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DEVELOPMENT CENTER

HI-TEMP GEON FLAMMABILITY, FLAME SPREAD, AND SMOKE GENERATION DATA

By

James Summers

December 11, 1970

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Introduction

Hi-temp Geon has been shown to be a very good material in regards to flammability, flame spread, and smoke generation. This data is generally scattered out in various reports. The purpose of this report is to summarize and bring together this data.

Results and Discussion

Several types of data are available on Hi-temp. These are:

1. Pyrolysis products (1)
2. Oxygen Index
3. Underwriters' Laboratory tunnel test on flame spread, smoke generation, and fuel development (2)
4. Smoke generation in a NBS Smoke Density Chamber.

In [redacted] O'Mara's work on pyrolysis of chlorinated PVC in helium at [redacted] the decomposition products were about 55% HCl, 36% carbonaceous [redacted] and 9% volatile hydrocarbons. (1) The volatile hydrocarbon [redacted] is about 25% benzene and 75% chloro and dichlorobenzenes. In comparison, PVC, when pyrolized under the same conditions, produces 57% HCl, 5% carbonaceous ash, and 38% volatile hydrocarbons. (3) The volatile hydrocarbons were 50% benzene. If the volatile materials are considered fuels or smoke generating materials, then chlorinated PVC is better than PVC. These data are illustrated in Figure 1. The work on oxygen index is that of C. V. Purves. The procedure (ASTM D2863) was to ignite the sample for 30 seconds, remove the flame and time the burn. The oxygen is adjusted to give either a) 3 minute burn or b) 5 cm. burn accepting whichever occurs first. These data are listed in Table 1.

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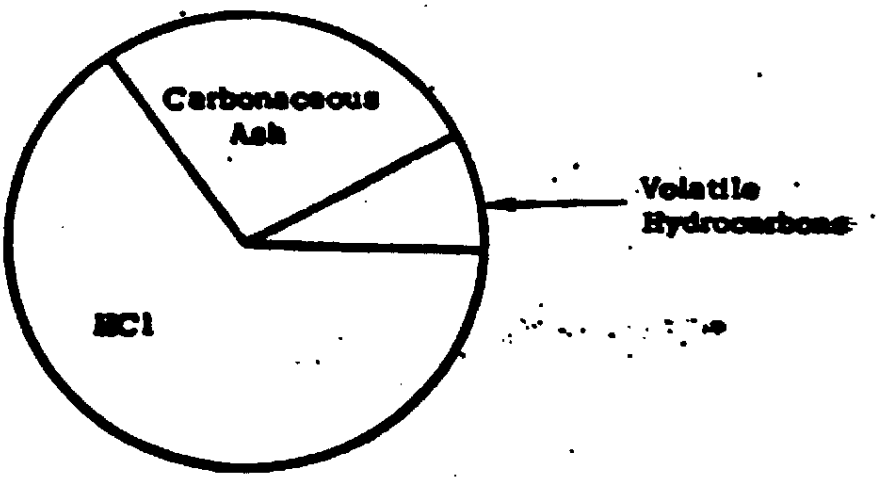
Figure 1.

600°C. Pyrolysis Products of Chlorinated PVC and PVC

Chlorinated PVC



PVC

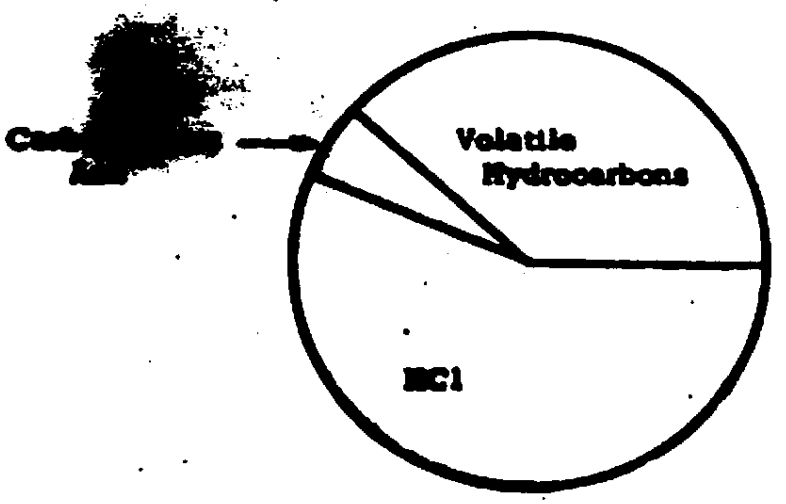


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Table 1.

Oxygen Index of Several BFG Polymeric Materials

Material	Oxygen Index % Oxygen
Hi-temp 88884 Gray 240 Extrusion Grade Cl PVC	61.4
Hi-temp 88885 Gray 250 Molding Grade Cl PVC	62.6
Hi-temp 3008 Tan 309 Molding Grade Cl PVC	56.9
Geon 85821 White 139 PVC Powder Compound	51.0
Geon 7082 White 138 PVC Cube Compound	50.2
Abson 89129 Natural 022 Self extinguishing ABS	27.8

As is seen in this table, the Hi-temp compounds require a richer supply of oxygen to burn than do the PVC compounds. This is also much greater than for self extinguishing ABS.

Some other work on oxygen index, by D. B. Hall and P. Marcuoci, was reported for thin rolled films of chlorinated PVC.[5] In these thin films, the oxygen index was drastically lower than with thick compound and showed a maximum with chlorine content. It was not known whether the failure was due to rapid spread of burning or [illegible]. These data are listed in Table 2.

Table 2.

Oxygen Index of Thin Rolled Films of Chlorinated PVC

Resin	Specific Gravity	Oxygen Index
601	1.54	36.3
607	1.54	31.1
607	1.55	32.3
601	1.50	35.4
607	1.58	28.6
617	1.61	27.0
617	1.62	26.6
617	1.67	26.6

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Tests were also made in the Steiner tunnel at Underwriters' Laboratory. These tests were followed by D. L. Milenius and T. F. Dunnigan. The standardized test method is described in ASTM E84-68 and UL Publication 723-1960 (ASTM E84-61). The gas is essentially methane with a flame temperature of 1230-1280°F. All air is diffusion air. Materials are compared to a Red Oak flooring Control. These data are listed in Table 3.

Table 3.

Tunnel Test at Underwriters' Laboratory

Material	Thickness Mils	Flame Spread Classification	Smoke Rating	Fuel co... Rating
Red Oak Flooring	-	100	100	100
Hi-temp 88885 Tan 309 Molding Grade C1PVC	20	5	45	0
Hi-temp 88884 Gray 260 Extrusion Grade C1PVC	26	8	25	0
Geon 85821 White Powder Compound	43	28	215	0
Geon 85838 White	54	38	407	2
Abson 89291 White Self extinguishing ABS	60	72	575	-
Abson 89129 Gray 234 Self extinguishing ABS	120	188	668	-

As is seen in Table 3, Hi-temp has a very low flame spread rating, a lower smoke rating than wood, and zero fuel contribution. PVC compounds also have a low flame spread rating, but not as low as Hi-temp. However, PVC has a higher smoke rating than [redacted] self extinguishing ABS has about the same flame spread rating as [redacted] generates more smoke. Again Hi-temp looks very good in this test.

Other smoke generation data were obtained at the Development Center on the NBS Smoke Density Chamber. Most of this work was done by C. V. Purks. The data were obtained in both flaming and smoldering conditions. In this test

$$D_m = D_s \text{ maximum,}$$

where $$D_s = \frac{\text{Volume of chamber}}{(\text{optical path length})(\text{Area of exposed sample})} \left[\log_{10} \frac{1}{\text{Transmittance}\ \%} \right]$$

The data are summarized in Table 4.

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Table 4.

Smoke Generation of BFG Compounds in an NBS Smoke Density Chamber

Compound	Smoldering Dm	Smoldering Time to Dm minutes	Smoldering Time to Ds = 16 minutes	Flaming Dm	Flaming Time to Dm minutes	Flaming Time to Ds = 16 minutes
Hi-temp Gray (.011 inches)	25	5	.25	29	4	.25
Hi-temp 88884 White Extrusion Grade Cl PVC	80	15.3	2.5	246	8.8	.65
Hi-temp 88885 Gray Molding Grade Cl PVC	108	13	1.4	269	4	.5
Hi-temp 88918 Natural	234	13	2.35	471	4	.55
Geon 7082 White PVC Cable Compound	443	17	1.9	700	5	.65
Geon Natural	86	15	1.15	232	.9	.25
Geon 89129 Self extinguishing ABS	457	20	1.65	700	2	.55

There is much scatter in the data of Table 4. Generally, though, Hi-temp looks better than PVC and ABS compounds.

Overall Discussion

In the several tests described here, Hi-temp has generally looked good in flammability and smoke generation tests. The mechanism that makes Hi-temp look good is unknown at present and, [redacted] information is needed to take full advantage of these good properties. [redacted] which need to be considered are:

1. Is Hi-[redacted] because of its low volatile hydrocarbon content? If this is true, [redacted] does chlorine content in the Cl PVC have on flammability and smoke generation? The data of Table 2 does not show a clear cut trend. It is known that Hi-temp mixed with other flammable polymers reduces the flammability; what does it do to smoke generation?

2. Is Hi-temp good because of its high amount of carbonaceous ash which may act as a crust to cut off air from the burning material? If so, what effect does molecular weight and chlorine content have on formation of the crust? How does the sample thickness effect the crust formation?

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3. What effect do pigment and rubber additives have on flammability and smoke generation?

4. Is Hi-temp good because the formation of HCl displaces oxygen from the material? This appears not to be true in PVC because high loadings of HCl absorbers do not effect the flammability. (4)

5. Do the few tenths of a percent of chloroform and carbontetrachloride in Hi-temp form phosgene in a flame? A small amount of phosgene, if present, may not be any more toxic than the HCl or carbon monoxide. However, we should be aware if it is present.

6. What effect does HCl have on prestressed concrete and steel beams in the heat of a fire and later long-term effects?

In the next few months we will be attempting to answer some of these questions at the Development Center. We will be looking at the molecular parameters, additives and blends, and products of combustion.

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