Polymers based on aryloxycyclotriphosphazenes with mixed functional groups

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Relevance of the topic. The development of modern technology requires the creation of more advanced polymers and materials based on them, with improved mechanical, physicochemical, dielectric, optical and other properties. Among such polymers, epoxy oligomers are of great importance, which are widely used as binders for the production of structural materials for various purposes, paint coatings, casting compounds, dielectrics and for other purposes. However, the main disadvantages of epoxy resins are the low thermal stability of products based on them and flammability. Currently, two main approaches are used to eliminate these shortcomings: the introduction of various modifiers (fire retardant fillers) and the synthesis of more heat-resistant and non-flammable epoxy binders.

Degree of topic development. Recently, at the Department of Chemical Technology of Plastics of the Russian Chemical Technical University named after. DI. Mendeleev developed simple and effective methods for the synthesis of phosphazene-containing epoxy oligomers (PEO) characterized by increased heat resistance and limited flammability. However, to regulate these and other properties, in particular, to achieve complete non-flammability of oligomers, it was necessary to improve existing methods for the synthesis of both oligomers and new polymers based on them.

The purpose of this work. The overall goal of this dissertation was to improve methods for the synthesis of phosphazene oligomers containing combinations of various functional groups in aryloxy radicals bound to phosphorus atoms - allylic, methyl carboxylate, carboxyl, epoxy, as well as to establish optimal ways to obtain fire-resistant or completely non-flammable polymer compositions with increased heat resistance on their basis.

Work tasks. Achieving this goal required solving the following tasks:

Establishing the possibility of using a previously developed one-pot method for the synthesis of oligophosphazene epoxides to obtain oligomers with mixed functional groups.

Identification of the influence of various factors on the yield and composition of the resulting mixed hydroxyaryloxycyclotriphosphazenes.

Finding optimal conditions for the epoxidation of intermediate phosphazene-containing polyphenols.

Establishment of the composition of phosphazene epoxides and conditions for their curing using DSC and thermogravimetry methods.

Scientific novelty.

1. Previously undescribed mixed aryloxycyclotriphosphazenes containing allyl, epoxy, 4-methylcarboxylate and carboxyl groups in aryloxy radicals attached to phosphazene rings were synthesized and characterized. It has been established that the hydrolysis of 4-methylcarboxylate and oxidation of allylic groups in these compounds occur without destruction of the phosphazene ring.

2. A method has been developed for the synthesis of oligomers with eugenol and epoxydiane substituents containing individual compounds with one, two and three epoxy groups.

3. The effectiveness of carboxyl-containing aryloxyphosphazenes as hardeners for both conventional epoxy oligomers (ED-20) and phosphazenes has been shown, and in the latter case completely non-flammable compositions containing at least 8% phosphorus are formed.

Theoretical and practical significance.

An unusual fact of inversion of the thermal effect of curing of phosphazene-containing epoxides with carboxyphenoxycyclotriphosphazenes was discovered, which is of theoretical interest.

Synthesized phosphazene-containing oligomers have reduced flammability or are completely non-flammable and can be used to obtain composite materials for various purposes.

Provisions to be defended:

1. Synthesis of mixed functional oligoaryloxycyclotriphosphazenes.

2. Phosphazene-containing epoxy oligomers based on diphenylolpropane.

3. Properties of synthesized oligoepoxyphosphazenes.

4. Optimization of technology for the synthesis of epoxyphosphazenes with mixed functional groups.