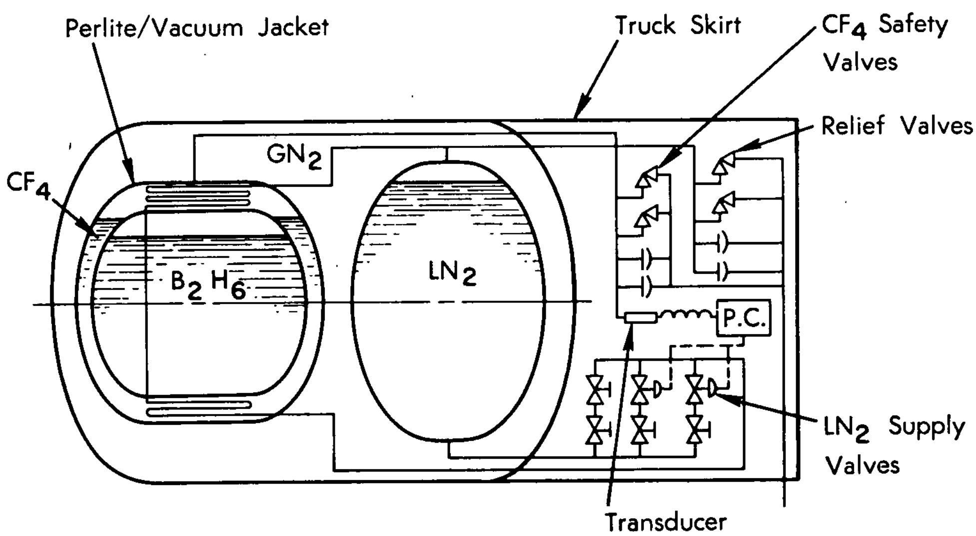
NASA TECH BRIEF
Ames Research Center

Safe Transport of Diborane in a Dual Refrigerant System — A Concept

The problem:

Diborane, B_2H_6, has valuable applications as a fuel for deep-space propulsion systems; however, it is difficult to transport, store, load, or drain in any appreciable quantity because of its pyrophoricity, toxicity, and high vapor pressure. At dry-ice temperature (194°K), diborane has a vapor pressure of 200 kN/m^2 (29 psia); storage of B_2H_6 is therefore more hazardous than storage of subcooled liquids under helium.



A system for safely transporting large amounts of diborane was required because current regulations permit shipment only in 18-kg (40-lb) containers packed in dry ice. When large quantities must be used, the contents of a series of small containers are transferred to a storage tank and then piped to the point of use. The small capacity of the shipping containers precludes direct loading or unloading of spacecraft propulsion modules that have propellant loads in excess of 272 kg (600 lb). Additionally, a separate drain unit of at least 318-kg (700-lb) capacity is required for disposal of contaminated fuel, or transfer of fuel from one storage tank to another.

The solution:

A mobile transport system, that can be carried by truck and parked in a storage area; the system consists of an inner container capable of holding 363 kg (800 lb) of diborane and an external, dual refrigeration unit which uses liquid nitrogen and Freon-14.

(continued overleaf)

How it's done:

The suggested design for the transport and storage system is illustrated schematically in the diagram (fill-lines, vacuum systems, etc. are not shown). The system consists of two refrigerant tanks enclosed in an evacuated steel container with 80-mesh perlite as an internal insulator. The primary refrigeration tank contains liquid nitrogen (LN_2) held at about 92°K by 310-kN/m^2 (45-psig) backpresure relief valves. The secondary refrigeration tank holds Freon-14 and surrounds the diborane tank as a thermal shield to control temperatures over the range from solid to liquid diborane (92° to 156° K).

In operation, a pressure controller compares the ullage pressure of the Freon-14 tank with the desired setpoint pressure (temperature) and opens or closes the LN_2 supply valve to the refrigerating coil in the Freon tank as required to maintain the set vapor pressure. The setpoint dial is calibrated in temperature units rather than pressure. In the vicinity of 92°K, the change in saturation temperature is 3 degrees per psia (0.44 degree per kN/m^2) vapor pressure change; temperature control with an accuracy of ±3° may be possible.

Liquid nitrogen at 92°K is above the freezing point of Freon-14; thus, Freon acts as a passive heat transfer medium and thermal shield. For simplicity, LN_2 flow is by gravity only. Heat of vaporization is absorbed in the Freon tank at a temperature difference of about 85°; the gaseous nitrogen then superheats to 139°K as it passes to the ullage coil and exhausts into the nitrogen tank vent line.

Notes:

1. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)
   Reference:
   NASA CR-109833 (N70-27095), Prelaunch Operations for a Space Storable Propellant Module.
2. See also Tech Briefs B72-10276 and B72-10278.
3. No additional documentation is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: B72-10277

Patent status:

No patent action is contemplated by NASA.

Source: Gordon R. Stone of
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