NASA TECH BRIEF

Propellant Tank Pressurization Analysis Program

The problem:

To produce a mathematical model of a tank pressurization system which includes many pertinent physical phenomena previously ignored in other models.

The solution:

A program for the analysis of a single propellant tank pressurization system.

How it's done:

To predict pressurization performance adequately the following phenomena have been considered.

Propellant Tank

1. Heat transfer between the gas and the walls, between the liquid and the walls, between the liquid and the gas, between the walls and the insulation, and between the insulation and the ambient.
2. Mass transfer within the gas space and at the gas–liquid interface.
3. Circulation within the gas and liquid spaces.
4. Venting of gas from the propellant tank.
5. Propellant tanks of circular or annular cross section, with radius an arbitrary function of axial distance.
6. Variation of gas density with temperature and pressure.
7. Variation of gas, liquid, wall, and insulation thermodynamic and transport properties with temperature and/or pressure.

Gas Storage Tank

1. Heat transfer between the gas and the wall and between the walls and ambient.
2. Variation of gas density with temperature and pressure.
3. Variation of gas and wall thermodynamic properties with temperature and/or pressure.

Pressure Regulator

The regulator set (or sense) pressure is a function of the regulator position; i.e., the pressure regulator is nonisochronous.

Ambient

The ambient heat transfer coefficient and temperature are functions of time and axial position for the propellant tank, and are functions of time only for the gas storage tank.

The propellant tank gas and liquid space, including walls and insulation are divided into nodes. A difference technique is used to perform the heat and mass transfer calculations which involves computation of evaporation or condensation rates, gas space mole fraction and temperature distributions. The propellant tank pressure and the pressurant temperature and flowrate are computed from the propellant tank requirements and the characteristics of the gas storage bottle (if any) and heat exchanger (if any), subject to limitations imposed by the maximum and minimum effective areas of the pressure regulator and the characteristics of the gas lines.

Notes:

1. This program is written in Fortran IV and MAP for use on the IBM 7094 computer.
2. This program can be used for analysis, simulation, and design of propellant pressurization systems.
3. Inquiries concerning this program may be made to:

   COSMIC
   Computer Center
   University of Georgia
   Athens, Georgia 30601
   Reference: B67-10625

Patent status:

No patent action is contemplated by NASA.

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