Algorithm Determines Wind Speed and Direction From Venturi-Sensor Data

Speed and direction are calculated from the spatial distribution of pressure readings.

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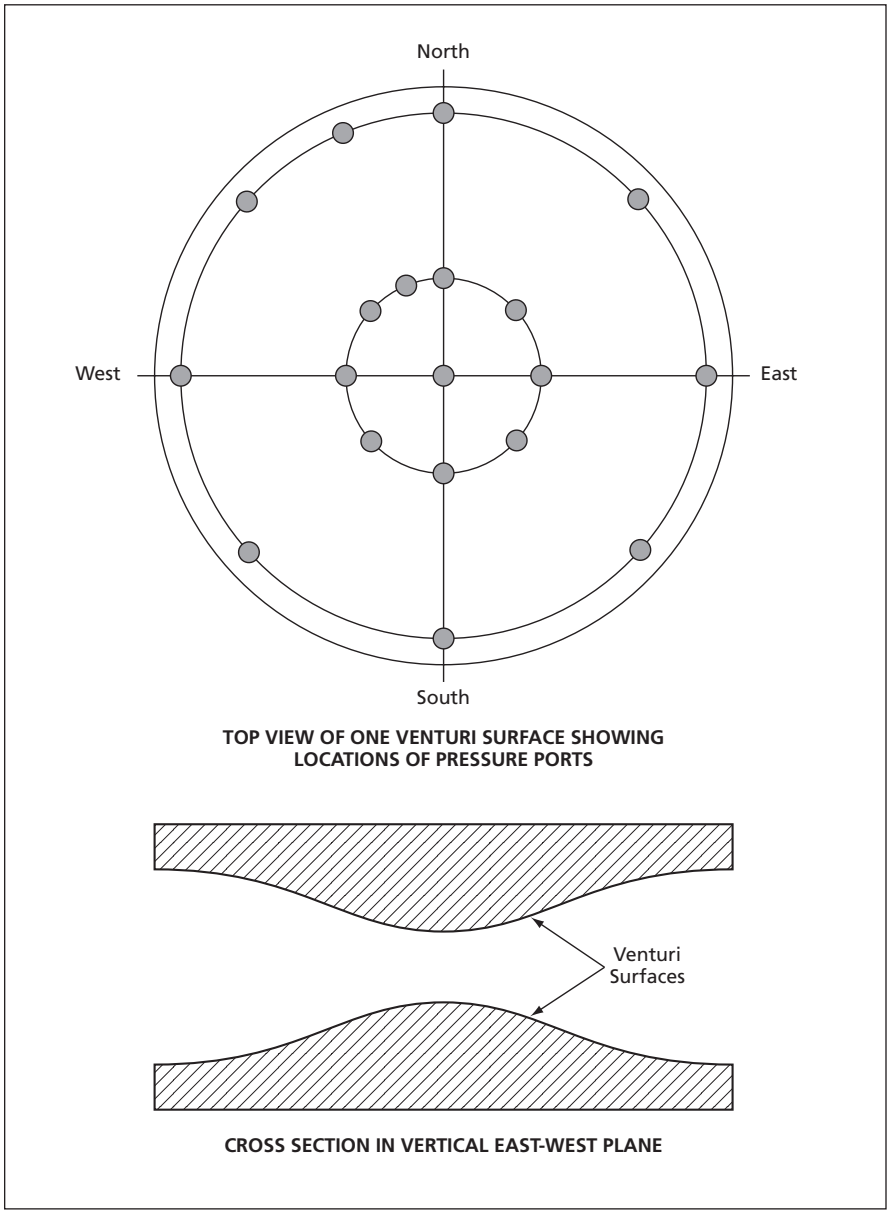
An algorithm computes the velocity of wind from the readings of an instrument like the one described in "Three-Dimensional Venturi Sensor for Measuring Extreme Winds" (KSC-12435), *NASA Tech Briefs*, Vol. 27, No. 9 (September 2003), page 32. To recapitulate: The sensor has no moving parts and is a compact, rugged means of measuring wind vectors having magnitudes of as much as 300 mph (134 m/s). The sensor includes a Venturi gap bounded by a curved upper and a curved lower surface that are axisymmetric with respect to a vertical axis and mirror-symmetric with respect to a horizontal midplane. One of the curved surfaces is instrumented with multiple ports for measuring dynamic pressures (see figure). The sensor also incorporates auxiliary sensors for measuring temperature, relative humidity, and static atmospheric pressure.

The design and operation of the sensor are based on the concepts of (1) using Bernoulli's equation (which expresses the relationship among variations of speed, density, and pressure along a streamline) to calculate the speed of the wind from differences among the pressure readings at the various ports; and (2) calculating the direction of the wind from the angular positions of ports selected according to comparisons among their pressure readings. The present algorithm performs these calculations. Although the algorithm is much too complex to describe here in detail, it is worthwhile to expand on the major underlying physical and mathematical concepts:

- The auxiliary measurements of temperature and relative humidity are used, along with the measurement of static pressure, to calculate the density of air for use in Bernoulli's equation.
- The pressure at the central port on the Venturi surface is always the lowest and is directly related to static pressure and the wind speed by Bernoulli's equation.
- The pressure readings from all the Venturi ports except the central one depend on both the speed and direction of the wind. Some convey more information about speed, while some convey more information about direction. The algorithm combines information from all the readings to resolve uncertainties in calculating the speed and direction.
- Pressures at upwind ports are greater than those at the central and downwind ports. Pressures are lowest at ports located at angular positions orthogonal to the wind. These directional characteristics are utilized to calculate the wind direction to within an angular interval of 45° for the pressure-port arrangement shown in the figure.
- The wind direction can be estimated more accurately by means of a polynomial interpolation from the real pressure readings to a fictitious set of pressure readings at ports in a rotated version of the real pattern of ports.



Pressure Ports at Multiple Locations on a Venturi surface provide samples of the spatial distribution of pressure, which distribution is directly related to the speed and direction of the wind.

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