FLOW MEASUREMENT

The measurement of quantity of flow of fluids is generally accomplished either by making observations on the change of state due to flow system configuration, such as the pressure drop across a metering orifice, or by the displacement of some device, such as a rotating vane system. The selection of the metering system will be determined by the type of fluid, the precision of measurement desired, the cost of equipment and installation, the range of flow quantity, the ease of maintenance, and the method of observation and recording.

Fluid meters may be classified as follows: (1) *Head Meters* (Pressure Sensitive), which may be of *Venturi, flow nozzle, orifice plate,* or *Pitot tube* types; (2) *Area Meters,* which may be of *gate, tapered tube,* or *tapered plug* types; (3) *Force Meters,* which may be of *vane, propellor,* or *turbine* types; (4) *Quantity Meters,* which may be of *weighing tank, reciprocating piston,* or *geared impeller* types.

Rate meters are generally of the first three groups, although rates are

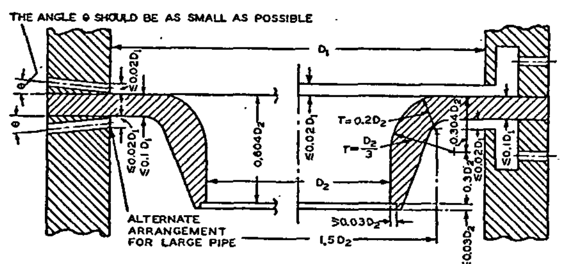

FIG. 8. DIMENSIONS FOR INTERNATIONAL STANDARDS ASSOCIATION FLOW NOZZLE
NOTE: From Reference 3. Used by permission of *A.S.M.E.*

obtainable from timed observations of quantity meters. Similar quantity measurements can be obtained by suitable integration of rate meter indications.

Head Meters

The head meter is of sufficient flexibility so that almost any type of flow measuring problem can be handled. For this reason, standard and reference measurements are usually made in this way. With proper care, extreme precision can be obtained. Also, an inexpensive installation can be made to give moderate precision. In general, a head meter requires fairly competent installation and maintenance to give satisfactory service.

Among the types of head meters, the Venturi has the advantage of having a low pressure loss, but requires considerable length of space. The orifice plate reduces the required length to a minimum at the cost of considerable pressure drop. The flow nozzle represents a compromise, but must be calibrated individually, or made with extreme care from standard specifications, to obtain a good precision of measurement. Standard configurations, for representative orifice plates and flow nozzles, are shown in Figs. 7 and

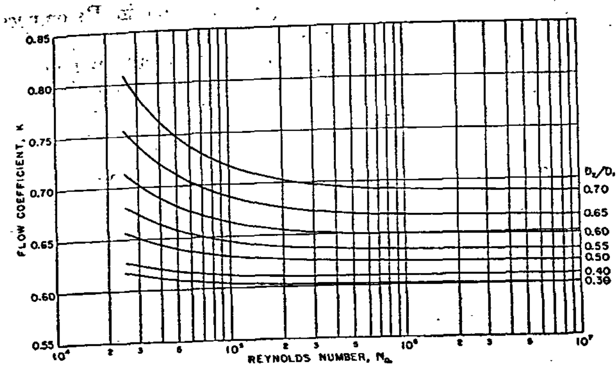

FIG. 9. FLOW COEFFICIENTS, *K*, FOR SQUARE-EDGED ORIFICE PLATES AND FLANGE TAPS IN SMOOTH PIPE
NOTE: From Table 6 of Reference 2.

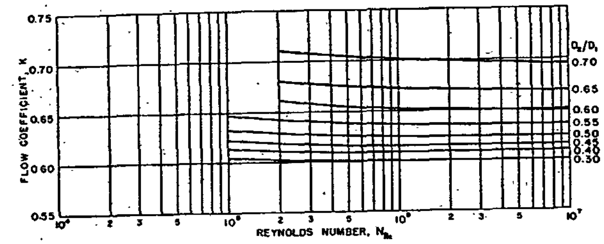

FIG. 10. FLOW COEFFICIENTS, *K*, FOR SQUARE-EDGED ORIFICE PLATES AND RADIUS TAPS IN SMOOTH PIPE
NOTE: From Fig. 36d of Reference 4.

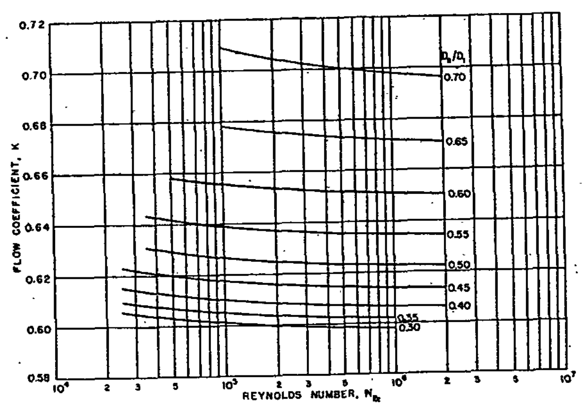

FIG. 11. FLOW COEFFICIENTS, *K*, FOR SQUARE-EDGED ORIFICE PLATES AND VENA CONTRACTA TAPS, IN SMOOTH PIPE
NOTE: From Table 7 of Reference 2.