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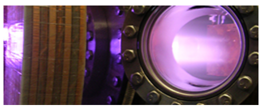

SPACE PROPULSION

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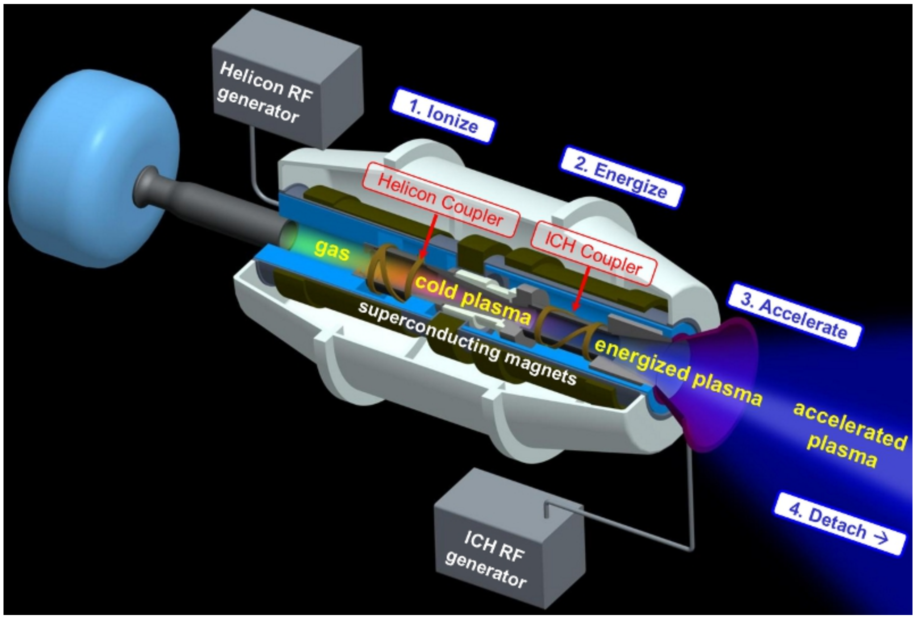
Our Engine

ESPAÑOL

The Variable Specific Impulse Magnetoplasma Rocket (VASIMR®) engine is a new type of electric thruster with many unique advantages. In a VASIMR® engine, gas such as argon, xenon, or hydrogen is injected into a tube surrounded by a magnet and a series of two radio wave (RF) couplers The couplers turn cold gas into superheated plasma and the rocket's magnetic nozzle converts the plasma thermal motion into a directed jet.



Principles of Operation

The primary purpose of the first RF coupler is to convert gas into plasma by ionizing it, or knocking an electron loose from each gas atom. It is known as the *helicon* section, because its coupler is shaped such that it can ionize gas by launching helical waves. Helicon couplers are a common method of generating plasma. After the helicon section, the gas is now "cold plasma", even though its temperature is greater than the surface of the Sun (5800 K). The plasma is a mixture of electrons and ions (the atoms they were stripped from). The newly formed electrons and ions carry charge and may then be contained by a magnetic field shielding the rocket core from the plasma. The second coupler is called the *Ion Cyclotron Heating (ICH)* section. ICH is a technique used in fusion experiments to heat plasma to temperatures on the order of those in the Sun's core (10 million K). The ICH waves push only on the ions as they orbit around the magnetic field lines resulting in accelerated motion and higher temperature.

Thermal motion of ions around the magnetic field lines is mostly perpendicular to the rocket's direction of travel and must be converted into directed flow to produce thrust. The rocket uses a magnetic nozzle to convert the ions orbital motion into useful linear momentum resulting in ion speeds on the order of 180,000 km/hr (112,000 mph).

VASIMR® Engine Compared to Other Electric Thrusters

The VASIMR® engine has three important features that distinguish it from other plasma propulsion systems:

The VASIMR® engine has the ability to more widely vary its exhaust parameters (thrust and specific impulse) in order to optimize mission requirements resulting in the lowest trip time with the highest delivered payload for a given fuel load.

The VASIMR® engine uses electromagnetic (RF) waves to create and energize the plasma within its core. In this way, the VASIMR® engine has no physical material electrodes in contact with the hot plasma. The lack of electrodes results in greater reliability, longer life, and enables a much higher power density than competing ion and Hall thruster.

The VASIMR® engine is able to process a large amount of power, meaning that it can then generate a larger amount of thrust. This larger thrust capability promises to make the VASIMR® engine useful for moving large payloads around low Earth orbit, transferring payloads from the Earth to the Moon, and transferring payloads from the Earth to the outer solar system. The VASIMR® technology is also highly scalable, meaning that higher power versions can be easily designed; making human missions powered by electric propulsion a reality

Power Sources

One of the key challenges in developing the VASIMR® engine is supplying power to it. A high-power electric thruster requires a lot of electricity, and generating that in space may require some engineering innovations. Below is a discussion of two options.

Solar Power

Solar power can be efficiently used for near-Earth VASIMR® missions, such as drag compensation for space stations, lunar cargo transport, and in-space refueling. Recent advances in solar array technology show a significant increase in solar power utilization (up to an order of magnitude).

A solar powered lunar tug concept using two VASIMR® engines.

Nuclear power

A nuclear reactor has a very large amount of energy per unit mass; a reactor core has the highest energy density of any useful energy source on earth. This high energy density and scalability make nuclear reactors an ideal power source in space. A nuclear-electric powered spacecraft could dramatically shorten human transit times between planets and propel robotic cargo missions with a very large payload. Trip times and payload mass are major limitations of conventional and nuclear thermal rockets because of their inherently low specific impulse (less than 1000 seconds). A VASIMR® propelled, nuclear-electric powered spacecraft promises to make fast human missions a reality.

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