# NASA TECH BRIEF

*Lewis Research Center*



## Probe Measures Gas and Liquid Mass Flux in High Mass Flow Ratio Two-Phase Flows

### The problem:

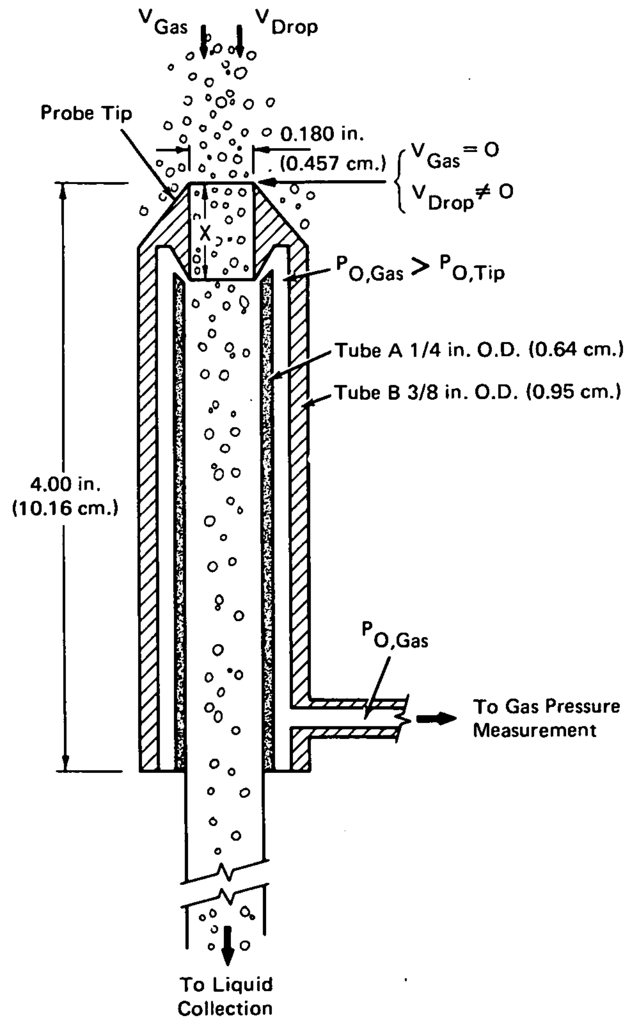
Conventional deceleration probes used for determining gas velocity and liquid mass flux in two-phase flow fields operate successfully only in low mass flow ratio flow fields where the ratio of droplet flow rate to gas flow rate is less than 0.3. Also, probes with external pressure tubes near the probe tip create local disturbances in the flow field which cause errors in the pressure measurement, and the probes are subject to flooding.

### The solution:

A deceleration probe constructed of two concentric tubes with a separator inlet operates successfully in flow fields where the ratio of droplet flow rate to gas flow rate ranges from 1.0 to 20, and eliminates the problems of local flow field disturbances and flooding.

### How it's done:

A schematic drawing of the concentric tube two-phase probe is shown in the figure. The tip attached to tube B is designed to prevent the passage of droplets (termed flooding) into the annulus formed by tubes A and B when the probe is utilized in mass flow ratios greater than 1.0.




The operating principle of the concentric tube two-phase impact probe is shown in the figure. The probe decelerates the gas and measures the gas phase stagnation pressure but leaves the flow-field upstream of the probe essentially undisturbed. When the droplets and gas (each at their own velocity) encounter the probe tip, the gas phase is stagnated at the probe tip where the pressure is approximately equal to the gas phase stagnation pressure; hence, the gas phase velocity can be determined. A droplet, due to its higher inertia, passes through the probe tip, decelerates to zero velocity, and is collected in the stagnation chamber formed by tube A for liquid flow rate determination. However, due to momentum exchange between the droplets and the gas, the droplets decelerate to some extent over the distance X, and the gas phase stagnation pressure, $P_0$, measured in the probe annulus, is greater than the true gas phase stagnation pressure, $P_{0,tip}$. The difference between the two pressures can be made small if the distance X is

(continued overleaf)

short, and the over-pressure error can be determined by proper calibration of the probe in known two-phase flow fields.

Mass flux ratio tests have demonstrated that this probe is an effective measurement tool for the characterization of liquid droplet/gas spray fields. It has been used to obtain gas and droplet mass flux information for wide ranges of local mass flux ratios and static pressures. The injected mass flux ratios in these studies varied between 1 and 20, and the static pressure varied between ambient and $787 \times 10^3$ N/m$^2$ (114 psia).

## Notes:

1. The principal advantages of the probe are:
   a. capability for determining gas phase stagnation pressures in high mass flow ratio two-phase flow fields;
   b. elimination of external pressure lines near the probe tip which create local disturbances;
   c. collection of solids or liquids in the stagnation chamber to provide a means for the determination of mean particulate mass flux; and
   d. simple and rugged construction.
2. 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-120819 (N72-21529), Gas-Liquid Space Storable Propellant Performance
3. Technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B72-10546

## Patent status:

NASA has decided not to apply for a patent.

Source: Richard J. Burick of
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