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Prediction of Performance of Centrifugal Pumps During Starts Under Pressure

Pressure-drop characteristics of centrifugal pumps during pressurized start-up have been studied analytically and a method for calculating start-up characteristics has been developed.

In the development of chemical and nuclear rocket engine systems, it is necessary to know system performance not only at the design point but also in a wide range of the off-design conditions. The need for this information is particularly severe in the case of engine systems where the hydraulic losses in the pump during start-up affect the engine transient characteristics. Prediction of the off-design operation of these pumps is difficult because of the lack of information on hydraulic losses at the discharge of centrifugal impellers and at the entrance to the diffusers.

The method developed was based on the analysis both of work done on the pump's impeller and of the hydraulic losses within a pump when it is subjected to flow forced by a pressurized tank.

Calculations of start-up characteristics were based on: (1) the pump geometry including blade angles, (2) the design-point flow, speed, and pressure rise, and (3) the pump characteristic in a range within approximately 10 percent of the design-point flow.

Values were calculated for three pump configurations and compared with experimental data. Test data available for two pumps with vaned diffusers verified the analytical method quantitatively. In the third case, a pump with a vaneless diffuser, the procedure was verified qualitatively.

An empirical correction factor based on an analytical extrapolation of the data from the pump's

high-speed characteristic was used to adjust the analytical equations for the generally unknown losses due to the mismatch of flow and blade angles at the entrance of the diffuser.

The close agreement of calculated and experimental performance points verified the analytical method. The study demonstrated that it is possible to predict the pressure-drop characteristic of centrifugal pumps with vaned diffusers provided that the high-speed characteristic is known.

Notes:

1. This analytical technique should be of value to the designers and users of centrifugal pumps.
2. Documentation is available from:
Clearinghouse for Federal Scientific
and Technical Information
Springfield, Virginia 22151
Price \$3.00
Reference: TSP69-10263
3. Technical questions may be directed to:
Technology Utilization Officer
Lewis Research Center
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No patent action is contemplated by NASA.

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