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Burning hazardous waste

This month, seven years after the passage of the Resource Conservation and Recovery Act, 80% of the hazardous wastes generated are ending up in land-based graveyards. But not much longer. Although many chemical companies see no long-term dangers in the practice, land interment is being regulated out—at federal and state levels—as a waste management option. The inevitable result: “The chemical industry is being pointed in the direction of incineration.”

cover: Robert T. Martinott

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McGraw-Hill Chemical Week, ISSN 0009-272X/83 (including Chemical Specialties and Chemical Industries), is published weekly, except for one issue in December, by McGraw-Hill, Inc. Subscription rates: U.S. and possessions, \$35 per year; single copies, \$5.00; Canada, CDN \$47 per year; elsewhere, upon request. Executive, Editorial, Circulation and Advertising Offices: 1221 Avenue of the Americas, New York, N.Y. 10020. Second-class postage paid at New York, N.Y., and at additional mailing offices; ID 102060. Postage paid at Montreal, P.Q., registration No. 9443. Title registered in U.S. Patent Office. Postmaster: Send form 3579 to Fulfillment Manager, Chemical Week, P.O. Box 430, Hightstown, N.J. 08520.

chemicalweek

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Burning hazardous waste

It's costly,
but it may be
the best solution

This month, seven years after the passage of the Resource Conservation and Recovery Act (RCRA), which mandated cradle-to-grave tracking of hazardous wastes, 80% of those wastes are ending up in land-based graveyards. A number of chemical companies, which generate 61% of the hazardous wastes in the U. S., see no long-term dangers in methods of disposing of hazardous wastes on land. Says Douglas Bass, associate corporate director of environmental affairs for Union Carbide: "We see landfilling as being perfectly acceptable and reasonable."

Nevertheless, a growing number of chemical companies are turning to incin-

eration as a means of getting rid of their waste products. Last summer, Occidental Chemical began operating an incinerator at Niagara Falls, N. Y., to destroy chlorinated and fluorinated wastes at the rate of 1.6 million

gal/year.

Bofors Nobel is installing a \$20 million system at its Muskegon, Mich., plant to dispose of benzene, toluene and perchloroethylene, as well as 350 million lb of sludge and contaminated soil that have accumulated on the company's 18-acre site during 20 years of operation. Also at Muskegon, BFC Chemicals is installing an incinerator to destroy by-products formed during the manufacture of agricultural chemicals.

More applying. Indeed, firms from all segments of industry are showing great interest in incineration. The Environmental Protection Agency says that while it has issued only four operating

permits for hazardous waste incinerators so far, it is processing another

There's no breakdown by industry in the applications that EPA has received or called in, but the odds are that the number of them came from chemical companies. EPA estimates that 32 incinerators are now operating at between 240 and 275 facilities around the country. And according to Morton Mullins, director of environmental engineering for Monsanto and head of Chemical Manufacturers Assn.'s special task force on RCRA, the chemical industry operates about half of those facilities. Mullins says, "We expect to see more [incineration]."

A big reason for the increased attention that incineration is drawing is regulatory. Amendments to RCRA that are now under consideration by the House and Senate would place severe restrictions on land disposal (*CW*, July 10). And many states, including California, New York, Illinois and Maryland, are promulgating regulations that are stiffer than those of the federal government.

Open-minded. As for landfills, deep wells and similar methods are being regulated out of existence for disposal, according to Gordon Lenz, technical manager for Chevron Chemical, "the chemical industry is being pushed in the direction of incineration." Lenz observes that incineration requires a lot of energy and that the costs are higher than those of other methods. But he adds, "I think that the industry is willing to accept that."

There are other good reasons for incinerating wastes, too. "With incineration, a lot of hazardous waste can be converted into harmless

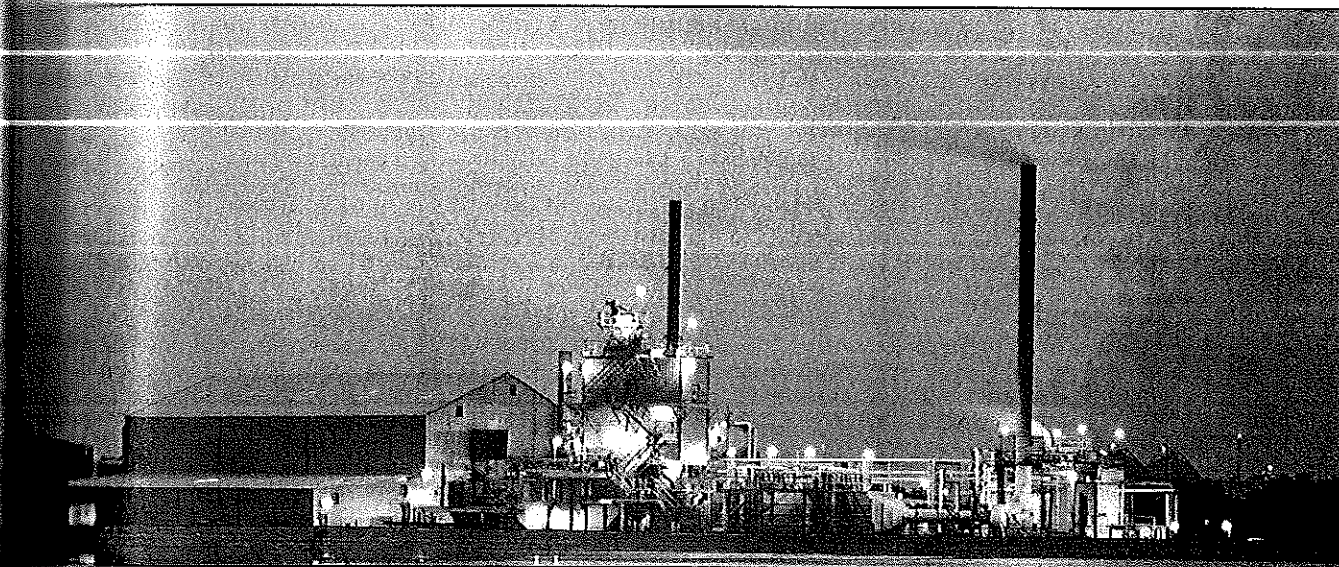
How nine commercial disposers handled waste in 1982

Management method	Price (\$/m.t.)	Received (thousand m.t.)	% Change from 1981	Capacity (thousand m.t.)	Capacity utilization
Landfill		1,990	1	36,870	18.5 years ¹
Drum	\$110-240				
Bulk	33-83				
Land treatment	5-24	331	17	1,500	22%
Incineration		94	18	119	79
Relatively clean, high-Btu liquids	(-13) ² -53				
Other organic liquids	53-237				
Solids, highly toxic liquids	395-791				
Chemical treatment		661	-10	1,518	44
Acids, alkalis	13-92				
Cyanides, heavy metals, highly toxic wastes	66-791				
Resource recovery	66-264	133	60	421	32
Deep-well injection		385	-19	999	39
Oily wastewaters	13-32				
Toxic rinse waters	132-264				
Transportation	8-16¢/mile	3,594	-1	—	—

¹ Lifetime at 1982 volumes. ² Some cement kilns and light-aggregate manufacturers pay for wastes. Source: Booz, Allen & Hamilton.

ous waste incineration. Processing another 100,000 tons a year, down by industry estimates. At EPA has received the odds are the same from chemical industry estimates that 32% of the waste is being operated at facilities around the country. According to Morton, environmental costs are high and head of the Chemical Industry's waste management Assn.'s spokesman says that the chemical industry is responsible for half of those facilities. "We expect to see more of them," he says.

the increased attention is drawing is not only to RCRA that requires incineration by the hazardous waste management plan, but also to the place severe restrictions on disposal (CW, July 1982). States, including California, New York, and Maryland, are imposing regulations on land disposal. The regulations are stiffer than those of the federal government. As a result, deep wells and other methods are being regulated out of the market for disposal. According to Gordon, technical market is still there. Future legislation might prohibit the use of vaults," he says for Chevron Chemical. "the chemical industry is being pushed in the direction of incineration." Lenz observes that incineration is a lot of energy and that the costs are higher than those of other methods. But he says, "I think that the industry is willing to accept that." There are other reasons for incineration, too. "With liquid-waste incineration, a lot of hazardous waste can be converted into harmless compounds, and what's left is minimal," says William Sessa, spokesman for the California Air Resources Board (CARB). Further, he says, "in some instances, the heating value of the waste is also applicable to a broad range of organic materials, and it effects a significant hazard reduction. Says Sessa: "You eliminate risks like groundwater contamination."



BFC Chemical, which says it incinerates 93-95% of its organic waste, opened a \$13 million rotary kiln at its complex at Plaquemine, La., in 1981.

the most expensive method for disposal of waste materials. Actual costs depend on the type of material that is being burned. For instance, in August, Booz, Allen & Hamilton of Bethesda, Md., updated its earlier surveys of nine large commercial hazardous waste management facilities, and it found (table, p. 22) that the price those companies were charging in 1982 ranged from \$5/metric ton for certain land treatments to \$791/m.t. for chemical treatment of some wastes. Some cement kiln and light aggregate manufacturers were buying relatively clean, high-Btu waste products materials, and companies that were supplying those markets were getting a credit of \$13/m.t. of waste generated. But the cost range for incinerating solids and highly toxic liquids was \$395-791/m.t.

Ways to cut costs. Sometimes the simple cost figures can be misleading, however. BFC Chemicals, for example, had little choice at its Muskegon plant. The company's property is too sandy to build a landfill that would meet new, stringent standards established by the state. Robert L. Axtell, manufacturing vice-president, says the company performed no detailed cost analysis; the cost of buying additional property simply would have been too high. So it chose to build an incinerator that will burn 10 gal of chlorinated hydrocarbons an hour at 4,000 F during a two-second cycle.

Incineration usually represents

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Much waste can be converted into harmless compounds, and what's left is minimal

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It is also possible to reduce the costs by integrating incineration into a broad process scheme to accommodate wastes. Bofors Nobel, for instance, will use a multistage approach that, says President Flanders, "can destroy almost anything known to man."

The new unit will employ a biological carbon treatment to degrade nonhazardous materials. Hazardous wastes will go to a wet oxidation unit that handles materials that are too toxic for biological treatment and too dilute for incineration. The toughest materials to handle, chlorinated solvents, will be pyrolyzed, and the organics that volatilize during the pyrolysis will be incinerated.

In that manner, says Nobel's Flanders, the burners will operate only long enough to destroy materials that cannot be treated by any other method. He estimates costs at 1.1¢/lb for biological carbon treatment; 1.5¢/lb for wet oxidation, 4¢/lb for pyrolysis; and 6¢/lb for incineration.

Getting approval. High capital and operating costs aside, getting a permit from EPA for an incinerator can be cumbersome and expensive. The company must provide the agency with a detailed chemical analysis of the various materials that it intends to burn. EPA determines the principal organic hazardous constituents (POHC) and demands a destruction and removal efficiency (DRE) of four 9s (99.99%) for each POHC. Then the incinerator operator must conduct test burns to establish that the unit meets the requirements. The test is used to define the conditions under which the incinerator will be permitted to operate. It's accompanied by gas chromatographic measurements, in com-

bination with other analyses, to determine the extent of waste destruction.

Such sophisticated measurements are not practical for routine operation. So for record-keeping and enforcement purposes, the agency uses indirect measures, such as air- and waste-feed rates and gas temperatures, to measure removal efficiency. The idea is that as long as actual values of those parameters remain within the limits prescribed during the test burn, the required DRE will be achieved.

Great savings. But a new CMA study suggests that such measurements could serve for the test burns. If that's so, it could mean considerable savings because, says Eva Fromm, a Houston-based senior chemical engineer for NUS, an environmental consulting firm, the permitting procedure, including test burns, can cost as much as \$200,000 for a medium-size incinerator.

Besides DREs, EPA has set other standards for incinerators. Polychlorinated biphenyls (PCBs), the only materials that must be burned, have to be incinerated to a DRE of six 9s. Incinerators cannot emit more than 180 mg of particulate matter/cu m of dry stack gas, a reduction from its earlier proposal of 270 mg/cu m. Incinerators burning more than 0.5% chlorine must remove 99% of the hydrogen chloride from exhaust gases.

Because the chlorine cannot be destroyed by incineration, HCl removal requires use of scrubbers. But that can actually improve the economics of incineration. Dow, for example, uses recovered HCl at Plaquemine to neutralize other wastes. At other locations, it recovers the material as salable acid. Jerry Martin, environmental manager at the Plaquemine complex, says that such considerations play a small role in justifying a new facility. However, scrubbing HCl from incinerators and stack gases accounts for an increasing amount, perhaps 4%, of total U.S. production.

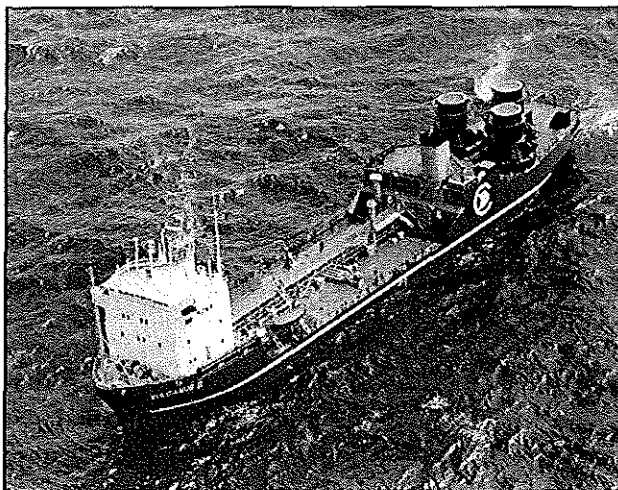
Getting tough. Companies that incinerate wastes primarily for energy recovery do not have to meet the DRE of four 9s. But they could come under more rigorous regulation.

EPA's Stephen A. Lingle, chief of the technology branch in the hazardous and industrial waste division of the Office of Waste Management, says that there are no plans to change, revise or review the existing regulations in any way.

However, the amendments that Congress is now considering would require such operators to notify EPA of what and where they are burning.

The notification is expected to be required within a year after President Reagan signs the bill—as he is expected to do. Then within two years of passage, EPA would have to issue regulations, and among those would be a labeling requirement that the fuels contain hazardous materials.

Wastes burned at sea need to achieve a DRE of only 99.9%. The rationale is that the incinerator ships operate far from population centers and that the sea and sea air provide a natural buffering action and eliminate the necessity of scrubbing. But the special treatment



Burning at sea: Chemical Waste Management has been operating Vulcanus I since 1972, mostly to serve Europe.

for ocean incinerators does not sit well with companies that are committed to land-based incinerations. Louis F. Centofanti, president of PPM, a Tucker, Ga., waste management firm, confesses to being "upset" over the more lenient standards for the incinerator ships.

And the special exclusion may not last. EPA's Lingle says, "As a practical matter, EPA will probably take the same approach that it is taking for land-based incineration."

Two techniques. Existing incinerator know-how is relatively straightforward. Current technology is based largely on either incinerating liquids, much as an industrial boiler does, or in tumbling both liquid and solid wastes through rotary kilns.

The incinerator ships will use state-of-the-art liquid-burning technology; the rolling motion of the ship presents problems for kilns. In burning liquids, material is pumped through a nozzle, where it vaporizes into droplets small enough

to burn within the allotted time. Inappropriate Technology cause the nozzle is the key, it must be designed for the viscosity of a specific waste, but a number of designs have been available.

Liquid incinerators that are employed to destroy municipal waste normally operate at about 1,500 F. However, the chance to operate ship incinerators and others that handle hazardous materials. It has been to destroy halogenated wastes operated at considerably higher temperatures. A mobile unit at its new installation in Niagara Falls, N.Y., is being instance, Hooker will run the incinerator for another new test.

Rotary kilns can accept a greater variety of materials, ranging from solids and destroys and sludges to liquids and gases. They are frequently the choice of chemical companies for on-site incineration. The plasma torch, employed by such companies as Dow Chemical and Eastman Kodak, is the torch will be.

The most important design characteristics for any incinerator, according to Monsanto of New York Mullins, are time, temperature and mixing. Mixing must be sufficient for the feed and for the torch, supplied to combine with oxygen. Residence time must be adequate to keep the materials in the combustion zone long enough to vaporize and react. And temperature has to be high enough to ensure complete combustion.

Hot and fast. Speeding up the mixing and heating process is the object of a number of newer designs under development. Thagard Research (Cape Mesa, Calif.), for one, has a high-temperature fluid wall reactor.

The bath method, a porous central cylinder, through which the waste passes, is ringed by an electrolyte. Radiant heat is transferred through the refractory cylinder to the waste.

The result, says Edwin Matovich, inventor, is rapid heating to high temperatures and therefore small opportunity for incomplete combustion. He says that the reactor handles inorganic as well as organic wastes and that it is probably the only technology that can destroy the chemically bind heavy metals so that they do not leach out of the slag. Matovich will not discuss costs except to say that a unit is comparable in capital and operating costs with a conventional high-temperature incinerator.

The process, whose 4500 F range exceeds the 2600-3000 F of most rotary kilns, has demonstrated its effectiveness in treating PCB-contaminated waste that a 200-lb for the EPA and the California Office of a near complete

allotted time. Appropriate Technology. And it's being the key, it must be used to clean up a stockpile of PCB-viscosity of a special soil that Southern California Edison has been accumulating, but it first pass test burns on several classes of materials.

rs that are employed. The waste normally is burned at 1,000 F. However, the chance to operate on a variety of and others that have been. It has been licensed by Vulcan Associates, a group of Miami investors, her temperatures. A mobile unit that can process 50 in Niagara Falls, N.Y., is being built in Denver by will run the incinerator for delivery in January.

accept a greater range of materials, including solvents and gases. The choice of chemical incineration is being studied by such companies as Dow Chemical and Kodak. The torch will be carried to Love Canal, N.Y., to solve the cleanup problem there. Efforts to clean up the site, the company of New York has used detergent to wash out toxic materials into a moat. Mixing must be done in the moat will be injected into the feed and the torch, supplied by Westinghouse in the with oxygen. Regeneration with Pyrolysis Systems must be adequate. The sludge the materials in the zone long enough to react. And there has to be a way to ensure complete destruction.

fast. Speeding up the destruction process, the company claims that it can clean up a number of sites in less than a year at a cost of \$1.2/gal. But to be competitive, the company says, cheap electricity must be available. The bath method. Molten salt reactors are showing promise. In a system developed by Rockwell International's Energy Systems Div., liquid, solid or gaseous wastes are fed into a molten bath of sodium or calcium carbonate. The big advantage is that the bed preheating to high temperatures so that the incineration can be done at a lower temperature than normally required. In Rockwell's unit, the bath is preheated to 1,500-1,800 F. The technology that added that the waste feed has a value of at least 4,000 Btu/lb, out of the slag. The heat of combustion maintains the temperature. The salt neutralizes HCl and scrubs the product gases. The company has demonstrated that it can destroy hexachlorobenzene with destruction efficiencies of better than six to seven percent, according to Seymour Sudar, the project development manager. He reports that a 200-lb/hour demonstration is near completion, after which ad-

ding, unlike landfills, final; there's no fear seepage 10 years later

ditional test burns will be undertaken. Fluidized-bed combustion is also being adapted to hazardous waste incineration. Air that is forced up through a perforated plate maintains a turbulent bed of inert granules at a high temperature. The granules transfer heat directly to injected waste. And the bed itself acts as a scrubber for certain gases and particulates.

Breakthroughs. A mobile unit based on the technique is under development by Energy, Inc. (Idaho Falls, Ida.), which expects to have it ready within a year. Eventually, the company expects to offer turnkey systems. Larry Brooks, who is heading the market development effort for the company, claims the unit offers a potential capital cost advantage of 30% over other methods. Prospective operating costs are also lower because there are no bearings, seals or refractory to maintain.

Even rotary kilns are the subject of innovation. A new design that was developed by Pedco (Cincinnati) employs principles learned in the granulation of fertilizer to achieve better mixing in the kiln. Pedco says its system ensures that all solids are carried to the top of the kiln and drop to the bottom twice during each revolution. "We think we can get a DRE of five 9s at temperatures of 1,500-1,600 F by the better contacting action," says Leland M. Reed, who has been developing the process for Pedco. He has been able to achieve such results while removing HCl by spinning the kiln at high speed and adding lime to the system. So far, the results have been achieved only on a small scale, but in December, Rollins Environmental Services, a major commercial waste treatment firm, will further investigate the prospects in a pilot plant at its Bridgeport, N.J., site.

But while new technology may improve costs and efficiencies, it will do little to help industry overcome a growing resistance on the part of citizens to have incinerators located in their area. SCA (Boston), a commercial waste management firm, for instance, is running into political turmoil over its \$22 million incinerator in Chicago.

The facility started up in January, but the company now wants to burn PCBs there. In test burns, it was able to demonstrate DREs of six-to-seven 9s, and EPA was prepared to approve it. But the approval is being held up because of a public outcry. Mary Montes, speaking for the neighborhood group opposing the project, objects to the fact that it is being placed among other

waste disposal sites and says that it will turn that part of Chicago into a "large bin" for the refuse of other localities.

Incinerator ships avoid the problem of finding locations for incinerators on land, but they have their own set of siting obstacles. The companies that want to operate the ships are facing hostile public reactions because of the need to store the hazardous wastes at port before they are burned at sea.

Chemical Waste Management (Oak Brook, Ill.) has been operating Vulcanus I since 1972, mostly to serve Europe. It has performed test burns of a variety of wastes, including PCBs. In January, Vulcanus II was launched and has performed its first test burns. Although results of the tests are not official, preliminary data indicate DREs that are well within EPA and international regulatory guidelines. But approval for a storage terminal will be determined by a public hearing in Brownsville, Tex., on a date that has not yet been set.

At-Sea Incineration is also awaiting the outcome of New Jersey state proceedings. The company, a subsidiary of Tacoma Boatbuilding (Tacoma, Wash.) is building two incinerator ships sched-

'It will become apparent at some point that landfills are not the answer'

uled to operate out of Port Newark, N.J. But it is far from certain that the company will win necessary approvals from the state.

Chemical companies and others that build incinerators on site may find it easier to win approval, however. PPM's Centofanti feels that the public finds it easier for the community to relate to such installations in terms of protecting jobs.

Won't go away. There may be also a growing acceptance of the need for incineration. Nobody is suggesting it as a panacea, and more chemical treatment, process modifications and recycling will be important features of chemical waste management.

But incineration seems destined to play a bigger role in treating certain wastes. Occidental's John F. Riordan, executive vice-president for Hooker Industrial & Specialty Chemicals, calls incineration a "key element" in Hooker's efforts to eliminate or reduce waste by-products. And CARB's Sessa feels that industry will have to deal with a whole new set of economics because "at some point it will become apparent that landfills are not the answer." □