Characterization of Emissions of Dioxins and Furans from Ethylene Dichloride (EDC), Vinyl Chloride Monomer (VCM) and Polyvinyl Chloride (PVC) Facilities in the United States. IV. Consolidated Report.

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INTRODUCTION

In conjunction with its Dioxin Reassessment, the US Environmental Protection Agency (EPA) has been collecting information on US sources of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/F). Pursuant to questions regarding the EDC/VCM/PVC industry, members of The Vinyl Institute (VI), a Business Unit of the Society of the Plastics Industry, agreed to characterize PCDD/F emissions from their facilities. This is the consolidated report of results of that program comprising analyses of products and emissions from EDC, VCM and PVC resin manufacturing facilities in the US. A panel of technical experts was also assembled to aid in the characterization effort and review methods and results. Products include PVC resin, EDC for non-vinyl-chain sale and aqueous hydrochloric acid (HCl_{aq}). Potential emission matrices include treated wastewater, wastewater treatment solids, combustor stack emissions, and spent oxychlorination catalyst. Various other minor streams are estimated. This study uses 1995 as the reference year to correspond to the US EPA Dioxin Reassessment.

EXPERIMENTAL

Sampling and analytical methods, some of which were developed or adapted especially for these matrices are described in Parts I, II and III.[1,2,3]

RESULTS

This project involves characterizing potential emissions from manufacture of EDC, VCM and PVC in the United States. A profile of industry production is shown in Table 1. A generic schematic of the materials and wastes involved in this manufacture is shown in Figure 1. A composite total of results from various streams is presented in Table 2. The most likely estimate for annual emissions and transfers to relevant repositories is approximately 34 g TEQ/y. Of this 11 g TEQ are released to air, 0.6 g TEQ to water, 0.7 g TEQ is landformed and the remainder is found in wastes which are mainly landfilled and therefore not a release to the open environment. For some streams most concentrations in the samples were below detection limits which, when using the convention of evaluating non-detects at half the detection limit, artificially increases estimated emissions.

DISCUSSION

For each matrix estimates of “Most Likely” and “Upper Bound” fluxes were made. The techniques for extrapolation differ for each matrix. In general, “Most Likely” involves summing

measured sites and application of an average emission factor to the sites which were not sampled and "Upper Bound" applies the largest single measured emission factor to sites for which data are not available. The "Most Likely" scenario corresponds to central estimates calculated in the EPA sources inventory[4] and we believe is most representative.

Based upon convention used in US EPA's Dioxin Reassessment[5], where non-detects are found, estimates are based on one-half the detection limit. This has led to significant conservatism in the reporting of PCDD/F in PVC resin since for 22 of 26 samples no PCDD/F were detected. PCDD/F was detected only when the detection limit was decreased from a nominal 1 pg/g to approximately 0.1 pg/g.

In its draft document[4], EPA estimates annual releases from known sources to air (2745 g TEQ) , water (20 g TEQ), and surface impoundment (208 g TEQ). EPA does not include releases to landfill. Releases from EDC/VCM/PVC manufacture are not included. By the same classification, the VI releases, identified 11 g TEQ/y released to air from combustor emissions, 0.6 g TEQ/y in waste water emissions, and 0.7 g TEQ/y to be landspread.

The VI made order-of-magnitude estimates for releases of PCDD/F in fugitive emissions from VCM, production and handling of heavy ends, and incinerator ash and acid-brick disposal. These estimates indicated a combined release of <1 g TEQ/y.

There is potential for reduction in emissions from combustors. As prospective US hazardous waste combustor regulations are implemented, modernization of combustors will occur. There is potential for significant reduction particularly for the liquid waste combustors. Study of time in service and other variables may decrease flows of PCDD/F in spent catalyst. More sensitive analysis of resin samples will reduce uncertainty regarding non-detects.

ACKNOWLEDGEMENT

The authors thank all participating member companies of the VI Dioxin Characterization Program for their input and permission to publish their analytical results. In addition, the authors are grateful for thoughtful remarks, criticism and insight provided throughout the program by Gary Amendola, Patrick Dyke, Heidi Fiedler and Michael Gross who acted as independent reviewers.

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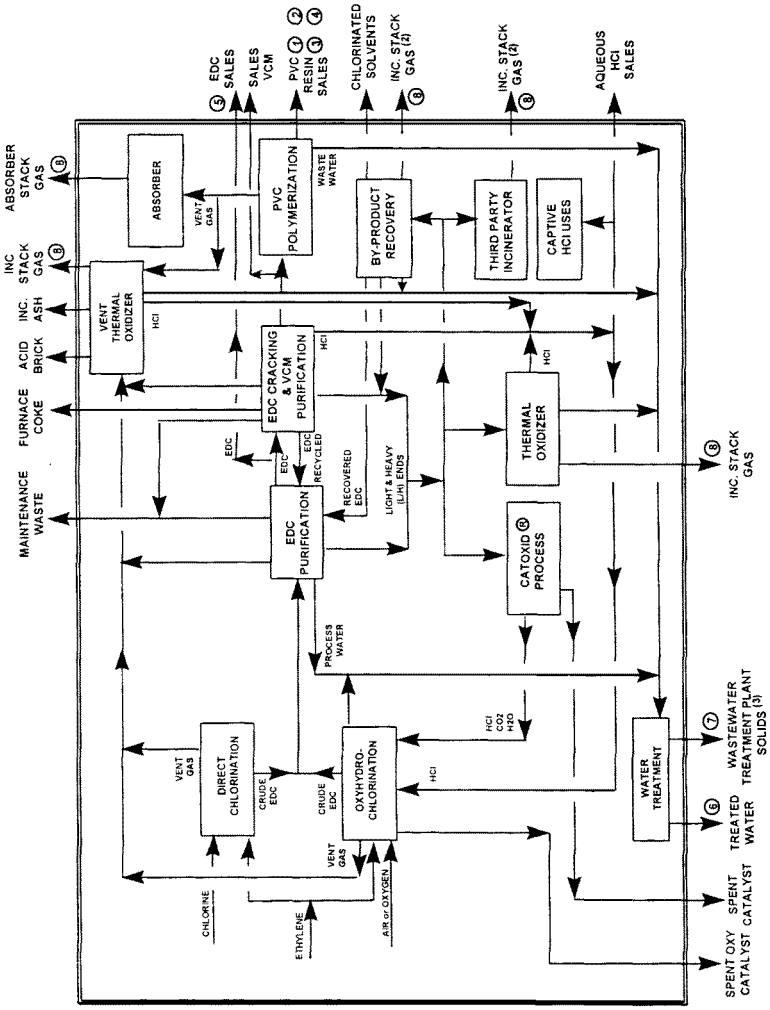
Figure 1. EDC / VCM / PVC PROCESS FLOWSHEET (1)



(1) THIS IS A COMPOSITE DRAWING BASED UPON NUMEROUS PRODUCTION SITES IN USA. IT IS ILLUSTRATIVE OF INDUSTRY PRACTICES. NOT ALL PROCESS STREAMS OR EFFLUENTS SHOWN ARE PRESENT AT ALL MANUFACTURING SITES.
(2) BY-PRODUCT RECOVERY AND OFF-SITE DISPOSAL WILL BE CHARACTERIZED FROM EXISTING INCINERATOR STACK DATA
(3) INCLUDES BOTH ON-SITE AND OFF-SITE DISPOSAL PRACTICES OF WASTEWATER TREATMENT SOLIDS

Table 1. U.S. Production of EDC, VCM and PVC (1995)

Material	Companies	Locations	Production, kmt[a]
EDC	11	15	11,115
VCM	10	14	6,173
PVC	15	28	5,656[b]

[a]Thousand metric tons
[b]Includes U.S. and Canadian production facilities

Table 2. Estimated Annual Inventory in grams TEQ

	Number of Samples		**Estimated Mass (g TEQ/a)**		
Medium Sampled	**Collected**	**Positive Findings**	**ND=0**	**Most Likely ND=DL/2**	**Upper Bound ND=DL/2**
Emissions					
Water – Treated Wastewater (PVC only sites)	6	2	0.011	0.15	
Water – Treated Wastewater (Integrated sites)	4	4	0.032	0.17	
Air – PVC-Only Vents	3	3		0.0014	0.0019
Air – EDC/VCM Liquid and Liquid/Vent	11	11		3.7	7.2
Air – EDC/VCM Vent	8	8		6.9	21.6
Air – Third Party/Transfer				0.65	2.3
Air – Suspension PVC Driers				<0.2	
Secure Landfill					
WW Treatment Solids	17	17		12.1	27.5
Spent Catalyst	9	9		6.7	26
Products					
Suspension & Mass PVC	20	1	0	3	6
Dispersion PVC	6	3	0.0004	0.1	
EDC	5	1	0.008	0.29	
HCl	2	2	0.004	0.0044	
Other				0.005	0.6
Total Annual Estimate				**34.0**	**92.1[a]**

[a]Where no explicit upper bound is calculated, "Most Likely" is assumed.