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NUCLEAR THERMAL ROCKET WITH FISSILE AND REACTION FUEL FROM LUNAR ISRU

Abstract

A nuclear thermal rocket (NTR) fueling concept is presented for the first time in which the earth-launched components are completely and totally free of radioactive materials. This is a crucial enabler to fast transport around the solar system as it will allay a great many concerns from private citizens and from competing nations. Outlined here is the use of lunar thorium and water ice to provide the fissile uranium and hydrogen reaction mass needed for a high performance NTR capable of reaching Mars or main belt asteroids in four months. In this way, an ordinary machine can be launched from earth, and only fueled when in lunar orbit, far from any concern of radioactive debris falling to earth. Lunar thorium can be concentrated by skull crucible heating because the melting point of thorium dioxide is higher than any other ceramic (3300 K), making it the remainder once the supernatant magma is poured off. Repeat refinements can be used to achieve high purity. The concentrated thorium is readily transmuted by thermal neutrons generated by beryllium when exposed to the high gamma ray flux of outer space, after first being cooled to thermal energies by a graphite moderator. Fertile thorium transmutes to protactinium (Pr91), which can be selectively removed by the THOREX process. This unstable atom decays with a half life of 27 days into U233 which is a fissile isotope with the desirable property of producing short-lived byproducts after being used as a nuclear fuel. Compressed pellets of uranium dioxide are built into fuel rods for suitably-designed NTR system. The hydrogen reaction mass for the NTR can be obtained from water ice harvested in permanently-shadowed regions of the moon and stored in solid-state porous silicon media, a process subject to four US patents. Hydrogen can be stored for extended durations, and released on demand using reactor heat. A portion of the hydrogen fuel can be stored in a two-meter thick shell sections to provide radiation protection for crew. The hydrogen therein could be withdrawn as a back-up supply of fuel, or for a final Hohmann transfer burn just before refueling. With both uranium and hydrogen supplied from the moon, this concept can produce abundant fuel for rapid transport around the solar system without any risk of dispersal of hazardous materials during earth launch. This breakthrough could help usher in a transformative tipping point in the exploration and exploitation of outer space.