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BLACK ENGINE CERAMIC ROCKET PROPULSION

Abstract

Today the field of space transportation becomes of higher interest, considering the growing competition world-wide. Particularly the New Space Companies in the US bring the global space transportation industry under pressure. DLR follows with a new ceramic rocket engine concept the goal of increase of efficiency and reliability. On the other hand weight, cost and operational risk shall be reduced aiming on world-wide competitiveness in the future. Concerning these requirements a specific rocket thrust chamber design, based primarily on the application of transpiration cooled porous and thermo-chemically resistant CMCs as inner combustion chamber liner material, is favored, aiming on the improvement of today's high performance standards, e.g. typical high performance main stage or upper stage propulsion systems. After meanwhile more than twenty years of intensive technology development, DLR offers within its Black Engine technology program a large portfolio of fiber reinforced structure systems for functional components in rocket thrust chambers or entire rocket engines respectively, using additionally CFRP for load carrying structure components or transpiration lubricated CMC journal bearings for lifetime increase of rocket turbo pumps. One major focus lies on high ratio of thermal and mechanical load de-coupling capability, promising rocket engines with lifetime and maintenance standards like aviation engines, which will be a significant progress for very often re-used main stages in the near future. The excellently working exclusively transpiration cooled ceramic rocket thrust chamber system, leads now to further system improvement. First evaluations are ongoing considering a new injection cooling method, where the porous CMC wall takes inherently both the function of cooling and injection. This new method is applied in a brand new design concept, reducing significantly typical pressure loss in the combustion chamber process and promising more than 5 Technology approaches described above are world-wide unique. Established international producers of launcher propulsion systems usually use metal designs today for thrust chambers, just improved by up-coming AM methods to increase manufacturing efficiency. DLR's new system improvements using porous CMCs as key components in rocket thrust chambers as well as CMC journal bearings in rocket turbo pumps predict coming international competitiveness in the field of space propulsion.