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TO Dr. A. E. Ardis AT Assonet DATE June 15, 1971

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SUBJECT POLYVINYL CHLORIDE - Current Awareness
NHTIS 71-30 Supplement II
Project 8625-001

Attached is our most recent collection of patents and articles on polyvinyl chloride. We have also included a few references on Toxicology problems in the vinyl chloride area.

As in the past, we will obtain copies of abstracted articles or full copies of those in which only the first page has been included as you request them.

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Sources:

British Plastics - March 1971
Flooring - April, May 1971
F&S Index of Corporations and Industries - March 2-May 4, 1971
Modern Plastics - April - May 1971
Plastics and Rubber Weekly - March - April 1971
Plastics Technology - April 1971
Plastics World - April-May 1971
SPE Journal - April-May 1971

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FIRE SAFETY FOR PLASTICS

ARE plastics a fire hazard? How can the hazards be assessed? How can they be ameliorated?

by CHARLES JENNINGS

A good basis to start from is an article by Dr Helmut Birkner and Dr Klaus Diebel, in German, in the house journal of Chemische Werke Hüls, called Der Lichtbogen.

The article begins from the viewpoint of plastics in building construction, notes the confusion—as in Britain — in terminology arising from the lack of definition, and goes on to the German standard classification of building materials, in DIN 4102, which groups the combustibles into three groups: difficult to burn, easy to burn, and something between the two.

The DIN test is described and it is noted that various materials fall into various groups. For some building purposes, only the highest group is permitted, 'difficult to burn within the meaning of DIN 4102'.

Rather than translate the ambiguous German into equally ambiguous English, it is better to begin at the beginning.

All organic compounds having carbon:carbon or carbon:hydrogen bonds are combustible; it is inherent in the molecule and differs mainly in temperature.

That may not be saying much that is helpful when you consider how combustible even metals can be.

But it does mean that there can be no actual incombustibility of organic polymers, whatever treatment you give them.

What is useful to remember about polymers is that there is a wide range of combustibility, of ignition temperatures, of continuity extinguishing. Also, remember that it takes two to make a fire: the substance that burns and the atmosphere it burns in.

From these considerations has been devised a test, called the oxygen index of inflammability, OII, which has proved to be one of the most precise and reproducible of the several indices of flammability or combustibility yet developed for polymeric materials.

Essentially, the index is the percentage concentration of oxygen, in a mixture of oxygen and nitrogen, which will just sustain equilibrium burning of the material under test.

In an article in Der Lichtbogen, the authors call it the 'J' oxygen index and quote figures like:—

ptfe	0.95
pvc	0.45
pc	0.26
pp	0.17
pe	0.17

It will be noticed that the earth's atmosphere — with which we are almost always concerned in cases of fire — has a J figure of 0.21, so that pc will not just burn in air under ordinary conditions, but pp and pe will.

Those J figures are for the uncompounded polymers but they can be substantially raised by adding suitable 'fireproofing' agents.

Birkner and Diebel discuss such agents, dividing them into three classes: filler additives, reactive ingredients, and after-treatments. The reactive ingredients are, broadly, the most potent and the most popular, giving an in-built protection.

looked at from the point of view of the essential requirements of a good fireproofing agent (reduction of burning, no deleterious effects on processing or working, no degradation of physical properties, and non-toxicity,) compromises are often necessary.

Flameproofing agents, like halogen—, phosphorous—, and antimony-containing compounds are considered in some detail by the authors who present an interesting table of the flameproofing substances referred to in recent patent specifications.

Three types

They are classified into three types: (1) organic additives like chlorinated paraffins, bromine compounds, and halogen phosphates, (2) inorganics like antimony trioxide, zinc and barium borates, (3) synergists like peroxides and hydrazine.

Of course, proportions are crucial and the form of the polymer — film, foam and block — is important.

An important part of the paper is devoted to test methods. Differential thermal analysis (DTA) and thermogravimetry (TGA) give the most fundamental insight into what goes on during burning, but the more simplified and practical tests, generally imitative of the special conditions of each situation, differ so widely in the conditions of testing and assessment of results that Hüls have been forced to design their own test for their development work measuring and improving the burning characteristics of plastics are fined down to the small area of a single material, polyurethane, and a single form of that material, flexible foam, they seem to be only a little easier to solve.

That is the general message of the paper by R. M. Pruitt in Journal of Cellular Plastics, November/December 1970, pp. 262-6, on the self-extinguishing characteristics of flexible urethane foam.

In opening his paper, the author thrashed about over the same ground of ambiguity and lack of definition, as worried the German authors, pointing out that 'of some fifty tests for flexible foams, none consistently correlate with foam in service conditions'.

Pruitt also classifies flame-resistance treatments into three kinds: (1) intumescent, shielding materials, (2) diluting fillers, (3) chemical interference with the burning.

The last has been the traditional approach, generally involving halogen- and/or phosphorus-containing compounds. But Pruitt makes two valuable points not mentioned by the Germans.

These are that bromine is more efficient than chlorine and that both have a synergistic effect with phosphorus. A large part of the paper is, in fact, devoted to examining the relationships between these three elements.

Physical effects on the rate of burning must not be overlooked. They are very obvious in urethane foam when comparing the results of using different types of isocyanate, such as TDI and MDI. Each of these, used alone, produces foams which are not self-extinguishing, yet, used together, the produce a foam which is self-

The cause seems to be that the mixture produces a foam which, on ignition, melts and flows away but then chars and so insulates the foam from the heat of the flame.

This effect leads on to the idea—an old one—of using incombustible, inorganic substances, incorporated by soaking the finished foam in a suitable solution or dispersion, followed by drying out.

Pruitt recommends $MgNH_4PO_4$ and the similar calcium salt, both of which are cheap and effective although expensive to incorporate.

Pruitt concludes with an examination of how far a practical burning test — a small, uncovered cushion of the foam, ignited by a sheet of burning newspaper — correlates with the standard laboratory test, ASTM D1692.

Correlation was indeed so poor that Pruitt pointedly remarks: 'we must ask ourselves if we want to continue playing the test-passing game.'

This final judgment may not be entirely acceptable because the 'service test' itself is not above suspicion, being not really representative of what actually happens to an upholstered seat when there is a fire in a room or a vehicle.

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