Manufacturing of propellant grains for solid rocket motors using additive technology

© S.S. Kurdov, V.E. Zavolokin, M.A. Komkov

Bauman Moscow State Technical University, Moscow, 105005, Russia

The paper considers the development of a propellant grain with the maximum cross-section curvature for SRM, which would provide maximum SRM thrust. However, modern propellant grain production technologies cannot enable the production of complex cross-section propellant grains due to existing geometrical and structural parameters of the fuel. It sidelines modern space engineering. Additive technologies make it possible to produce complex curve shaped items. The development of 3D-printer capable of printing the propellant grain for SRM would allow producing SRM with different power characteristics depending on customer's preferable tasks. In our work we introduce a new technology for producing the propellant grain for SRM. Moreover, we describe some fundamental principles and potential problems of producing 3D-printer for printing the propellant grain for SRM. We also suggest the ways to solve the problems and give the printer conceptual image and its hardware flowchart. In order to carry out tests on fine-tuning technologies of printing the relevant propellant grain, we analyze a specific model of the propellant grain for SRM. Finally, we propose other fields of application for the high-energy propellant grain technology.

Keywords: *solid rocket motor, additive technology, 3D-printer, rocket-space engineering, rocket-space technology, mixed fuel*

REFERENCES

[1] Jones R. Hybrid Rocket Engines Use Additive Manufacturing to Combine the Advantages of Solid and Liquid Propellants. *Stratasys*. Available at: http://www.stratasys.com/resources/case-studies/aerospace/rocket-crafters (accessed January 10, 2017).

[2] Yagodnikov D.A., Andreev E.A., Eykhenvald V.N., Kozlov V.A. *Osnovy proektirovaniya raketnykh dvigatelnykh ustanovok na tverdom toplive* [Design principles of solid fuel rocket propulsion systems]. Moscow, BMSTU Publ., 2009, 168 p.

[3] *Fused deposition modeling (FDM).* Available at: https://en.wikipedia.org/wiki/Fused_deposition_modeling (accessed January 10, 2017).

[4] *Karamelnoe raketnoe toplivo* [Caramel rocket fuel]. Available at: https://ru.wikipedia.org/wiki/Карамельное_ракетное_топливо (accessed January 10, 2017).

[5] Sidorov O.I., Poisova T.P., Khayrullin Z.Ya., Parshina E.I., Metelev A.I., Samoylenko A.F., Milekhin Yu.M., Merkulov V.M., Banzula Yu.B., Kapitonov A.V., Parfenova N. N. *Sposob izgotovleniya prochnoskreplennogo s korpusom raketnogo dvigatelya zaryada smesevogo raketnogo tverdogo topliva* [Method of manufacturing a firmly fastened rocket-motor case rocket engine of composite propellant grain propellant]. Patent RF, no. 2008129339/02, 2009, bul. no. 33, 13 p.

Kurdov S.S., student, Department of Rocket and Space Engineering Technologies, Bauman Moscow State Technical University, engineer, Design Bureau Salyut.
e-mail: ksylvestr@yandex.ru

Zavolokin V.E., student, Department of Rocket and Space Engineering Technologies, Bauman Moscow State Technical University; technical interpreter, equipment specialist, Robert Bosch Ltd. e-mail: valdman8@mail.ru

Komkov M.A., Dr. Sc. (Eng.), Professor, Department of Rocket and Space Engineering Technologies, Bauman Moscow State Technical University. Research interests include technology of space-rocket engineering. e-mail: cm12@sm.bmstu.ru