Applying of gas-generating compositions for liquid rockets effectiveness improving

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Residues of unused liquid propellant (up to 3% of initial fueling) cause a range of problems after stop of the main liquid rocket engine (LRE) of space launch vehicles (SLV). If a stage of SLV is left on the orbit after finishing its mission then the presence of unused residues of self-lighting rocket propellant components (RPC) (such as asymmetrical dimethylhydrazine and nitrogen tetroxide) on board can lead to this stage explosion. There are already 160 explosions of rocket stages by now. If the stage of the rocket crashes in falling areas then toxic RPC spills (including kerosene) contribute chemical pollution of soils and water.

Recommendations of international organizations applying reduction of near-Earth space pollution nowadays advise to perform dump of unused RPC residues overboard. Nevertheless, the dump of liquid through discharge valve in space is almost impossible because of discharge valve plugging with "snow" formed of frozen liquid.

Another possible variant of the solution is a hot gas – so-called heat transfer (HT) insertion inside propellant tank that allows propellant residues' evaporation. Obtained gas mixture (HT, tank turbocharge gas residues, evaporated component) can be easily removed from the tank through a discharge valve.

The next step is the following: to use gasified products (not to dump them) in LRE in a process of raising an impulse of stage maneuver performance. For instance, it can be descend of the stage or change of coordinates and scatter of falling points of the stage. Another problem appears then: optimization of realized maneuver. It can be solved by means of increase of energy characteristics of gasification products that flow into the LRE from propellant tanks.

The applying of solid gas-generating composition (SGGC) is offered to obtain HT due to specific features of its combustion products:

- high heat capacity for propellant residue gasification process realization, for example, kerosene, liquefied natural gas, oxygen inside propellant tank);
- ability to have the given gas productivity and temperature at the output; the given combustion rate, that is the given gas release rate;
- no chemical reaction with propellant components till the time of mixture supply into the combustion chamber;
- the maximum specific impulse increase is possible by means of gasification products reaching the LRE from both fuel (pressurized gas in tank + evaporated kerosene + HT gases) and oxidizer tanks (pressurization in tank + evaporated Oxygen + HT gases).

Some variants of possible SGGC are listed:

- several kinds of gunpowder, usual rocket propellants that form hot gases such as nitrogen, CO, water, hydrogen as combustion products – for the fuel tank;
- a variety of already known compositions that generate hot nitrogen or/and oxygen in combustion process – for the oxidizer tank.