Less smoke from PVC

A new proprietary additive reduces particulate density that is generated when PVC burns.

In the early days of plastics, the commonly asked question about flammability was: Does it burn? This led to the institution of various small-scale test procedures whose results were expressed in terms such as self-extinguishing, slow-burning, or burning. It is now clear that too much reliance was placed on the first two classifications as to product safety. Little attention was paid to the hazards of smoke and toxic-gas generation and, in the case of so-called self-extinguishing materials, the fact that most plastics along with most other organic materials will burn in an active fire was ignored. Now there is general recognition that many test methods for flammability do not reveal the facts as they are experienced in a general-fire atmosphere and are at best laboratory tests for comparing small samples with no direct bearing on real-life situations.

Table 1. Density of smoke generated by various materials in the NBS smoke chamber.

Material	Type of combustion: Flaming	Type of combustion: Non-flaming
Red oak	75	395
Yellow pine	80	490
Polycarbonate	324	36
Polystyrene	468	345
Polyvinyl chloride	525	270

Table 2. Polymers with reduced flammability and smoke.

Polymer	Oxygen index[a]	Smoke density rating[b]
Polyvinyl chloride	40	97
Chlorinated PVC	50	46
Polycarbonate	27	74
Polyphenylene oxide	29	86
Polysulfone	30	60

[a] ASTM-D-2863
[b] ASTM-D-2843

Hazards in burning plastics

When plastic materials are exposed to an active, large-scale fire they usually soon become part of the flaming mass. In so doing, they are generally consumed by the fire and generate a mixture of gaseous and particulate products of combustion. These can be in the form of visible smoke, often very dense, and invisible gases which may or may not be toxic, but often obscure the vision, and irritate the respiratory tract and the eyes of persons in the vicinity. The presence of true toxic gases in the products of combustion can result in the death of those exposed and dense smoke may prevent their finding an escape route from the fire area. Various methods are available for measuring smoke density in fires; however, at present toxic-gas measurement tests are in an early stage of development.

An action program

Having recognized the hazards of smoke and toxic gases it became necessary to develop realistic tests for measuring the amounts of each generated in a fire. Various test methods are currently available which measure the optical properties of smoke as well as one which measures smoke weight*. Systematic studies of toxic-gas measurement are just beginning and significant progress in this area is not anticipated in the near future. Initial attention has been focused on rigid PVC systems and the solid airborne particulate smoke component as measured by both the Arapahoe smoke chamber (ASC) and the National Bureau of Standards (NBS) smoke chamber.

Rigid polyvinyl chloride (PVC) was chosen for study for three primary reasons.

- Rigid PVC is widely used in interior construction applications where smoke causes a serious life safety hazard.
- Rigid PVC generates large quantities of smoke during combustion (*Table 1*).
- Rigid PVC is inherently flame retardant so no additional additives are required to improve flame retardancy.

Prior to discussing the new technology, it may be worthwhile to consider the current state of the art in flame-retardant low-smoke products. *Table 2* lists some plastics which feature some degree of flame retardancy and lower smoke generation than polyvinyl chloride. In each case, smoke reduction was obtained by polymer design. This data illustrates that the optimum blend of flame retardancy (high oxygen index) and reduced smoke (low smoke-density rating) is obtained with chlorinated PVC. Any plastics processor will attest to the fact that chlorinated PVC is not a minor modification of PVC and in fact processes quite differently. Consequently, it appears that the fabricator or product designer does not have a simple choice between alternatives in order to take positive action toward safer low-smoke products based on current technology. This is the background on the development of this new smoke suppressant technology.

* Arapahoe smoke chamber (ASC) developed by Arapahoe Chemicals Inc., Boulder, Colo.

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