Green Design

Power Generator With Thermo-Differential Modules

Lyndon B. Johnson Space Center, Houston, Texas

A thermoelectric power generator consists of an oven box and a solar cooker/solar reflector unit. The solar reflector concentrates sunlight into heat and transfers the heat into the oven box via a heat pipe. The oven box unit is surrounded by five thermoelectric modules and is located at the bottom end of the solar reflector. When the heat is pumped into one side of the thermoelectric module and ejected from the opposite side at ambient temperatures, an electrical current is produced.

Typical temperature accumulation in the solar reflector is approximately 200 °C (392 °F). The heat pipe then transfers heat into the oven box with a loss of about 40 percent. At the ambient temperature of about 20 °C (68 °F), the temperature differential is about 100 °C (180 °F) apart. Each thermoelectric module, generates about 6 watts of power. One oven box with five thermoelectric modules produces about 30 watts.

The system provides power for unattended instruments in remote areas, such as space colonies and space vehicles, and in polar and other remote regions on Earth.

This work was done by John R. Saiz of Johnson Space Center and James Nguyen of Jacobs-Sverdrup. Further information is contained in a TSP (see page 1).

MSC-24268-1

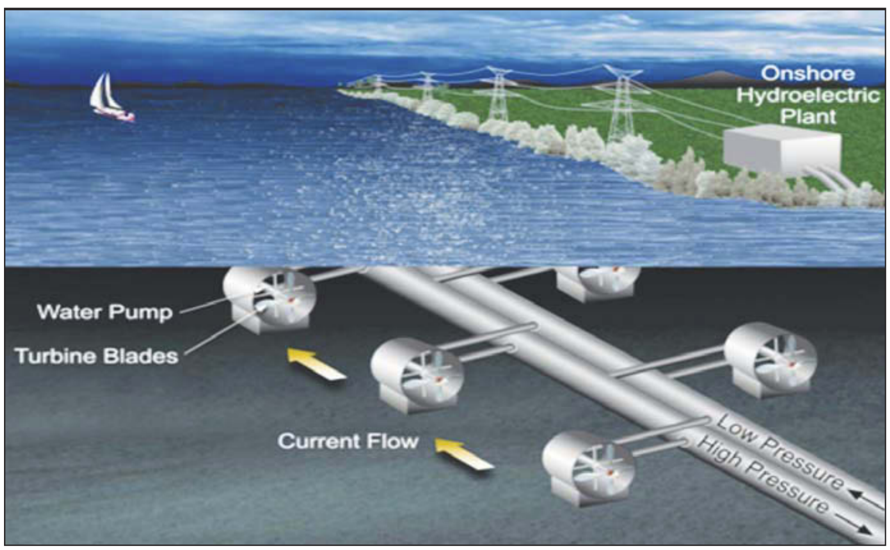
Mechanical Extraction of Power From Ocean Currents and Tides

No electrical equipment would be submerged in the ocean.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed scheme for generating electric power from rivers and from ocean currents, tides, and waves is intended to offer economic and environmental advantages over prior such schemes, some of which are at various stages of implementation, others of which have not yet advanced beyond the concept stage. This scheme would be less environmentally objectionable than are prior schemes that involve the use of dams to block rivers and tidal flows. This scheme would also not entail the high maintenance costs of other proposed schemes that call for submerged electric generators and cables, which would be subject to degradation by marine growth and corrosion.

A basic power-generation system according to the scheme now proposed would not include any submerged electrical equipment. The submerged portion of the system would include an all-mechanical turbine/pump unit that would superficially resemble a large land-based wind turbine (see figure). The turbine axis would turn slowly as it captured energy from the local river flow, ocean current, tidal flow, or flow from an ocean-wave device. The turbine axis would drive a pump through a gearbox to generate an enclosed flow of water, hydraulic fluid, or other suitable fluid at a relatively high pressure [typically ≈500 psi (≈3.4 MPa)].



Turbine Blades Would Intercept Flow in the ocean or other natural body of water. The turbine would drive a pump to obtain a smaller, higher-pressure flow that would be piped to an above-water facility for use in generating electric power.

The pressurized fluid could be piped to an onshore or offshore facility, above the ocean surface, where it would be used to drive a turbine that, in turn, would drive an electric generator. The fluid could be recirculated between the submerged unit and the power-generation facility in a closed flow system; alternatively, if the fluid were seawater, it could be taken in from the ocean at the submerged turbine/pump unit and discharged back into the ocean from the power-generation facility. Another alternative would be to use the pressurized flow to charge an elevated reservoir or other pumped-storage facility, from whence fluid could later be released to drive a turbine/generator unit at a time of high power demand.

Multiple submerged turbine/pump units could be positioned across a channel to extract more power than could be extracted by a single unit. In that case, the pressurized flows in their output pipes would be combined, via check valves, into a wider pipe that would deliver the combined flow to a power-generating or pumped-storage facility.

This work was done by Jack Jones and Yi Chao of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

Innovative Technology Assets Management
JPL
Mail Stop 202-233
4800 Oak Grove Drive
Pasadena, CA 91109-8099
E-mail: iaoffice@jpl.nasa.gov

Refer to NPO-45174, volume and number of this NASA Tech Briefs *issue, and the page number.*

Nitrous Oxide/Paraffin Hybrid Rocket Engines

Thrusts can exceed those of engines that burn HTPB fuels.

Marshall Space Flight Center, Alabama

Nitrous oxide/paraffin (N_2OP) hybrid rocket engines have been invented as alternatives to other rocket engines — especially those that burn granular, rubbery solid fuels consisting largely of hydroxyl-terminated polybutadiene (HTPB). Originally intended for use in launching spacecraft, these engines would also be suitable for terrestrial use in rocket-assisted takeoff of small airplanes. The main novel features of these engines are (1) the use of reinforced paraffin as the fuel and (2) the use of nitrous oxide as the oxidizer.

Hybrid (solid-fuel/fluid-oxidizer) rocket engines offer advantages of safety and simplicity over fluid-bipropellant (fluid-fuel/fluid-oxidizer) rocket engines, but the thrusts of HTPB-based hybrid rocket engines are limited by the low regression rates of the fuel grains. Paraffin used as a solid fuel has a regression rate about 4 times that of HTPB, but pure paraffin fuel grains soften when heated; hence, paraffin fuel grains can, potentially, slump during firing. In a hybrid engine of the present type, the paraffin is molded into a 3-volume-percent graphite sponge or similar carbon matrix, which supports the paraffin against slumping during firing. In addition, because the carbon matrix material burns along with the paraffin, engine performance is not appreciably degraded by use of the matrix.

The use of nitrous oxide as the oxidizer offers the following advantages:

- Because nitrous oxide is non-toxic, the extra precautions for handling of toxic oxidizers are unnecessary.
- Unlike liquid oxygen, nitrous oxide can safely be stored for indefinitely long times under non-cryogenic conditions: for example, it can be stored at 0.7 the density of water at a pressure of 700 psi (≈4.8 MPa) at a temperature of 20 °C.
- Because it can be stored non-cryogenically, nitrous oxide can be stored in a rocket prior to launch, making it possible to launch in less time than would be required if it were necessary to transfer the oxidizer fluid from cryogenic storage.
- Nitrous oxide can serve as its own autogenous pressurant gas, eliminating the need for the high-pressure helium tanks that are necessary for pressurizing propellant fluids in fluid-bipropellant and hybrid rocket engines of prior design. The elimination of the helium tanks and associated plumbing increases reliability while reducing mass and cost.
- Subcooled liquid nitrous oxide could be used as a propellant in upper rocket stages to reduce upper-stage engine masses and thereby enable increases in payloads. Alternatively, subcooled nitrous oxide could be used with oxygen pressurant to increase the specific impulses achievable at given tank weights.

Another advantage is the potential to use nitrous oxide as a monopropellant, in place of hydrazine. Although the specific impulse achievable by use of nitrous oxide is somewhat lower than that achievable by use of hydrazine, cost would be reduced and safety enhanced by elimination of the toxic hazard posed by hydrazine.

Yet another alternative would be to utilize catalytic decomposition of nitrous oxide in a monopropellant reactor to effect a hybrid ignition system. The exhaust of a nitrous oxide from a monopropellant reactor is a 2:1 N_2/O_2 mixture at a temperature of 1,200 °C. This exhaust can be used to ignite a hybrid propellant as many times as desired, making it possible to restart a stopped hybrid rocket engine.

This work was done by Robert Zubrin and Gary Snyder of Pioneer Astronautics for Marshall Space Flight Center.

For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32542-1.