
A COMPARATIVE REVIEW OF THE COMBUSTION TOXICITY OF POLYVINYL CHLORIDE

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INTRODUCTION

OVER THE PAST FIFTEEN YEARS CONSIDERABLE ATTENTION HAS been given to the combustion toxicity of materials. This concern has largely been the result of a recognition that most fire deaths result from the inhalation of toxic gases, particularly carbon monoxide (Harland and Wooley, 1979; Halpin and Berl, 1978; and Birky et al, 1979). Although the relative importance of toxicity in the overall fire hazard of a material is not known, it is recognized to be one of the many factors, (i.e. quantity, configuration, compartment volume and surface area, ventilation, flammability and combustion properties, presence and type of ignition source, fire protection systems, building occupancy, and code enforcement) which influence fire hazard (likelihood or probability of injury).

One of the materials which has drawn particular attention over the years is polyvinyl chloride (PVC). Many early attempts to compare the combustion toxicity of PVC and other materials with natural products such as wood involved the analysis of combustion gases and their respective toxicities. While qualitative and quantitative differences were found, many materials released similar types, namely commonly known asphyxiants such as carbon monoxide (CO) and carbon dioxide (CO₂), irritants, and complex organic chemicals. In the case of PVC and wood, both materials produced CO and CO₂ and complex organics. However the subject of real contention was the production of irritants—

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The Toxicity of Hydrogen Chloride and of the Smoke Generated by Poly (Vinyl Chloride), Including Effects on Various Animal Species, and the Implications for Fire Safety

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ABSTRACT: Toxicity of smoke is only one of many factors determining the hazard or the risk resulting if a product were involved in a fire in a specific scenario. Other factors include: amount of smoke (i.e., concentration of combustion products in the atmosphere), rate and quantity of heat release, mass loss rate, and flame spread rate, as well as such "environmental" factors as ignition source characteristics, fire detection and suppression devices, building occupancy, and code enforcement. A factor almost specific to the smoke generated from burning poly (vinyl chloride) (PVC) is the decay of hydrogen chloride (HCl) by reaction with building surfaces. The values of smoke toxic potency measured will also be affected by a number of parameters, including combustion mode, exposure mode, toxicological end point, and statistical analysis of results.

A crucial factor, often overlooked, is the choice of an animal model appropriate as a surrogate for man, and its validation. Test animals are frequently chosen on the basis of convenience, cost, or other characteristics (e.g., sensitivity) rather than because of their similarity to man. This is particularly important in combustion toxicology, where one test species may not be a good model for all the major combustion products generated. Thus, comparisons of materials producing different major combustion products must be approached with caution to ensure that any apparent differences encountered in tests are not simply an artifact of test species.

Over recent years, increasing evidence has surfaced that some rodent species are poor models for the toxic response of man to irritant gases or to smoke-containing irritants. Studies on HCl (as a pure gas) and on the smoke generated from the burning of PVC have indicated that mice are much more sensitive than rats. More importantly, they are much more sensitive than primates. It has also been established that rats are a good model for primates in terms of the lethal effects of irritant products. Although primates have survived 15-min exposures to 10 000 ppm of HCl, 2500 ppm is lethal to mice. Moreover, under the same exposure conditions, mice will die at PVC smoke levels four to seven times lower and HCl levels seven to ten times lower than those at which rats will. In contrast, lethal doses of asphyxiants such as carbon monoxide (CO) are similar in rats and mice.

These results indicate that the response of the mouse significantly overestimates the toxic potency of HCl and of PVC smoke to man.

KEY WORDS: PVC, HCl, poly (vinyl chloride), hydrogen chloride, smoke toxicity, fire hazard, animal models, toxic potency, smoke, fire

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