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POLYMER MATERIALS FIRE PROTECTION BY VARIOUS ADDITIVES APPLICATION EFFICIENCY ESTIMATION

(presented by DSc Pozdeev S.)

It is executed an analysis of various flame retardants use to reduce the combustibility of polymer materials. It is established that the main indicators used to evaluate fire resistance are the ignition temperature and oxygen index. The effect of the inert filler content on the flame propagation velocity according to the UL94-HB standard is studied.

Keywords: polymer materials, flammability, fire-retardant fillers, flame retardants, oxygen index, flame propagation velocity, UL94-HB standard.

Problem formulation. Today to increase fiberglass products exploitation safety, they are subjected to rather stringent requirements for their performance characteristics, including their combustibility.

Polymers combustibility (tabl. 1) determined with high content of carbon and hydrogen in their macromolecules. On heating above destruction temperature macromolecules easily disintegrate into low-molecular saturated and unsaturated hydrocarbons, which undergo exothermic oxidation reactions.

Tabl. 1. Flammability characteristics of some polymeric materials

Material	Pyrolysis products	Combustion gas	$T_{comb.}$, °C (ASTM 1929-68)	Oxygen index, % (ASTM 2863-76)
Polyolefines	Olefin, paraffin, alicyclic restsof hydrocarbon	CO, CO_2	343	17,4
Polystyrene	Monomers, dimers, styrene terpolymer	CO, CO_2	360	18,3
Polyacrylates	Monomers	CO, CO_2	338	17,3
Polyvinyl-chloride	HCl, aromatic hydrocarbon	HCl, CO, CO_2	454	47 (self-extinction)
Polycarbonate	CO_2, phenol	CO, CO_2	482	27 (self-extinction)

The nature of most polymer materials is such that they can't be made completely fireproof. It can only reduce their ability to ignite and sustaincombustion.In accordance with [2] methods for polymer materials combustibility reducing, can be conventionallydivided into four groups:

1. Fire protection with the use of flame-resistant materials (fireproof coatings);

2. Introduction of fillers;

3. Introduction of flame retardants or fire-retardant agent compounds;

4. Polymeric materials modification.

So, in work [3] various kinds additives application and their influence on polymers fire danger indicators is considered. It is shown that in introducingfillers and flame retardants into the polymer binder, it is possible to obtain a material with significantly reduced fire hazard indices.

According to these sources, the main estimated indicators of polymers fire hazard are materials ignition temperature and oxygen index.

By the oxygen index(OI) value materials divided into:

1) noncombustible, OI ≥ 75%;

2) hardlycombustible, OI=50-70%;

3) combustible hardlyinflammable(self-extinction), OI=27-50%;

4) combustible, OI = 20-26%;

5) combustible highly inflammable, OI< 20%.

However, modern standardization causes transition to international standards, one of which is the UL-94 standard. According to it flammability is determined by the alphabet letters A (hardly combustible), E (short-term ignition resistance) and F (materials not resisting ignition).The flammability is also estimated from flame spread speed along a horizontally arranged sample.

Thus, fire hazard indicators reduction according to international standards on various types of flame retardants application in polymer binders is one of the problems in this area.

Analysis of recent research and publications. Latest researchers and publications analysis determined, that of various fillers and flame retardants use within the range of 15-90% (by weight) makes it possible to achieve an oxygen index of 27%, which corresponds to the “self-extinguishing” polymer.

Thus, polyoxymethylene and polyethylene combustibility (OI) dependence on fillers concentration ($Al(OH)_3$, Al_2O_3) was investigated in [4]. It was found that using these excipients, the OI can reach values equal to 70% (with input components content up to 90% by mass parts). In this case, inert fillers are the most accessible for use, and also applicable for virtually any polymer materialstype.

By using active compounds, such as silicon- and phosphorus- containing compounds [5-7], the limit of “self-extinction” (OI=27%) is with content in polymer is up to 15% (by mass parts) is reached. However, their use is possible for a limited area of polymer materials.

As a polymeric materials flame retardants, various intumescent compositions are also used [8-10]. But their use is impossible in construction plastics due to the bloating effect, i.e. constructiondestruction under fire.

In all the above-listed works, the polymeric materials fire hazard was evaluated only by standard methods (oxygen index and ignition temperature values), however, none of the UL-94 parameters was investigated.

Thus, solving the problems of reducing the polymers fire danger indicators, it becomes necessary to consider the inert fillers amount effect on their fire hazard, namely –flame spread speed along a horizontally arranged sample.

Statement of the problem and its solution. The objective of this paper is to determine percentage content of $Al(OH)_3$ and Al_2O_3influence on flame spread speed according to UL94-HB – Plastic material. Test method.

In polymeric materials samples, according to [4], inert fillers were introduced until reached the "self-extinguishing limit", in which self-combustion is impossible (fig. 1).

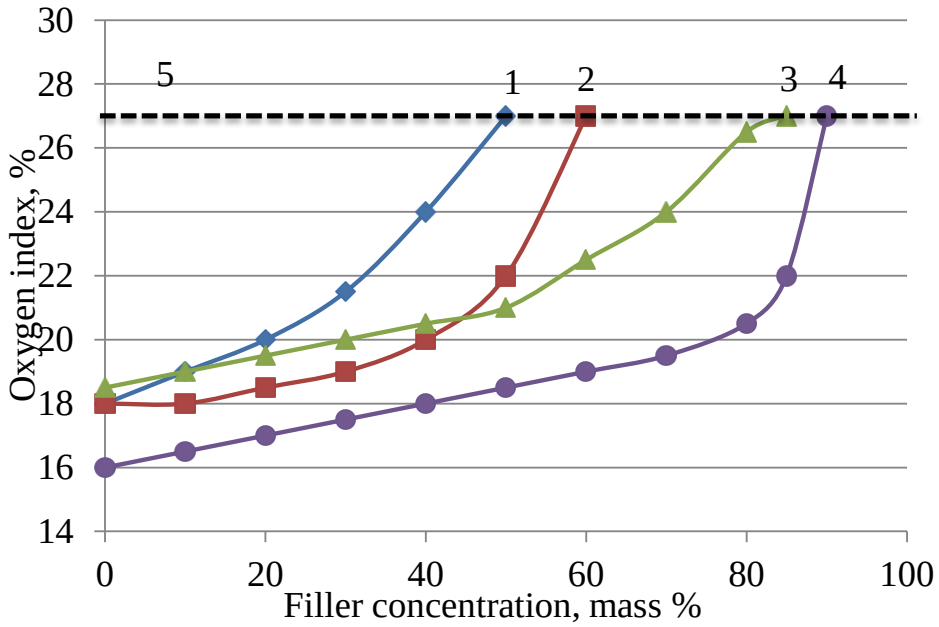

Fig. 1. Dependence of polystyrene (1, 3) and polyethylene (2, 4)oxygen index on $Al(OH)_3$ (1, 2) Al_2O_3 (3, 4)concentration. The straight line 5 corresponds to the so-called "self-extinguishing" material (OI=27)

Flame spread speedresearch according to UL94-HB, similar to [5], conducted on a horizontally placed sample 10 mm thick (fig. 2).

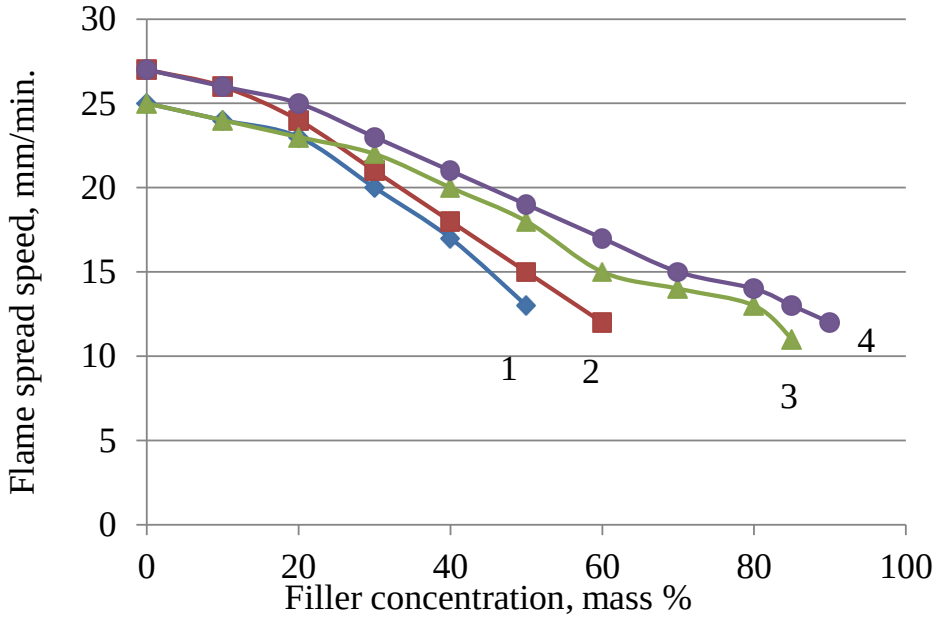

Fig. 2. Dependence of flame spread speedon a horizontally located sample according to UL94-HB for polystyrene (1, 3) and polyethylene (2, 4) on $Al(OH)_3$ (1, 2) Al_2O_3 (3,4)concentration

The gas burner, which providedsample ignition was located at angle of 45° for 30 seconds or until the flame spreded through the sample by 25 mm. During the tests, distance traversed by combustion front and time were registered. The results were recorded in mm / min.

The analysis of fig. 2 shows that use inert fillers for polymeric materials flame retardant in range of"self-extinguishing limit" allows to reduce the flame spread speed in 2,25÷2,45 less. This effect is due to bound water content in aluminum oxides and hydroxides.Their destruction is accompanied by phase transitions, which affects flame spreadspeed over the flame-retardant material.

Conclusions. On the example of fireproof polyesters and polystyrene, effect of polymer material filling degree on change values of the linear flame spreadspeed along their surface is shown. It is shown that using inert fillers in range of"self-extinguishing limit", a decrease offlame spreadspeed along them to 44% is achieved.

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Оцінка ефективності вогнезахисту полімерних матеріалів шляхом застосування різних добавок

Проведений аналіз використання різних вогнезахисних добавок для зниження горючості полімерних матеріалів. Встановлено, що основним показником, який використовується для оцінки вогнезахисту є значення температури спалахування та кисневий індекс. Досліджено вплив вмісту інертних наповнювачів на швидкість розповсюдження полум'я у відповідності до стандарту UL94-HB.

Ключові слова: полімерні матеріали, горючість, вогнезахисні наповнювачі, антипірени, кисневий індекс, швидкість розповсюдження полум'я, UL94-HB.

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Оценка эффективности огнезащиты полимерных материалов путем применения различных добавок

Проведен анализ использования различных огнезащитных добавок для снижения горючести полимерных материалов. Установлено, что основными показателями, используемыми для оценки огнезащиты являются значения температура воспламенения и кислородный индекс. Исследовано влияние содержания инертных наполнителей на скорость распространения пламени согласно стандарту UL94-HB.

Ключевы еслова: полимерные материалы, горючесть, огнезащитные наполнители, антипирены, кислородный индекс, скорость распространения пламени, UL94-HB.