salts act as a catalyst in the corrosive attack of HCl on metal.

Two final contracts were only recently awarded to Union Carbide Corporation and Arthur D. Little, Inc., respectively. The first is for an "Investigation of the Biodegradability of Plastics," and the scope of the effort will be limited to determination of the effect of molecular weight, end group composition, and polymer chain structure on biodegradability. The systems studied will be structurally related to polyethylene and polystyrene, the two largest volume packaging plastics. Subsequent studies would be directed to the determination of the utility of the polymers containing biodegradable structures as packaging materials. The second contract is for a "Study of the Incentives for Plastic Recycling and Reuse." Its objectives are to: (1) develop a number of complete strategies to be applied to the total system to improve recycling and reuse; (2) evaluate each strategy from a systems approach, taking into consideration the probability of success, administrative problems, legal constraints, and economics;

and (3) select the best strategy. This, theoretically, would be translated into legislation.

There is work going on outside government circles which is aimed at solving the problems caused by plastics. It would appear, for instance, that incinerable plastic bottles for popular carbonated soft drinks are just around the corner. One such product, known as Barex 210, was developed by Vistron Corporation, a subsidiary of Standard Oil of Ohio, and is being test marketed by the Pepsi-Cola Company under the trade name of "Plastastic." This material is an acrylonitrile methyl acrylate copolymer--a "high-barrier acrylic thermoplastic which can be blow-molded into bottles substantially better in resistance to gas permeation and chemical attack and in the retention of flavors and fragrances of food and cosmetics than other plastic bottles now available."

Another such material is XT polymer, produced by the American Cyanamid Company. It, too, is halogen-free, and should produce no problems of corrosion on incineration. It offers the same transparency, inertness, and rigidity for which acrylic plastics are noted, and is suitable for the same general uses as is Barex 210.

A recent press release from the University of Toronto in Canada indicates that a research team in the Chemistry Department may have taken an important step forward toward development of a biodegradable plastic. The key to their new process is to attach a few "sensitizer groups" along the backbone of a polymer chain which can be included during the commercial synthesis of the plastic and may be in such low

concentrations that they do not obviously affect the general physical properties of the material. These "sensitizer groups" have the property of absorbing the ultraviolet light of the sun and using this energy to break the polymer chain. When the chains are broken, the plastic loses its physical strength and becomes brittle so that it is easily broken up by natural erosion--wind, waves, or rain--into small particles which become part of the soil and are then in a form which can be attacked by microorganisms.

If the "sensitizing group" is properly selected, it will not absorb visible light, but only certain wavelengths of ultraviolet. Hence, it is postulated that a package or bottle would have a greatly extended life indoors and would begin to disintegrate only when discarded outdoors.

A British team of scientists is working on the same proposition with polyolefins at the University of Ashton in Birmingham. This team uses a two-component additive system that absorbs ultraviolet light of 280 to 330 millimicrons wave length. The additive forms free radicals which add on oxygen, yielding hydroperoxy radicals. These, in turn, abstract a hydrogen atom from the polymer molecule, causing breakdown of the long chain backbone and thus degradation. The polymer itself can indicate when degradation is about to take place, since the free-radical mechanism that initiates the action can also cause color changes in dyes included in the polymer.

Obviously, there are many problems yet to overcome before marketable products are available. For example, additives must be

produced which are non-toxic, and such additives must be unaffected by plastics fabricating techniques (extrusion, molding, etc.) and must not unfavorably affect the working properties of the plastic. Also, the system must be applied to yet untried plastics, such as polystyrene and polyvinyl chloride, which may present special problems. In addition, the economics of the system must be carefully worked out and evaluated. The important thing is, progress is being made.

Where do we go from here? I'd like to quote from a speech made by Senator Thomas F. Eagleton of Missouri, a member of the Senate Public Works Committee, to a meeting of the Midwestern Division of the National Association of Secondary Materials Industries in St. Louis recently:

Our nation is at a watershed in its economic development. Since the first trees fell at Jamestown and Plymouth, we have pursued a policy-- a right and necessary policy for a young country-- of exploiting our natural resources. Now we must turn to conserving our resources, protecting our environment, and recycling what we already have for maximum use.

What action must the Federal Government take during the 1970's to eliminate future problems caused by plastics and other wastes and to head in the direction pointed out by Senator Eagleton? There are many paths open to it, some of which I have already mentioned in terms of legislation introduced for consideration. It could restrict production of plastics, ban no-return beverage containers, impose severe disposal taxes on plastic materials, etc. Or it could lead

the way in assuring new developments in plastics which will allow our continued use of them at the desired levels without future injury to the environment.

The recently enacted "Resource Recovery Act of 1970" gives a good indication of the route the Federal Government will take. This Act provides funds for extensive research toward: uses and outlets for recovered wastes; modification of product characteristics to enhance recycling; improved collection, separation, and containerization; use of Federal procurement to develop market demand for recovered resources; incentives and disincentives to accelerate reclamation of materials; effects of existing public policies upon the recycling of materials; and the necessity of imposing disposal charges on packaging, vehicles, and other manufactured goods. The Act also provides funds for demonstrating resource recovery systems, improvements in such systems, and related technology. It is clear that the Federal Government expects to find solutions to the problems by routes other than restrictive legislation against the source materials if at all possible.

What actions must be taken by the nation's municipal authorities who are faced with the stark realities of the problem on a day-to-day basis? They must accept the fact that adequate management of waste materials is a dire necessity for the future, and the procedures now being commonly practiced in so many locations will no longer be tolerable. They must likewise accept the fact that proper management will require greater expenditures of funds, and they must be prepared to

provide those funds. They must be willing to install the new systems, or improve their existing ones, as the new developments in waste management are demonstrated. They must realize that protection of their environment is not wholly the responsibility of the Federal Government, nor of the waste-producing industries, but is also the responsibility of every community and every citizen.

What actions must be taken by industries, and by the plastics industry in particular? The plastics industry must shoulder part of the responsibility for financing the management of wastes which it produces. We can no longer tolerate the attitude taken by some that industry's responsibility is solely that of providing consumer items to the American public which are aesthetically pleasing, efficient, durable, and at lowest possible cost, and that disposal of these items after use is solely the responsibility of the user. This was clearly spelled out by former Secretary of Health, Education, and Welfare, the Honorable Robert H. Finch, in his testimony before the Subcommittee on Air and Water Pollution, Senate Committee on Public Works, September 30, 1969. He said:

I would propose that our investigation and study include a review of possible methods, including the economic consequences of applying such methods, by which more of the burden of waste disposal might be shifted to those who introduce waste into the environment. For example, . . . We need to study ways of removing bottles and cans and other containers from the category of a social cost. It may be efficient for industry to use these containers only because the efficiency formula excludes the cost to society of disposing of indestructible non-returnable containers. The separation and reclamation

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of such containers would clearly benefit society;  
the [present] non-returnable container does not.

The message then, is clear. When new products are developed, the industry must consider waste management problems in addition to the items of durability, consumer appeal, and economy. For products that are on the market today, methods for recovery, reuse, and/or ready disposability must be devised. Industry must begin to allocate a greater portion of its research and development dollar to solving the solid waste management problems created by its products. If industry doesn't take more positive steps to help solve the waste problems it creates, and take them now, Federal regulation will likely result.

Many of you, I am sure, are aware of the creation, by the President, of the National Industrial Pollution Control Council (NIPCC). This Council is composed of 63 members, each of whom is a top corporation executive with a major U.S. company (either Chairman of the Board or President). The purpose of the Council is to provide advice to the President and the Chairman of the Council on Environmental Quality on industrial policies and progress relating to improvement of environmental quality. Each two members of the Council represent a major industry that has a part in the problem of pollution and pollution control, and these two members serve as chairman and vice-chairman of a sub-council, with another six people from that industry added. So we now have approximately 250 top American businessmen working on the problem of alleviating pollution in all its forms.

Each of the sub-councils, having been given its charge, has met at least once. The types of questions to which they have been asked to supply answers are:

1. What is the nature of the problem in our industry?
2. How does it manifest itself in production, in our products, and in disposal of by-products?
3. What are we doing about it in terms of dollars and in terms of action?
4. What are the barriers with which we are confronted in getting the job done?
5. How long will it take us to resolve the problem?
6. What can government or others do to help us?

In regard to the last question mentioned, our Bureau has been approached and has agreed to cooperate fully with the Council in helping it achieve its goals. This represents one form of joint Federal-industrial cooperation that should be beneficial.

Our Bureau has been working directly with the Coca Cola Bottling Company to establish a joint relationship with the beverage container industry. Our initial contacts were for the purpose of becoming acquainted with Coca Cola's program in the area of solid waste management, and to ascertain wherein the Coca Cola efforts interfaced with or duplicated those of the Bureau. As a result of these contacts, a worthwhile dialogue has resulted in which we expect to include other major beverage manufacturers. The hoped-for end result will be a joint Federal-industry study covering the entire

industry and including the total realm of interest. Why couldn't we develop the same kind of cooperative effort with the plastics industry?

We firmly believe that both reusable and biodegradable plastics can be devised without sacrificing the positive characteristics that make plastics desirable. Evidence from the research work currently underway convinces us of that. We further believe that it will not be necessary to make a drastic change in our mode of living away from the trend of convenience packaging and the "throw away" habit. However, we will have to look closely at packaging of various types to determine if the materials used have sufficient present or potential value as candidates for recycling processes. As the earth's available resources dwindle, the acceptability of convenience packaging may be governed by a different set of priorities. Certainly, we must find the appropriate recycling or disposal mechanism for each material.

Your industry is particularly well qualified to deal with specific solutions to these critical problems, since most of the solutions involve polymer chemistry. The reservoir of knowledge in this field lies not with the Federal Government, but with academia and industry. These, therefore, are in the best position to conduct much of the needed research. The plastics industry must shoulder its share of the load and "move out" with it.