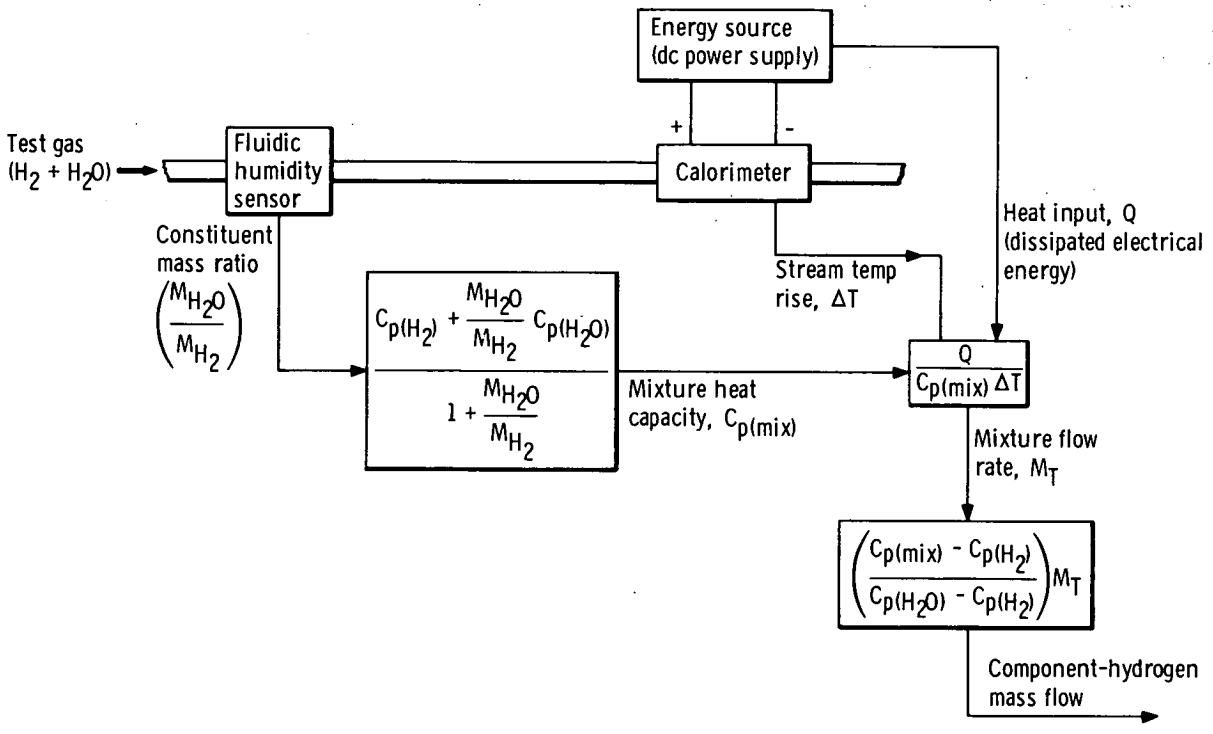
November 1973 B73-10230

NASA TECH BRIEF

Lewis Research Center

Fluidic Device for Measuring Constituent Masses of a Flowing Binary Gas Mixture

Instrument Schematic



The Problem:

To measure the constituent mass flows of hydrogen and water vapor in a flowing binary gas mixture.

The Solution:

A device consisting of a fluidic humidity sensor and a specially designed flow calorimeter. The calorimeter provides readings of the gas stream temperature rise produced by a measured amount of heat that is dissipated into the gas stream, and the humidity sensor is used to obtain a continuous calculation of the specific heat capacity of the gas mixture. Calculations of the total mass flow and the component flow rates of the gas stream are then obtained by applying the measured values in the general definitions of specific heat capacity and the heat capacity of the gas mixture.

How It's Done:

The humidity sensor is used to detect the mass ratio of the binary gas stream. The main element of the sensor is a fluidic oscillator and its operation is described in the first report referenced below.

(continued overleaf)

The flow calorimeter is designed to introduce a metered amount of heat into the flowing gas stream and measure the resultant temperature rise of the gas stream. The design consists of an electrical heating element and thermocouples to measure the stream temperature rise immersed in the gas stream in a thermally isolated volume. The construction of the calorimeter is described in the second report referenced below.

A schematic block diagram of the instrument is shown in the figure. The output of the humidity sensor is the mass ratio of the constituent gases. Values for the mixture heat capacity are obtained from the values of mass ratio. The calorimeter provides values for the amount of heat input, Q, and the resultant stream temperature rise, ΔT. Using these values in the equation for specific heat capacity, values are calculated for the total and component mass flow rates of the binary mixture.

Tests of the instrument indicated an accuracy of ±2 percent over a significant flow range (Reynolds number in the calorimeter exit tube ranged from 1240 to 5540). The dynamic characteristic of the device was determined by testing its response to a step in the flow rate of a hydrogen test stream and found to have a time constant of approximately 4.5 seconds.

Notes:

1. This instrument was developed to measure the constituent mass flows of hydrogen and water vapor in a flowing gas stream, however, the principles of the instrument are such that the constituent mass flows of other binary gas flows can be measured in the same manner.
2. Further information is available in the following reports:

   NASA TM-X-1269 (N66-33487), Use of a Fluidic Oscillator As A Humidity Sensor for a Hydrogen-Steam Mixture

   NASA TM-X-2741 (N73-18445), A Fluidic Device for Measuring the Constituent Masses of a Flowing Binary Gas Mixture

   Copies may be obtained at cost from:

   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B73-10230
3. Specific technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B73-10230

Patent Status:

NASA has decided not to apply for a patent.

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