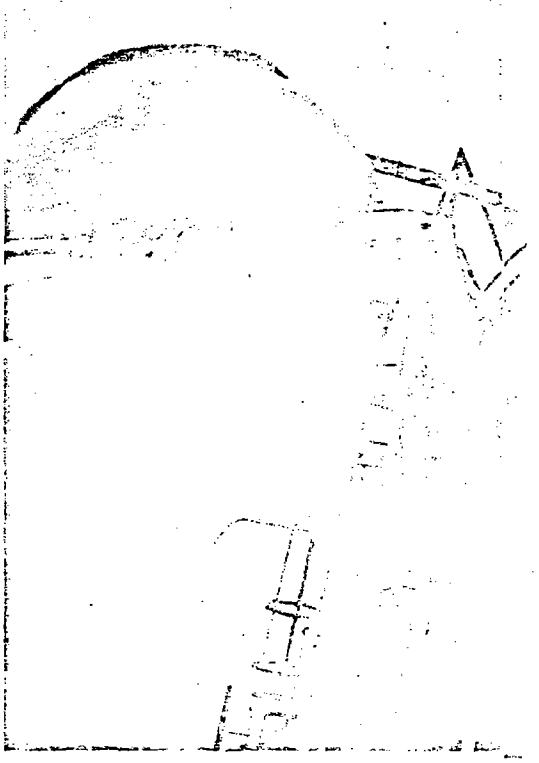
Oxo alcohols ride PVC expansion wave

Most output goes to plasticizers for polyvinyl chloride, growth of which is threatened by pollution worries



Producers of oxo alcohols for plasticizers and other uses are coming out of their latest round of expansions in high spirits—and, apparently, with considerable justification. The flexible polyvinyl chloride business, which accounts for more than 80% of oxo alcohol output in the U.S., continues to grow at an extremely healthy rate this year after an extraordinary performance in 1969.

Beneath this outward show of buoyancy by the oxo alcohol producers, however, flows an undercurrent of anxiety over the intermediate and long-term prospects for PVC in packaging. The source of the anxiety is mounting criticism nationally of the solid waste disposal headaches posed by the burgeoning use of PVC in packaging. Already, movements are under way at the federal, state, and local levels of government aimed ultimately at outlawing the use of PVC in consumer packaging.

Anxiety. Chemical industry anxiety over the ban-PVC-from-packaging movement is not confined solely to oxo alcohol producers, for as oxo alcohols go, so go many constituent materials, including ethylene, propylene, butylene, and ethanol.

For now, at least, the flexible PVC business is booming, and oxo alcohol producers seem preoccupied with ensuring ample capacity to meet ever-growing PVC plasticizer demands. From the looks of things, meeting this demand should pose no problems. For example:

- Continental Oil is boosting *n*-alkanol capacity from 100 million pounds to 150 million pounds a year by mid-1971.
- Enjay Chemical recently has expanded branched-chain alcohol capacity to 200 million pounds per year.
- Oxochem Enterprises, a joint venture of W. R. Grace and Commonwealth Oil & Refining, will bring on stream by year's end a 2-ethylhexanol plant with a capacity of 250 million pounds per year. It will be located in Penuelas, P.R.
- Monsanto expects to start up a new 150 million pounds-per-year linear alcohols plant in second-quarter 1971. (Linear alcohols are mixtures of alcohols made from alkenes by an oxo reaction followed by reduction.)

These expansions cap an overall boost in the four categories of oxo alcohols giving total capacity of more than 1 billion pounds. These categories include normal alkanols, mostly linear alcohols, highly branched alcohols, and 2-ethylhexanol.

A billion pounds of capacity has given some producers the uneasy feeling of too much too soon. For one, Larry Pickholz of Houdry division of Air Products thinks that the newly extended total U.S. oxo alcohols capacity marks the latest phase in an exaggerated stepwise growth of alcohols for plasticizers. Mr. Pickholz explains that, while PVC growth is comparatively uniform, plasticizer alcohol capacity generally grows by fits and starts to match it. He predicts that PVC demand for plasticizers will not meet present annual capacity of 1.25 billion pounds until 1973–74.

Antipollution. Beyond the immediate concern of overcapacity and possible price weakness lurks a spectre of general market collapse under the growing pressure from antipollution forces. The problem is that incineration of flexible PVC liberates hydrogen chloride gas. Flexible PVC contains 30% plasticizer ester, such as dialkyl phthalates and adipates, formed from oxo alcohols and second reactants, such as phthalic anhydride.

The hydrogen chloride is not only a serious pollutant but also damages incinerators, critics claim. Without incineration, PVC turns up as a solid waste problem. Federal, state, and local pollution control authorities are coming under increasing political pressure to force the packaging industry either to come up with a practical solu-

Carbide is leading U.S. oxo alcohol producer

	Plant location	Products	Annual capacity (Millions of pounds)
Celanese	Bay City, Tex.	2-Ethylhexanol	80[a]
Conoco	Lake Charles, La.	Normal alcohols	150, mid-1971
Dow-Badische	Freeport, Tex.	2-Ethylhexanol	40[a]
Enjay	Baton Rouge, La.	Branched alcohols	200
Ethyl Corp.	Houston, Tex.	Normal alcohols	100
Getty-Air Products	Delaware City, Del.	Branched alcohols	na
Oxochem Enterprises	Penuelas, P.R.	2-Ethylhexanol	250, late 1970
Gulf Oil	Philadelphia, Pa.	Linear alcohols	35-40
Monsanto	Texas City, Tex.	Linear alcohols	150, mid-1971
Pennwalt	Dover, Ohio	2-Octanol	na
Shell Chemical	Deer Park, Tex.	2-Ethylhexanol	80[a]
Tennessee Eastman	Long View, Tex.	2-Ethylhexanol	110
Union Carbide	Texas City, Tex.	2-Ethylhexanol and branched alcohols	235
	Institute, W.Va.; Seadrift, Tex.; Ponce, P.R.	2-Ethylhexanol	
USS Chemicals	Haverhill, Ohio	Branched alcohols	na

a C&EN estimates.
na = not available

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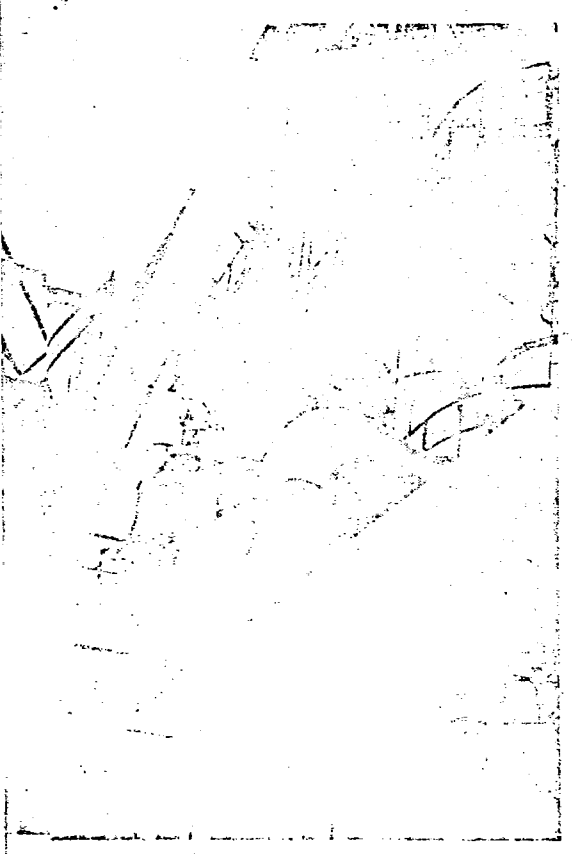

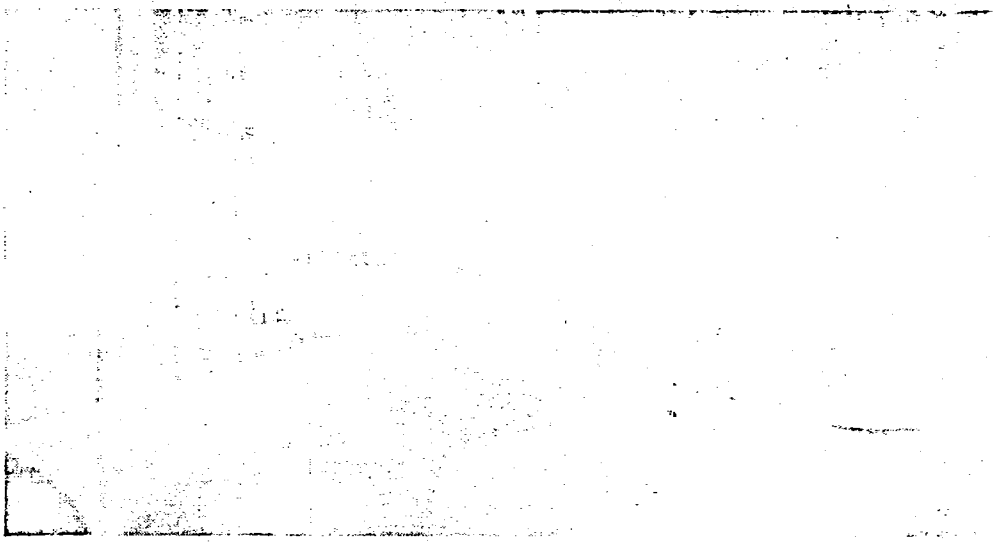

Conoco is expanding its Alfol alcohols plant at Lake Charles, La. (above). PVC film (right), major market for alcohol-derived plasticizers, rolls off Reynolds Metals' production line

tion to the PVC waste disposal problem or to discontinue use of the plastic in consumer packaging. Helping to tighten the political screws are various citizen action groups for environmental quality which for the most part have begun to switch from the shotgun approach to singling out specific targets in their assault on industrial pollution generally.

Industry has not absorbed this attack without taking initiative of its own to find solutions that could remove obstacles to PVC in packaging. For example, the Society of the Plastics Industry (SPI) is sponsoring an $82,000 study at New York University, New York City, aimed at improving incinerators. TRW, Inc., is studying burning and recycling plastics by a $100,000 grant from the Department of Health, Education, and Welfare. And Monsanto's Enviro-Chem Systems subsidiary has developed a pyrolysis method to eliminate hydrogen chloride emission.

These projects are complemented by firm antipollution policies taken by the plastics industry. SPI contends that, "Both polyvinyl chloride and polystyrene have been attacked erroneously as serious air pollutants and have come under threat of restrictive legislation."

SPI's countereforts to such a threat include sponsoring the research project conducted by New York University. The study is intended to determine the effect that burning plastics have on incineration and on the production of pollutants. The research involves working with a conventional municipal feed-type incinerator and analyzing its refuse and flue gases. SPI expects the project to produce recommendations for improved incinerator designs and procedures to alleviate any disposal problems caused by plastics.

Misunderstood. Up to now, SPI believes, the incineration properties of PVC have been seriously misunderstood. SPI maintains that, "Contrary to much erroneous comment, hydrogen chloride as a by-product of PVC is a negligible air pollutant, and its effect in incinerator corrosion has been exaggerated." In the U.S., the total production of all PVC is equivalent to less than 0.6% of all municipal refuse, SPI says, and only a fraction of PVC is incinerated.

In incinerator refuse, there are many materials besides PVC that produce hydrogen chloride and other chlorides, among them food wastes, grass, leaves, shrubbery, paper, and salt. "It is the judgment of the industry that the additional quantities of PVC that will be incinerated in the next few years will not significantly increase corrosion in incinerators," SPI says.

Nevertheless, SPI puts its weight behind plastics re-use and acknowledges the hurdles to be overcome. The plastics industry must seek to develop packaging systems that are returnable and that use less material, the society says. "It is in our interest to pursue these activities. Even if it were not, public pressure eventually will make it mandatory."

There are formidable technical barriers to true recycling of plastics—the reduction of them to their monomer or polymer constituents—SPI says, but efficient re-use of used plastics for new purposes is a very real possibility.

At stake. Oxo alcohol makers may well hope for the success of SPI's work on PVC. A rundown of higher alcohols processes shows the multitiered technical investment and materials outlets which are at stake. Normal alkanols, such as those made by Continental Oil and Ethyl Corp., come from polymerization of ethylene with Ziegler-type catalysts. Hydrolysis ends the reaction and leaves a product that is a mixture of 1-alkanols with even numbers of carbon atoms.

Gulf's starting materials are alpha olefins, produced by polymerization of ethylene, but terminated by elimination to 1-alkenes with even numbers of carbon atoms. In a reaction with carbon monoxide and hydrogen—the oxo process—a mixture of normal and 2-methyl aldehydes is produced, which can be reduced by hydrogenation to a mixture of normal and 2-methylalkanols with odd numbers of carbon atoms. Because the carbon skeleton is formed from ethylene polymerization, the structure of the alcohols is mostly linear.

Enjay's highly branched alcohols come from oxo reactions of olefins produced by combination of propylene and butylene refinery fractions. Olefins containing from nine to 12 carbon atoms are formed, though some heptenes and octenes are produced as well. The olefin mixture is put through the oxo process with reduction, which adds a hydroxymethyl group to the highly branched carbon skeleton.

A pure compound used in plasticizers is 2-ethylhexanol. This alcohol is produced by base-catalyzed condensation of *n*-butyraldehyde, followed by hydrogenation. Widespread use of 2-ethylhexanol comes partly from the variety of methods possible to use for its manufacture.