INVESTIGATING THE THERMOHYDRAULIC EFFICIENCY OF THE LIQUID-PROPELLANT ROCKET ENGINE POROUS TRACT OF COOLING WITH THE INTERCHANNEL COOLANT FLOW

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Abstract

We have developed a method of estimating thermohydraulic efficiency of the cooling tract. In order to obtain the values of thermohydraulic characteristics and conduct further thermohydraulic efficiency research we tested the model element of the porous cooling tract with the interchannel coolant flow as part of the laboratory practicum at the premises of the laboratory research stand. Combustion products of the 76% ethanolaqueous solution with the air of 700…1000 °C temperature were used as a working medium, and industrial water and air were used as a coolant. The thermohydraulic efficiency of the porous tract in the applied processing and evaluation method upon the heat pickup maximum criterion under otherwise equal conditions is about 0,4…0,7,it grows with increase of number Re and more actively in the laminar region. High efficiency is registered on trials on the water (in the laminar region). It is also established that the efficiency improvement can be achieved by applying more thermally conductive porous materials and by advances in the porous netting material manufacturing technology as well as in the procedure of the coolant feed and withdrawal.

Keywords

Thermohydraulic efficiency, porous tract, liquid-propellant rocket engine cooling, thermal protection

References

[1] Demyanko Yu.G., Konyukhov G.V., Koroteev A.S., Kuz'min E.P., Pavel'yev A.A. Yadernye raketnye dvigateli [Nuclear jet engines]. Moscow, OOO “Norma-Inform” publ., 2001, 415 p.

[2] Kalinin E.K., Dreytser G.A., Yarkho S.L. Intensifikatsiya teploobmena v kanalakh [Intensification of heat exchange in channels]. Moscow, Mashinostroenie publ., 1990, 206 p.

[3] Aleksandrenkov V.P. Study of efficiency of intensifying heat emission in the ring channel with central heat supply. *Vestn. Mosk. Gos. Tekh. Univ. im. N.E. Baumana, Mashinostr.* [Herald of the Bauman Moscow State Tech. Univ., Mechan. Eng.], 2012, no. 4, pp. 43–50.

[4] Aleksandrenkov V.P. To issue of estimating the efficiency of application of the porous mesh material in ring heat exchange channel. *Vestn. Mosk. Gos. Tekh. Univ. im. N.E. Baumana, Mashinostr.* [Herald of the Bauman Moscow State Tech. Univ., Mechan. Eng.], 2011, spec. iss. “Energetic and transport mechanical engineering”, pp. 179–185.

[5] Pelevin F.V., Avraamov N.I., Semenov P.Yu. Recuperative heat exchanger for fuel-tank pressurization of liquid rocket engine. *Inzhenernyy vestnik* [Engineering Bulletin], 2014, no. 10. URL: http://engbul.bmstu.ru/doc/740030.html.

[6] Kudryavtsev V.M., ed. Osnovy teorii i rascheta zhidkostnykh raketnykh dvigateley. V 2 kn. [Theory and calculation fundamentals of liquid rocket engines. In 2 vols.]. Moscow, Vysshaya shkola publ., 1993.

[7] Aleksandrenkov V.P., Moshik T.M. Issledovanie effektivnosti razlichnykh sposobov intensifikatsii teplootdachi v trakte okhlazhdeniya ZhRD v unifitsirovannykh peremennykh [Research in normalized variables on effectiveness of different ways of heat exchange intensification in coolant passage of liquid rocket engine]. *Aktual'nye problemy rossiyskoy kosmonavtiki. Materialy XXXIX Akademicheskie chteniy po kosmonavtike* [Actual problems of Russian cosmonautics. Proc. XXXIX Academic readings on cosmonautics]. Moscow, 2015, RAS commission publ.

[8] Kirillov P.L., Yur'yev Yu.S., Bobkov V.P. Spravochnik po teplogidravlicheskim raschetam (yadernye reaktory, teploobmenniki, parogeneratory) [Handbook on thermohydraulic calculations (nuclear reactors, heat exchangers, steam generators)]. Moscow, Energoatomizdat publ., 1990, 360 p.

[9] Mikheev M.A. Osnovy teploperedachi [Fundamentals of heat exchange]. Moscow, Energiya publ., 1977, pp. 388–393.

[10] Aleksandrenkov V.P., Metodicheskie ukazaniya k domashnemu zadaniyu po distsipline «Teplozashchita i prochnost' konstruktsiy ZhRD» [Methodology instructions to the homework on "Thermal protection and structural toughness of liquid rocket engine". Moscow, 2012, Bauman Press, 2012, 74 p.

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