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DESIGN OF A NOZZLE FOR SPACE PROPULSION USING GAS CORE NUCLEAR REACTORS OF A LONG RANGE SPACECRAFT: DESIGN PARAMETERS AND CHALLENGES

Abstract

One of the future's promising sources of fuel for long distance space travel is using Gas Core Nuclear Reactor based Rockets (GCNRR). Especially when long distances are involved, Gas Core Based Nuclear systems can provide the necessary specific impulses as well as the power required for the onboard systems. GCNR works when gaseous nuclear fuel is used to heat up liq. H2 which is the propellant. As GCNRR have been tested and found to give very high specific impulse in the magnitude of 750-2500 seconds. Such technology shouldn't be held back, one of the reasons for it is still in design stage is due to absence of complete design parameters such as the UF6 liq. H2 mixing chamber, nozzle design the reactor core design. Given the parameters from the outlet of the mixing chamber on can easily determine the design/dimension of the nuclear reactor core as such. The reactor core needs to be provided with an additional liquid H2 port so that the designed temperature could be maintained in case it surpasses the design limit. The designed core temperature is proportional to the specific impulse. In the core design, the main part that actually contributes to the generation of specific impulse or thrust is the nozzle. Therefore this work is an effort to study the parameters of the gases coming out based on which the rocket nozzle is designed appropriately. A computational approach is adopted to design the nozzle profile based on the output data from the reactor. Software such as ANSYS as well as COMSOL is used to analyze the output of gases from the reactor until the end of the nozzle. Challenges of containing Uranium Hexafluoride, which is a fissionable fuel is also discussed as loss of UF6 would lead to financial loss as well as it would cause drag effect in the nozzle chamber. Most optimal parameters for a nozzle is plotted and discussed for GCNRR in this paper.