NASA TECH BRIEF

Lewis Research Center

Liquid Methane Gelled with Methanol and Water Reduces Rate of Nitrogen Absorption

Gelation of liquid methane by injecting either water or methanol particles has been shown to be a satisfactory method for reducing the rate of nitrogen absorption in subcooled liquid methane to an insignificant value. Adding less than 1.5 weight-percent water or methanol reduces the nitrogen absorption rate to the low value. Increased specific fuel consumption will not be excessive due to the gelant required.

Liquid methane is of interest as a jet-engine aircraft fuel because of its greater heat sink capacity and greater heat of combustion as compared with conventional fuels. One method of preventing boiloff at altitude is to subcool the liquid methane; however, subcooled methane can dissolve prohibitive quantities of nitrogen or air. Sealing the subcooled methane tanks to exclude air results in a vapor pressure in the tank at ground level that is less than atmospheric pressure. As a result, the tank walls tend to collapse. Pressurizing the ullage space in the tank with a noncondensable, nonreacting gas eliminates the collapsing load. Helium, hydrogen, and neon are gases relatively insoluble in liquid methane, and can be used to pressurize the tanks; however, helium and neon are relatively expensive, and hydrogen is hazardous. Therefore, means for reducing the rate of nitrogen solubility in subcooled liquid methane are being investigated.

One approach to limiting the quantity of pressurant nitrogen or air that is dissolved in the liquid methane is gelation. Gelation decreases the rate at which these gases dissolve in the liquid by limiting the mass transfer mechanisms in the liquid phase to a diffusion mechanism.

The gelling of liquid methane with water or methanol accomplished a significant reduction in nitrogen solubility for greater than ten hours. A typical nitrogen absorption rate for ungelled liquid methane at 97K and one atmosphere partial pressure of nitrogen is 3 gm/cm^2 of surface/hour; while with 1 weight percent water as gelant, the value is reduced to 0.034 $gm/cm^2/hr$; and with 1 weight percent methanol as gelant, the value is reduced to 0.045 $gm/cm^2/hr$.

Gelation is accomplished by the dilution of the gelant vapor with an inert carrier gas such as helium or with methane. The gaseous mixture is injected through a heated tube and orifice directly into the liquid methane so that condensation occurs immediately within the bulk of the liquid. The direct dispersion of the particles in the liquid avoids condensation of particles on the walls of the vessel and eliminates the necessity of additional mixing normally required to produce a gel.

Notes:

1. In addition to reducing the dissolution of pressurant gases by the gelled liquid methane, the gel structure provides positional stability in the tanks and reduces sloshing.
2. Similar techniques can be used with other semi-cryogenic liquid hydrocarbons to accomplish the same purposes. This information should be of interest to shippers of liquified natural gases.
3. 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-72876 (N71-25772), Investigation of the Suitability of Gelled Methane for Use in a Jet Engine.
4. Technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B72-10330

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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