Fire and explosion hazard of a number of naphthoquinone diazide photoresists

Shushpanov Alexander Nikolaevich

Annotation

A wide range of solid organic compounds, which are used in both chemical and related industries, contain explosive groups in the structure, so they can significantly affect the fire and explosion hazard of the substances. Critical conditions may occur at the production site and at the end customer during transportation and storage. One or another effect in such conditions (increased temperature, the occurrence of a source of ignition initiation, the sudden occurrence of local heating points in the substance due to impact or friction) can potentially cause these substances to behave like explosives or their intermediates.

The present study focuses on naphtoquinone diazides (NQD) and photoconductive substances made on their basis. The compounds described in this paper are of great interest from the point of view of high-tech industries (microelectronics etc). These compounds have an explosiphoric diazide group in their structure inside an energetically active quinondiazide structure, and the end products carry several such groups at once, which significantly increases the potential for fire and explosion hazard of such compounds. The study of the thermal and mechanical stability, kinetic parameters and fire and explosion hazard characteristics of such substances can not only provide useful information for industrial safety in the production sector, protecting both experimental and large-scale production, but also open the way to potentially new research.

Scientific novelty

In this work, for the first time, thermal analysis was carried out for five substances, their behavior was studied when heated both in an oxidizing atmosphere (air) and in an inert atmosphere (helium or nitrogen). For all substances, the values of the onset temperature of exothermic decomposition were established for the first time.

For four substances, the kinetic parameters of the initial stage of thermal decomposition have been determined for the first time and has been made an assumption about its mechanism.

For five substances, the values of exothermic effects of the initial stage of thermolysis were calculated for the first time.

For all substances, indicators of fire and explosion hazard in the state of airgel and aerosol have been determined for the first time.

It is shown that the laws of the classical theory of thermal explosion are applicable to calculate the flash points of three substances.

Using the critical pressure method and the GOST 4545-88 method, it is shown that three substances are sensitive to mechanical influences.

For five substances, the enthalpies of formation and heat of combustion were obtained for the first time by calculation methods.

Theoretical and practical value

In the theoretical aspect, this work studies previously unexplored or insufficiently learned properties of compounds - thermal stability, sensitivity to mechanical stress, kinetic parameters of the decomposition of these substances; a number of important indicators of fire and explosion hazard are determined for the first time in the research.

The results of studies on thermal decomposition and fire and explosion hazard obtained in the course of work were transferred to the manufacturer to create technological regulations for the production of the studied compounds in terms of safe operating modes of equipment and safe operation of production, establishing and clarifying categories of industrial buildings for fire and explosion hazard, explosion hazard categories of technological units, which is confirmed by the act about implementation.

Key points for the thesis presentation:

Results of calculation and experimental studies of fire and explosion hazard properties of five compounds.

Results of studies of substances by methods of thermogravimetry and differential thermal analysis.

Results of experimental studies of the kinetic parameters of thermal decomposition of five compounds.

The results of calculating the value of the exothermic effects of the initial stage of thermolysis of substances.

The results of calculating the thermodynamic parameters of combustion and explosion for three substances using the Real program.

Results of calculating the flash points for three substances using the laws of the theory of thermal explosion.

Calculation of enthalpies of formation and heats of combustion of five substances, carried out using additive calculation methods, as well as the program for semiempirical quantum calculations MOPAC2016.

Results of studies of substances for sensitivity to impact.