BUREAU OF INDIAN STANDARDS

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भारतीय मानक मसौदा

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(अनुमानित तरीके)

Draft Indian Standard

METHOD OF FLOW ESTIMATION BY JET CHARACTERISTICS (APPROXIMATE METHODS)

Hydrometry Sectional Committee, WRD01

Last Date for Comments: 24/06/2022

FOREWORD (*Formal clauses of the foreword will be added later*)

This method may be applied for approximately estimating the rate of flow through a horizontal pipe discharging freely into the atmosphere, such as discharge from a pump installed at a tube-well or any other lift pumps.

This standard is one of a series of Indian Standards on methods of measurement in closed conduits. Other standards published so far in the series are given on page 6.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with *IS 2:1960 'Rules for rounding off numerical values (revised)'*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

The composition of the Committee responsible for formulation of this standard is given at Annex A.

Draft Indian Standard

METHOD OF FLOW ESTIMATION BY JET CHARACTERISTICS (APPROXIMATE METHODS)

Hydrometry Sectional Committee, WRD01

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1. SCOPE

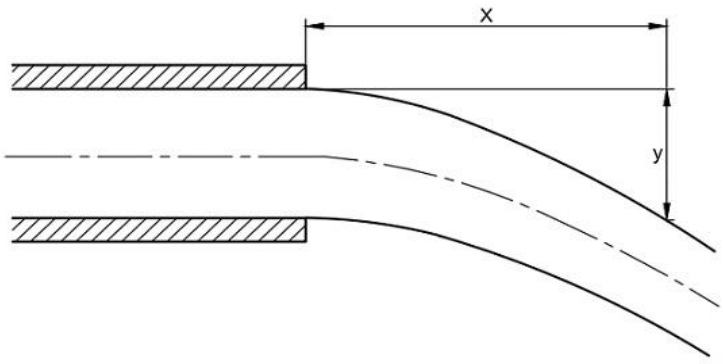
1.1 This standard lays down the procedures for estimation of flow in closed circular horizontal conduits flowing full and freely discharging into atmosphere as a free jet. The characteristics of this free jet are expressed in terms of the vertical drop of the jet over a certain horizontal distance from the free end of the pipe.

1.2 This method should not be used where there is a heavy tendency of jet to disintegrate and when the jet fluctuates violently.

2. PRINCIPLE OF METHOD

2.1 Neglecting the friction due to air, the jet issuing from the pipe takes a parabolic trajectory under the influence of the constant forward momentum flux and the gravitational field. Under these conditions (*see* Fig. 1) it can be shown that the discharge, *Q* in l/min bears the following relationship with the diameter of the pipe d, horizontal distance from the exit end of the pipe *x*, and the drop of the jet, *y* (all in millimetres):

$$\frac{Q}{d^2\sqrt{g}} = K\sqrt{\frac{x^2}{y}}$$



NOTE - It is preferable to avoid any fitting (like flange, coupling) near the end of the pipe; otherwise due correction should be made.

FIG.1 DEFINITION SKETCH

3. GENERAL REQUIREMRNTS FOR MEASUREMENTS

3.1 The pipe shall be flowing full at all times during the measurement and shall discharge freely and steadily into atmosphere.

3.2 The discharge pipe shall be level and shall consist of preferably a straight length of 40 d, subject to a minimum of 10 d upstream of the exit end.

3.3 The internal surface of the pipe shall be clean, free from pitting and deposits and not encrusted.

3.4 The exit end of the pipe shall be in flush with the inner surface of the pipe and its plane parallel to a normal cross-section of the free jet.

3.5 The co-ordinates *x* and *y* shall be measured upstream of the disintegrating region of the jet. Keeping the horizontal distance *x* constant, at least six readings of *y* should be taken at the crest of the jet and the average value should be used to ensure that the deviation in the measurement of discharge to be within ±3 percent.

4. COMPUTATION — QUANTITIES TO BE MEASURED

4.1 Equation — Equation of the type given in 2.1 is considered for finding the volume rate of flow. The constant K in that equation is experimentally found to be 0.573 as against a theoretical value of 0.555 and the equation shall read as:

$$\frac{Q}{d^2\sqrt{g}} = 0.573\sqrt{\frac{x^2}{y}}$$

4.2 Example for the calculation of rate of flow.

4.2.1 Method of application of the equation in 4.1 will be as follows:

Diameter of the pipe = 50 mm

x, Horizontal distance = 400 mm

y, Vertical drop of jet = 170 mm

g, Gravitational constant = 9 800 mm/s^2

Therefore, Volumetric discharge = $0.573\ d^2\sqrt{g}\sqrt{\frac{x^2}{y}} \times 60 \times 10^{-6}\ 1/\text{min} = 264\ 1/\text{min}$

The error in computation of discharges Q arising out of error in measurement of x and y can be computed by using the following formula.

$$\frac{\Delta Q}{Q} = \sqrt{\left(\frac{\Delta x}{x}\right)^2 + \left(\frac{\Delta y}{2y}\right)^2}$$

Where, Δx and Δy are the measurement errors in x and y respectively while ΔQ is the computed error in discharge Q.

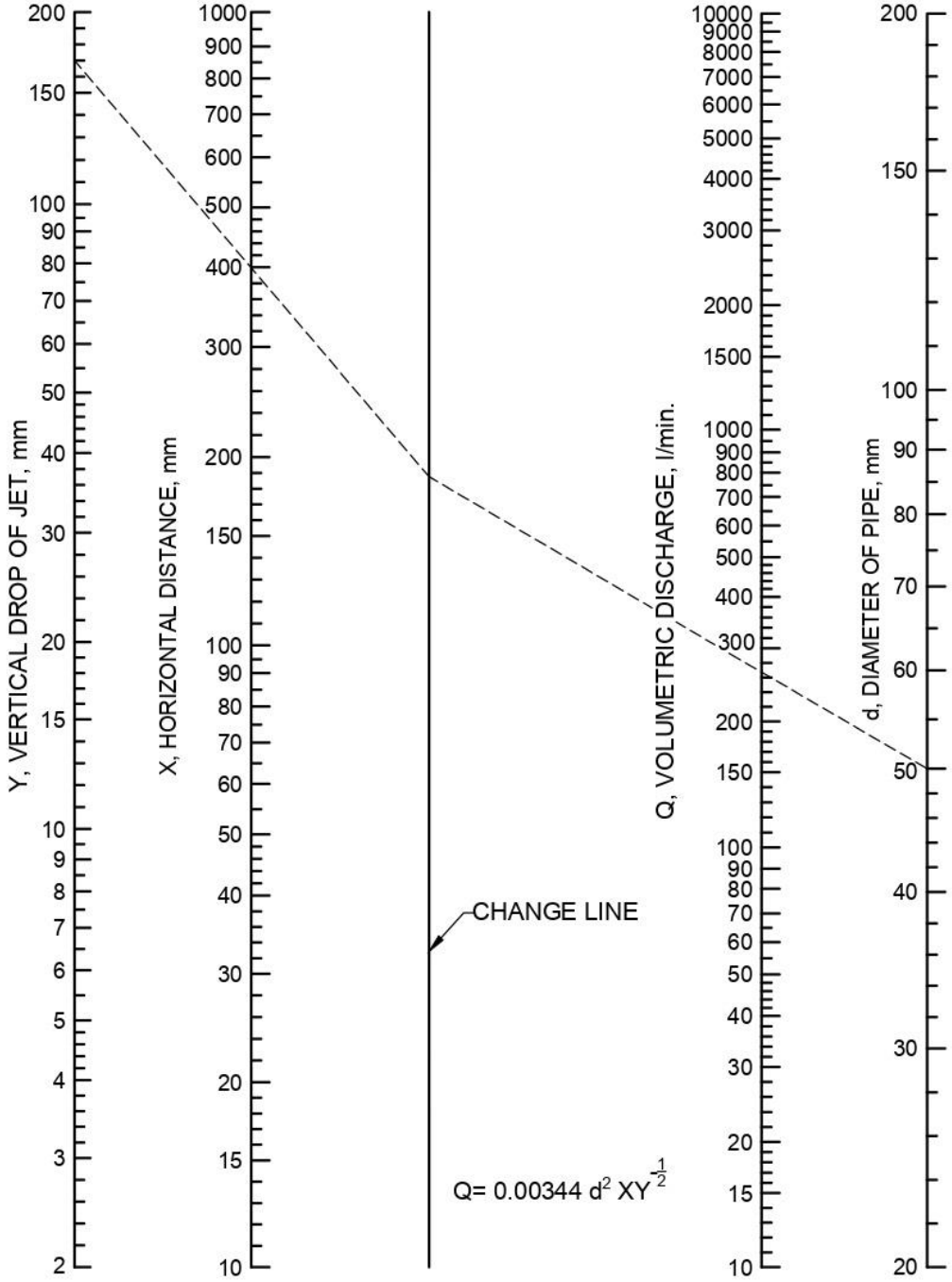
An error of 5 mm in the measurement of *y* yields an error of 1.5 percent in the discharge for the diameter and discharges specified, that is from 25 to 200 mm and from 75 1/min to 10 000 1/min. For other values larger errors will be involved.

4.3 Alternately, the nomograph given in Appendix A may be used for *y* from 2 to 200 mm and *x* from 10 to 1000 mm with pipe sizes from 20 to 200 mm.

Appendix A

(clause 4.3)

NOMOGRAPH FOR SOLUTION ON JET CHARACTERISTICS OF FLOW



NOTE : g is assumed as 9800 mm/s^2

$k\sqrt{g*60*10} < 0.00344$

INDIAN STANDARDS ON FLUID FLOW MEASUREMENT

IS:

1191-2003	Glossary of terms and symbols used in connection with the measurement of liquid flow with a free surface (*second revision*)
1192-1981	Velocity-area methods for measurement of flow of water in open channels (*first revision*)
1194-1960	Forms for recording measurement of flow of water in open channels
2912-1999 ISO 1070 : 1992	Recommendation for liquid flow measurement in open channels by slope-area method (approximate method) (*first revision*)
2913-1964	Recommendation for determination of flow in tidal channels
2914-1964	Recommendations for estimation of discharges by establishing stage-discharge relation in open channels
2915-1964	Instructions for collection of data for the determination of error in measurement of flow by velocity area methods
2951 (Part 1) - 1965	Recommendation for estimation of flow of liquids in closed conduits : Part 1 Head loss in straight pipes due to frictional resistance
2951 (Part 2)- 1965	Recommendation for estimation of flow of liquids in closed conduits : Part 2 Head loss in valves and fittings
2952 (Part 1)- 1964	Recommendation for methods of measurement of fluid flow by means of orifice plates and nozzles : Part 1 Incompressible fluids
2952 (Part 2)- 1975-	Recommendation for methods of measurement of fluid Row by means of orifice plates and nozzles : Part 2 Compressible fluids
3910-1992	Current meters (cup type) for water flow measurement (*first revision*)
3911-1994	Surface floats (*first revision*)
3912-1993	Sounding rods (*first revision*)
3913-2005	Suspended sediment loads samplers (*first revision*)
3917-2003	Scoop type bed material samplers (*first revision*)

3918-1966	Code of practice for use of current meter (cup type) for water flow Measurement
4073-1967	Fish weights
4080-1994	Vertical staff gauges (*first revision*)
4477 (Part 1)-1967	Methods of measurement of fluid flow by means of venturi metres: Part 1 Liquids
4477 (Part 2)-1975	Methods of measurement of fluid flow by means of venturi metres: Part 2 Compressible fluids
4858-1968	Velocity rods
4890.1968	Methods for measurement of suspended sediment in open channels
6059-1971	Recommendation for liquid flow measurement in open channels by weirs and flumes - weirs of finite crest width for free discharge
6062-1971	Method of measurement of flow of water in open channels using standing wave flume-fall
6063.1971	Method of measurement of flow of water in open channels using standing wave flume
6064-1971	Sounding and suspension equipment
6330-2012 ISO 3847 : 1977	Recommendation for liquid flow measurement in open channels by weirs and flumes - end depth method for estimation offlow in rectangular channels with a free overfall (approximate method) (*first revision*)
6339-2013	Methods of analysis of concentration, particle size distribution and specific gravity of sediment in streams and canals (*first revision*)