THE KNOWLEDGE BASE FOR DEFINITION OF CHARACTERISTICS OF THE CONDENSED COMBUSTION PRODUCTS

Valery A. Babuk, Alexander N. Ivonenko
Baltic State Technical University
1, First Krasnoarmeyskaya Str., St.-Petersburg, 190005, Russia

Metal fuel (as a rule, aluminium) is an indispensable component high-energy solid rocket propellants. A consequence of usage of this component is formation the condensed combustion products (CCP). Properties of these products make essential impact on quality of system propellant-motor. They define intensity of slag-formation in the chamber, intensity of interaction of combustion products with motor elements, and also level of losses of a specific impulse.

Formation CCP is carried out directly at a surface of burning propellant. Evolution of these products as a part of a stream of combustion products takes place further. It is possible to assert that the propellant composition makes essential impact on properties CCP and quality of propellant is defined, including, and characteristics of these products.

Despite numerous attempts of mathematical modeling of formation process of the condensed products at a surface of burning propellant, the problem of forecasting of CCP properties depending on parameters of propellant composition and burning conditions is not solved by this time. The situation is in many respects similar to a situation with modeling of burning process and forecasting of the law of burning rate: numerous works are performed on modeling of burning process; however the results used for practical purposes obtain only at carrying out of experimental works.

Told above has allowed to draw a conclusion on expediency of use of approaches of the theory of expert systems for definition (estimation) of characteristics CCP. In framework of the present work the knowledge base of system of decision-making on properties CCP depending on parameters of propellant composition and conditions of its burning is developed. The carried out work is based basically on the results obtained in BSTU.

The condensed products are delivered from a surface burning of propellants in a gas phase as two fractions: agglomerates and smoke oxide particles (SOP). Obtaining of the following information for description of CCP is expedient.

1. Fraction of metal fuel participating in agglomeration process.
2. Functions of size distribution density of agglomerates and SOP.
3. Mass fraction of oxide in agglomerate.
4. Type of agglomerates.

Properties of CCP are defined by characteristics of a surface layer of burning propellant which in turn define laws of processes as agglomerations, and formation smoke oxide particles. It is possible to allocate depending on factors of propellant composition some types propellants, which have relatives laws of formation of a surface layer, and, hence, and CCP.

1. Propellants on the basis of inactive binder, micro-sized aluminium and oxidizers: ammonium perchlorate, ammonium dinitramide, nitramines.
2. Propellants on the basis of active binder, micro-sized aluminium and oxidizers: ammonium perchlorate, nitramines.

PDF created with pdfFactory trial version www.pdffactory.com

3. Propellants on the basis of inactive binder, micro-sized aluminium and oxidizers: ammonium nitrate, ammonium perchlorate.

4. Propellants on the basis of inactive binder, nano-sized aluminium and oxidizers of a various kind.

The estimation of required characteristics CCP can be carried out for the specified types of propellants. This estimation is based on use of some procedures: formalized (model of propellant structure, model size distribution of agglomerates, model of evolution of agglomerating particles) and not formalized (experimental data about characteristics of CCP). These procedures contain in the knowledge base which, besides, contains the information on the assumptions underlying used models, accuracy of obtaining of the experimental information, experimental data of various works.

The system using the knowledge base offers the user the information (characteristics CCP depending on parameters of propellant composition and burning conditions) on which basis the user makes the decision, i.e. system acts in a role of the original expert.

Results of the carried out work can be considered as the contribution to the new approach to creation high-energy propellant.

PDF created with pdfFactory trial version www.pdffactory.com