Publication is available for discussion in the framework of the on-line Internet conference "*Butlerov readings*".
http://butlerov.com/readings/
Submitted on March 24, 2017.

Correlation of physical-mechanical characteristics composition power materials

© **Vladimir N. Popok**
Joint Stock Company "Federal Research and Production Center "Altay".
Socialistic St., 1. Biysk, 659322. Altay Kray, Russia.
Phone: +7 (3854) 30-19-37. E-mail: vnpopok@mail.ru

Keywords: composition power materials, durability, elastic modulus, deformation, the filled compositions, excipients, percolation threshold.

Abstract

The purpose of the present article is a qualitative analysis of correlative ratios between physical-mechanical characteristics of the composition power materials (CPM) of various rated basic compounding at a variation of prescription geometrical factors. Physical-mechanical characteristics of composition power materials (durability σ, elastic modulus E, the ultimate strain of ε, etc.) are formed by a complex physical and chemical properties of components and structure of the filled compositions. The most important geometrical factors of CPM are: structure and properties binding; relation of the common volume ratio of a solid phase (φ) to the maximal filling (φ_m); similar characteristics for separate types of excipients; values of thresholds of a percolation ($\varphi_{кр}$); characteristics of interaction between an excipient and polymeric matrix. Physically reasonable empirical ratios connecting the relative elastic modulus and the relative deformation of the filled compositions with the relative degree of admission of compositions are so far constructed. The normalization of values of the module and deformation is carried out with use of similar characteristics (E_o, ε_o) the baked binding. Strongly non-linear, but the monotonic nature of dependences of E/E_o and $\varepsilon/\varepsilon_o$ from the geometrical factors including the relative degree of admission of φ/φ_m allows to assume the monotonic dependence between an elastic modulus and deformation of compositions of CPM (taking into account influence of content of curing agent and change of dispersion of excipients on condition of φ≈const).

As far as this dependence is unambiguous and steady against change of the listed factors of influence and is a subject of the real work. Also the correlation assessment in couples of variables durability - an elastic modulus and durability deformation of CPM is carried out. It is shown that for the CPM wide group on the basis of inert and fissile binding the unique monotonic are observed with values of coefficients of correlation, high on an absolute value, and determinations of dependence between an elastic modulus and deformation. The received correlations show a perspective of independent regulation of these two characteristics and confirm effectiveness of paths of modification of basic rated compoundings of CPM for ensuring necessary level of physical-mechanical characteristics.

References

[1] L. Nielsen. Mechanical characteristics of polymers and polymeric compositions. *Moscow: Chemistry*. **1978**. 311p. (russian)
[2] V.V. Moshev, A.L. Svistkov, O.K. Garishin, etc. Structural mechanisms formation of mechanical characteristics of granular polymeric composites. *Ekaterinburg: Publishing house UO RAN*. **1997**. 508p. (russian)
[3] A.S. Ermilov, E.M. Nurullaev. Mechanical properties of elastomers filled with solid particle. *Mechanics of Composite Materials*. **2012**. Vol.48. No.3. P.243-252.
[4] K. Matous, H.M. Inglis, X. Gu, D. Rypl, T.L. Jackson, P.H. Geubelle. Multiscale modeling of solid propellants: From particle packing to failure. *Composites Science and Technology*. **2007**. Vol.67. P.1694-1708.
[5] V.N. Popok, N.I. Popok. Percolation in composition power materials. Characteristics of combustion, ignition and sensitivity of mixes to mechanical influences. *Butlerov Communications*. **2014**. Vol.39. No.8. P.1-16. ROI: jbc-02/14-39-8-1

[6] S. Gallier. Heterogeneous solid propellants: from microstructure to macroscale properties. *Progress in Propulsion Physics*. **2011**. No.2. P.21-34.

[7] V.N. Popok, V.N. Khmelev. Composite condensed chemical fuels on the basis of ammonium nitrate. Principles of configuration and property. *Biysk: Publishing house of the Altai State Technical University*. **2014**. 222p. (russian)

[8] Solid Propellant Selection and Characterization. *Space Vehicle Design Criteria Monograph. NASA SP-8064*. **1971**.

[9] Power condensed systems. Short encyclopedic dictionary. Under the editorship of the academician B. P. Zhukov. *Moscow: Janus K*. **1999**. 596p. (russian)

[10] A.S. Ermilov, E.M. Nurullaev. Energy of the mechanical destruction of an elastomer filled with solid particles. *Mechanics of composite materials*. **2015**. Vol.50. No.6. P.757-762.

[11] T.L. Smith, W.H. Chy. Ultimate tensile properties of elastomers. *Journal of Polymer Science. Part A-2*. **1972**. Vol.10. No.1. P.133-150.

[12] A.S. Yermilov, E.M. Nurullayev. Concentration dependence of strengthening of rubbers and rubbers dispersible excipients. *Journal of Applied Chemistry*. **2012**. Vol.85. No.8. P.1371-1374. (russian)

[13] E.M. Nurullayev, A.S. Yermilov. Definition composition of composite material on a desired value of energy to break. *PNRPU bulletin. Space Technique*. **2015**. No.41. P.173-183. (russian)

[14] L. Nielsen. Composite Materials. Properties as Influenced by Phase Geometry. *Springer – Verlag – Berlin*. **2005**. 263p.

[15] E.M. Nurullayev, A.S. Yermilov, N.Yu. Lyubimova. Optimization composition of the filled three-dimensionally sewed rubber used in space technique according to mechanical characteristics. *PNRPU bulletin. Space Technique*. **2016**. No.46. P.160-171. (russian)

[16] S. Behera. Effect of RDX on Elongation Properties of AP/HTPB Based Case Bonded Composite Propellants. DRDO Science Spectrum, March **2009**. P.31-36.

[17] C.W. Hughes, J.H. Godsey, R.F. Keller. High energy propellant. *US Patent № H1341*. **1994**.

[18] G. Perrault, R. Lavertu, J.-F. Drolet. High-energy explosives or propellant composition. *US Patent № 4289551*. **1981**.

[19] K. Menke, P.B. Kempa, T. Keicher. High Energetic Composite Propellants based on AP and GAP/BAMO Copolymers. *39th International Annual Conference of ICT (Karlsruhe Federal Republic of Germany)*. **2008**.

[20] T. Keicher, W. Kuglstatter, S. Eisele, T. Wetzel, H. Krause. Isocyanate-Free Curing of Glycidyl Azide Polymer (GAP) with Bis-Propargyl-Succinate (II). *Propellants, Explosives, Pyrotechnics*. **2009**. Vol.34. P.210-217.

[21] I.V. Borodachev, E.V. Volkhonskaya, Yu.V. Hooke, etc. Dee - N-oxides of dinitriles of dialkylbenzene as the low-temperature hardeners of rubbers with small unsaturation. Way of receiving di-N-oxides of dinitriles of dialkylbenzene. *Russian Federation patent № 2042664*. **1992**. (russian)

[22] Lu Gong-Lian, Du Lei, Zhang Xiao-Ping. Design of the Self-Assembled Monolayer on Aluminum Powder Surface to Improve the Mechanical Properties of NEPE Propellant. *39th International Annual Conference of ICT (Karlsruhe Federal Republic of Germany)*. **2008**.

[23] V.M. Zinovyev, G.V. Kutsenko, A.S. Yermilov. High-energy excipients of solid rocket fuels and other high-energy condensed systems. Physical-, thermochemical characteristics, receiving, application. *Perm: PSTU publishing house*. **2011**. (russian)

[24] G.N. Amarantov, E.A. Novotochinov, Yu.T. Odintsov, S.V. Eryshkanov, V.M. Zinovyev, D.S. Gurov. The forecast change of mechanical characteristics of power condensed systems at the long-lived operation executed by means of an assessment of change structural characteristics of polymeric binding. *PNRPU bulletin. Space technique*. **2015**. No.41. P.157-172. (russian)