NON-HALOGEN BASED FLAME-RETARDANTS

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Symmary: Admixtures containing no halogens can be classified as new admixtures that enhance flame proofness of polymer materials and meet modern requirements for environment protection. Boron compounds are widely used in cellulose-based materials (especially, in heat-insulated materials).

The use of borates as combustion retarders (CR) is reduced to several compounds. These are boric acid and borax, some diborates and orthoborates of I-IV metal groups, barium diborates, and mainly zinc borates such as $2ZnO{\cdot}3B_2O_3{\cdot}3,5H_2O$ (2·3·3,5), which under the brand name *Firebrake* is widely used as a synergetic admixture to halogen-containing CRs and antimony oxides for flame protection of polyvinylchloride, polyether, polyolefin, rigid polyurethane. Zinc borate 2·3·2 as well as $Zn_3(BO_3)_2{\cdot}3,5H_2O$ and $ZnO{\cdot}B_2O_3$ are also used as synergetic admixtures to polyamides. All these admixtures are effective only in the presence of halogen-containing compounds. The most widely used is zinc borate 2·3·3,5. Two more zinc borates 4·1·1 and 4·1 are used as CRs. These compounds are stable at high temperatures: the first are stable up to 415 °C, the latter up to 550 °C. Yet, they are effective only in the presence of halogens and antimony oxides.

An admixture of a new zinc borate 3·5·14 ($3ZnO{\cdot}5B_2O_3{\cdot}14H_2O$ trizinco decaborate tetradecahydrate) has been developed. It is a white crystalline substance resembling very small needles. It is poorly soluble in water with hydrolysis, but dissolves congruently in boric acid solutions: 0.83 g/l in 3% H_3BO_3 and 1.68 g/l in 5% H_3BO_3 (at 25 °C); in diluted HCl it dissolves with decomposition. A method for the zinc borate 3·5·14 production has been developed with the product output of 90%. The method involves also recycling of forming waste waters. Zinc borate 3·5·14 can be identified from the data of chemical and X-ray phase analysis (the most intensive reflexes in debyegram are Å:9.591(10); 6.689(10); 2.49(9); d_{20} – 2.49 g/cm^3).To invent CRs for polymer materials produced at high temperatures, a zinc borate 3·5·1 ($(3ZnO{\cdot}5B_2O_3{\cdot}H_2O)$ has been synthesized. Zinc borates 3·5·14 and 3·5·1 have been tested as CRs for alkyd varnishes. A 5% admixture of zinc borate 3·5·14 retards combustion and inflaming of wood samples, eliminates decay (the flammability rate is 0.18 due to the Latvian Standard LV-238-2005). The concentration of zinc borate 3·5·14 of 12-20 kg/m^3 in wood greatly reduces mass losses at combustion (by 5-15%); at a concentration 4-19% of zinc borate 3·5·14 in cellulose sulfate the oxygen coefficient (OC) significantly increases (by 31-56%). Zinc borate 3·5·14 and ammonium-zinc decaborate $(NH_4)_2ZnO5B_2O_310H_2O$ have occurred effective CRs for polyamide fibres. At the 20% concentration of CR in polymers, flameproof polycaproamides with OC > 27.6% (State Standard 21.044-89) have been produced. The typical formulation of water-dispersive paints for foam coverings foresees the exchange of toxic chloroparaffin (4.6%) for zinc borate 3·5·14 (5%). For a better effect, an admixture of zinc borate 3·5·14 was modified by calcium carbonate (5%) and by magnesium hydroxide (5%). The mass loss in wood samples (150x60x30) was 2.5-3.93% due to the standard LV-238-2005. Non-toxic CDs, i.e., zinc borates 3·5·14 and 3·5·1, are effective in the absence of toxic halogens and antimony oxides and can be used for the production of ecologically safe systems of combustion retarders.

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