EVALUATION OF AFTERCOOLER PERFORMANCE FOR GROUND TESTS OF ROCKET ENGINES FOR ORBITAL BOOSTERS

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Abstract: The physical and mathematical model describing heat and mass transfer in dense gas suspensions of water droplets in decelerated high-temperature combustion products of rocket fuel, allowing the characteristics of the aftercooler for ground tests of rocket engines for orbital boosters to be estimated, has been developed. Numerical calculations showed that the use of water sprays with drops of 0.5–0.2-millimeter radius with load factor from 5 to 8 kg/m^3 makes it possible to reduce the pressure and temperature of the combustion products of hydrogen–oxygen rocket engine in an aftercooler from 0.6 to 0.03–0.05 atm and from 2700 to 300–360 K, respectively, for a time period ranging from 10 to 50 ms. These estimates are obtained under the assumption of a spatially uniform distribution of water droplets in the aftercooler volume without regard for such effects as velocity slip between phases, as well as deformation and fragmentation of droplets in the gas stream. It is expected that with these effects taken into account, the length of the aftercooler should not exceed 3 to 8 m.

Keywords: high-altitude test facility; hydrogen–oxygen rocket engine; aftercooler; water sprays; cooling and condensation of water vapor; theoretical model; performance estimation

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