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COMBINED PRESSURIZATION SYSTEM AND GAS-REACTIVE CONTROL SYSTEM OF THE REUSABLE STAGE OF THE LAUNCH VEHICLE

Abstract

The application of an oxidizer (O) fuel tank pressurization system for launch vehicles (LVs) with a liquid rocket engine (LRE) was carried out. The O tank is pressurized with a vapor-gas mixture obtained from mixing cold helium gas and hydrogen peroxide decomposition products. The chamber for mixing hydrogen peroxide decomposition products and helium pressurizing gas is located in the O tank. According to preliminary evaluation, the proposed combined pressurization system will reduce the pressurization system design weight and simplify LRE design by eliminating the heat exchanger and feed lines for supplying cold helium gas to the heat exchanger and to the O tank. The controlled heat exchange system based on hydrogen peroxide and cold helium gas can reduce oxygen evaporation into the gas phase. The combined pressurization system has the ability to expand its functions: providing conditions for the LRE launch, ensuring angular maneuvers when the LRE is shut down. There is considerable experience in using hydrogen peroxide on the LVs of "Soyuz" type. The use of the proposed technical solution provides the following advantages (by the example of "Soyuz 2.1v" type LV): a) removal of the helium heat exchanger as part of the LRE, thereby its composition is simplified and its reliability is increased, with the weight of the heat exchanger being $\sim 70-80kg$; b) removal of long high-pressure feed lines from O tank, where spherical helium tanks are stored, to the heat exchanger and back (which mass for the first stage of LV is $\sim 100kg$), which will make the LV stage structure lighter and simpler; c) refusal from the use of an autonomous unit with gas reserve (analogue of "Falcon-9" LV) for angular maneuvers and providing conditions for launching the LRE of the separated first stage to realize soft landing (up to 300 kg); d) the possibility to reduce the technological environmental impact in case of LRE emergency cut-off by controlling the emergency stage descent to the impact areas with minimal environmental damage.