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HAZARDOUS PRODUCT PRODUCED BY ELECTRICAL INSULATION

IN BRIEF ... Generation of HCℓ occurs when PVC cable insulation is heated, externally or by internal heating induced by electric overload. The HCℓ vapor may be present in the atmosphere, at hazardous levels, prior to the generation of black smoke--so that fire-fighting personnel may not be readily cognizant of the danger.

A recent study at the NBS Building Research Division (U.S. Department of Commerce), has shown that when polyvinyl chloride (PVC) wire insulation is heated it goes through two stages of decomposition. In the initial stage, when the level of heat input is relatively low, a white HCℓ mist is generated. In the latter phase, when the material is exposed to higher levels of heat input or an open flame, a dark sooty smoke is released.

The release of the HCℓ prior to the development of dense smoke presents a potentially hazardous situation, especially to fire-fighting personnel. The HCℓ in this state is colorless, but forms a white mist resembling steam by combining with moisture in the air. Although

innocuous in appearance, the HCℓ acts as a primary irritant and corrosive agent to the respiratory system.

The decomposition phases of PVC are a function of the temperature of the material. Gaseous hydrogen chloride is released from PVC when the temperature reaches about 450 °F. The rate of release depends upon the temperature and density of the material. The gas, on exposure to moisture in the air, forms white fumes of acid vapor by absorption of moisture. The vapor is very reactive and can be easily adsorbed on contact with a surface. If the temperature is maintained below 650 °F, dark smoke or soot will not form. Above 650 °F, carbonaceous degradation products in the form of black smoke are present.

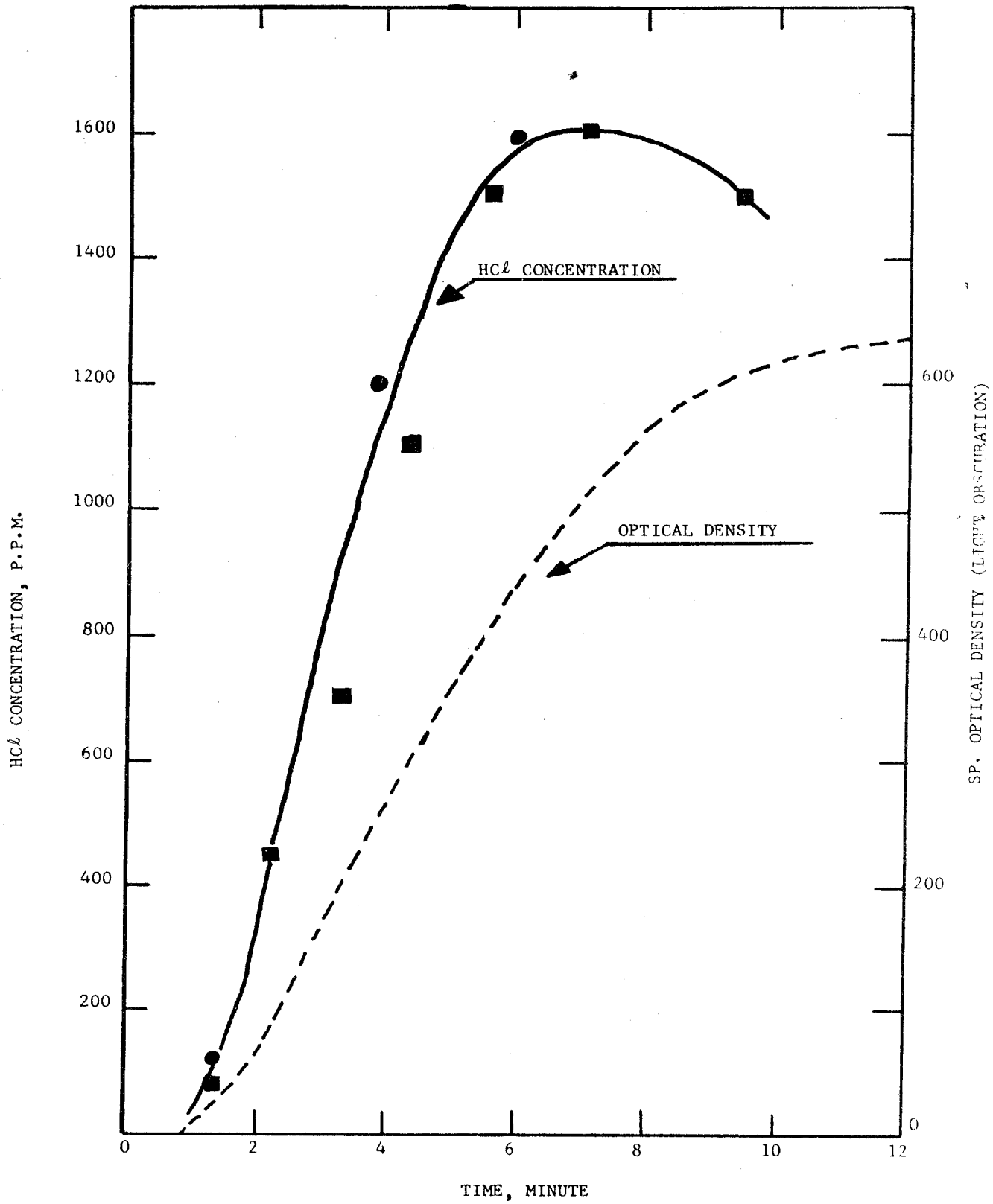
In the NBS study a specimen of an electric cable covered by black plastic insulation, composed mainly of PVC with some amounts of fillers and plasticizers, was tested. The insulation was cut and flattened to fit in the standard holder in a smoke density chamber.[1/] The specimens were irradiated with 2.5 watts/cm^2 heat energy for non-flaming exposure tests.

Results were obtained in terms of optical density and quantity of HCℓ concentration (fig. 1). In the 18 cu ft chamber, the combustion products from a 6.5 sq in sample reached a HCℓ concentration of above 1 600 ppm. From 1 000-2 000 ppm of HCℓ is considered to be dangerous

on short exposure,[2] whereas 5 000 to 10 000 ppm of carbon monoxide are needed for comparable effect. Fire-fighting personnel should thus be alert to the possible dangers of electrical insulation decomposition in a fire situation.

1/ Gross, D., Loftus, J. J., Robertson, A. F., Method for Measuring Smoke from Burning Materials, ASTM STP No. 422.

2/ Henderson and Haggard, Noxious Gases, Reinhold Publishing Co.


1600
1400
1200
1000
800
600
400
200
0
2
4
6
8
10
12
HCℓ CONCENTRATION
OPTICAL DENSITY
HCℓ CONCENTRATION, P.P.M.
SP. OPTICAL DENSITY (LIGHT OBSORBATION)
600
400
200
0
TIME, MINUTE

CAPTION FOR ILLUSTRATION:

Figure 1. HCℓ concentration and optical density of PVC electrical insulation decomposition products are shown in these plots. The data were obtained in an NBS study that showed hazardous concentrations of HCℓ can be released when polyvinyl chloride wire insulation is heated.

Attached

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