NASA TECH BRIEF
Manned Spacecraft Center

Optimization of Fluid Line Sizes with Pumping Power Penalty IBM-360 Computer Program

The problem:

Calculations for determining the optimum size of fluid lines are too time consuming to do by hand.

The solution:

A computer program has been developed to calculate and total the weights for tubing, fluid in the tubing, and weight of a fuel cell power source necessary to power a pump based on flow rate and pressure drop.

How it's done:

The larger the tube diameter, the greater the weight of the tube and fluid. For a fixed fluid flow rate, the larger the tube diameter, the lower the fluid pressure drop, and, consequently, the lower the pumping power and weight of the electrical power supply. The greater the flow rate, the higher the pressure drop, the related pumping power required, and the weight of the power source.

Using different stainless steel tubing sizes and flow rates, the systems rates have been calculated for a Shuttle Orbiter water and Freon 21 system. Two different power penalties for pumping power were used in the calculations for all conditions. The optimum water system line size was 1/2 to 5/8 inch (1.26 to 1.59 cm) diameter for a flow rate of 500 lb/hr (227 kg/hr). The optimum Freon 21 system line size was approximately 5/8 to 3/4 inch (1.59 to 1.89 cm) diameter for a flow rate of 1800 lb/hr (817 kg/hr).

This program can be used for fluid systems used in any type of aircraft, spacecraft, trucks, ships, refineries, and chemical processing plants. The weight and the pumping power of the plumbing system can be equated to the cost. The line size can then be optimized relative to weight or cost.

Notes:

1. This program was developed using the FORTRAN IV language to be utilized on the IBM-360 computer. It can be used on any computer that has a F-IV compiler.
2. Inquiries concerning this program should be directed to:

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   112 Barrow Hall
   University of Georgia
   Athens, Georgia 30601
   Reference: MSC-17930

Source: Donald Jelinek of
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