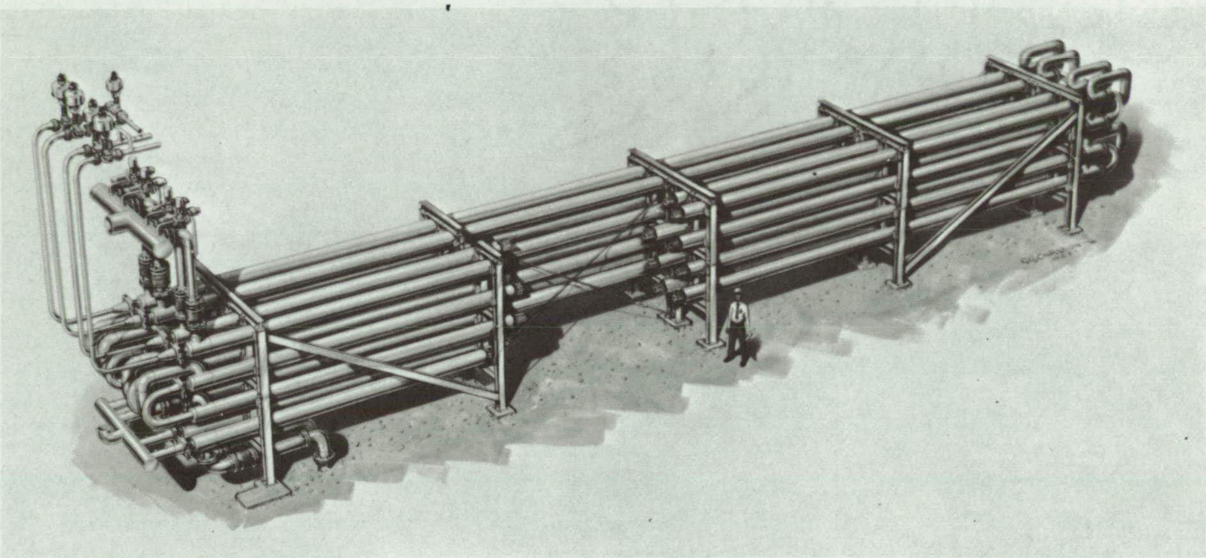
AEC-NASA TECH BRIEF

The Water-Cryogen Heat Exchanger



The problem:

Development of the nuclear rocket has required the conversion of an enormous quantity of liquid hydrogen into gaseous hydrogen at a very high rate during test runs, using heat for the transformation. Typically, 300,000 gallons of LH_2 had to be converted in one hour, which meant that in each second 8 gallons had to be raised from a temperature of −422°F to +50°F. This involved a total heat flux exceeding 77,000 Btu per second. No commercial vaporizers existed which approached this capacity. Even aircraft jet engines were inadequate at this demand rate, and were also undesirable because of cost and complexity.

The solution:

Design of the first known cryogenic heat exchanger in which water is used as the heating medium.

How it's done:

The exchanger consists of 4 identical units, manifolded for parallel operation. Each unit is 80 feet long, and consists of concentric pipe which is looped into 4 passes, providing a 320 foot run per pass. The outside pipe forms a water jacket, while the inside pipe, made of specially extruded aluminum, carries the hydrogen.

The key to the system involves preheating 100,000 gallons of water using a small propane burner, which brings the water to +200°F in one week. For the test run this reservoir is "dumped" into the heat exchanger at 748 lb/sec. Because of the exchanger manifolding and pipe size, the water pressure drop is under 5 lb; water temperature after converting the hydrogen is +80°F. In 4 years of usage the exchanger has been cycled several hundred times without a significant

(continued overleaf)

problem. Contrary to expectation, no ice clog has ever occurred. After one 45-second water valve failure, ice had not even formed half-way across the water jacket cross section.

Applications of this principle become increasingly attractive as the volume of liquid to be converted is increased, since commercial vaporizers are used for lesser amounts. Prototype analysis, supported by full-size construction and use, indicates that scaling presents few problems. One possible usage lies in the treatment of liquified natural gas in cities, so that gas can be brought on-line quickly during rush hours. Other uses could include LOX and LN_2 conversion for steel mills, high volume inert purging in many commercial processes, and oceanographic installations.

Note:

Inquiries concerning this innovation may be directed to:

Technology Utilization Officer
AEC-NASA Space Nuclear Propulsion Office
U.S. Atomic Energy Commission
Washington, D.C. 20545
Reference: B70-10591

Patent status:

No patent action is contemplated by AEC or NASA.

Source: Keith Boyer, John R. Bartlit, and Kenneth D. Williamson of Los Alamos Scientific Laboratory under contract to Space Nuclear Propulsion Office (NUC-11029)