Fire Retardant Polyisocyanurate Foam

The problem:
To increase the fire retardant properties of low-density polymer foams.

The solution:
A polyisocyanurate foam with pendant nitrile groups which form thermally-stable heterocyclic structures at a temperature below the degradation temperature of urethane linkages.

How it's done:
The nitrile groups are introduced as acrylonitrile grafted to a low-hydroxyl number polyol prepolymer which may be of the type typically derived from glycerin and propylene oxide. Because the modified polyol has a low hydroxyl number and low functionality, the resulting polyisocyanurate-polyurethane foam structure has mechanical flexibility, whereas the polyisocyanurate polymers do not. The polymeric structures containing nitrile groups cyclize at low temperatures to form nitrogen-containing heterocyclic ring structures; subsequent degradation of these structures and the polyisocyanurate-urethane structures at an elevated temperature provides a high char yield, implying a correspondingly lowered yield of the volatile flammable species which are formed in comparatively large quantities by state-of-the-art polyurethane polymer foams based on polyols such as sucrose and glucose.

The new type of rigid foam is typically prepared by homogenizing in a ball mill a mixture of the polyol grafted with acrylonitrile, a tertiary amine catalyst, an inorganic base, a char stabilizer such as potassium fluoroborate, and a blowing agent. Grinding is continued until all dispersed solids are reduced at least to a diameter of $50 \times 10^{-3}$ mm. It may be desirable to incorporate other polymeric materials (such as poly (vinyl chloride-vinyl acetate) copolymer) and inert refractories such as silica to increase density or to impart particular properties to the finished foam; other additives may be materials such as encapsulated flame retardants, cell stabilizers, colorants, etc. The premix formed by milling is then blended rapidly and thoroughly with a polymeric isocyanate, for example, a polymethylene polyphenyl isocyanate, and immediately poured into a mold to cure for about 16 to 24 hours.

When exposed to a JP-4 fire at a heat flow rate of $10-13$ Btu/ft$^2$ sec ($11.1 - 14.8 \times 10^4$ W/m$^2$), 5-cm thick state-of-the-art polyisocyanurate foams burn through in about 55 seconds; in contrast, the new type of polyisocyanurate foams withstand burn-through for more than 600 seconds.

Reference:

Note:
No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
Ames Research Center
Moffett Field, California 94035
Reference: B72-10269

(continued overleaf)
Patent status:
Inquiries about obtaining rights for the commercial
use of this invention may be made to:
Patent Counsel
Mail Code 200-11A
Ames Research Center
Moffett Field, California 94035

Source: Salvatore R. Riccitiello and
John A. Parker
Ames Research Center
(ARC-10280)