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Devices to Measure Flow Rate Formulas

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List of 25 Devices to Measure Flow Rate Formulas

Devices to Measure Flow Rate

Orifice Meter

1) Actual Velocity at Section 2 given Coefficient of Contraction

fx

Open Calculator 

$$v = C_v \cdot \sqrt{2 \cdot [g] \cdot h_{\text{venturi}} + \left(V_{p2} \cdot C_c \cdot \frac{a_o}{A_i} \right)^2}$$

ex

$$11.86091\text{m/s} = 0.92 \cdot \sqrt{2 \cdot [g] \cdot 24\text{mm} + \left(34\text{m/s} \cdot 0.611 \cdot \frac{4.4\text{m}^2}{7.1\text{m}^2} \right)^2}$$

2) Actual Velocity given Theoretical Velocity at Section 2

fx

Open Calculator 

$$v = C_v \cdot V_{p2}$$

ex

$$31.28\text{m/s} = 0.92 \cdot 34\text{m/s}$$

3) Area at Section 2 or at Vena Contracta

fx

Open Calculator 

$$A_f = C_c \cdot a_o$$

ex

$$2.6884\text{m}^2 = 0.611 \cdot 4.4\text{m}^2$$



4) Area of Orifice given Area at Section 2 or at Vena Contracta

$$\text{fx } a_o = \frac{A_f}{C_c}$$

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0_img.jpg\)](#)

$$\text{ex } 2.94599\text{m}^2 = \frac{1.8\text{m}^2}{0.611}$$

5) Coefficient of Contraction

$$\text{fx } C_c = \frac{C_d}{C_v}$$

[Open Calculator !\[\]\(17413706fd4997a1a4bdf85c6864eee1_img.jpg\)](#)

$$\text{ex } 0.717391 = \frac{0.66}{0.92}$$

6) Coefficient of Contraction given Coefficient of Discharge

$$\text{fx } C_c = \frac{C_d}{C_v}$$

[Open Calculator !\[\]\(4b7a79268f6ba26c1471d4232fffa85a_img.jpg\)](#)

$$\text{ex } 0.717391 = \frac{0.66}{0.92}$$

7) Coefficient of Discharge given Coefficient of Contraction

$$\text{fx } C_d = C_v \cdot C_c$$

[Open Calculator !\[\]\(3342c215b2a8b663596a81468d5dc314_img.jpg\)](#)

$$\text{ex } 0.56212 = 0.92 \cdot 0.611$$



8) Coefficient of Velocity given Coefficient of Discharge

$$\text{fx } C_v = \frac{C_d}{C_c}$$

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0_img.jpg\)](#)

$$\text{ex } 1.080196 = \frac{0.66}{0.611}$$

9) Discharge through Pipe given Coefficient of Discharge

fx

[Open Calculator !\[\]\(17413706fd4997a1a4bdf85c6864eee1_img.jpg\)](#)

$$Q_O = C_d \cdot W \cdot (H_{\text{Bottom}} - H_{\text{Top}}) \cdot \left(\sqrt{2 \cdot 9.81 \cdot H} \right)$$

$$\text{ex } 0.040529\text{m}^3/\text{s} = 0.66 \cdot 3.1\text{m} \cdot (20\text{m} - 19.9\text{m}) \cdot \left(\sqrt{2 \cdot 9.81 \cdot 0.002\text{m}} \right)$$

10) Theoretical Velocity at Section 1 in Orifice Meter

$$\text{fx } V_1 = \sqrt{(V_{p2}^2) - (2 \cdot [g] \cdot h_{\text{venturi}})}$$

[Open Calculator !\[\]\(95b425611cbd2b8716a140cf67c81822_img.jpg\)](#)

$$\text{ex } 33.99308\text{m/s} = \sqrt{((34\text{m/s})^2) - (2 \cdot [g] \cdot 24\text{mm})}$$

11) Theoretical Velocity at Section 2 in Orifice Meter

$$\text{fx } V_{p2} = \sqrt{2 \cdot [g] \cdot h_{\text{venturi}} + V_1^2}$$

[Open Calculator !\[\]\(56549452e01ca28bdf2500ced9653143_img.jpg\)](#)

$$\text{ex } 58.03406\text{m/s} = \sqrt{2 \cdot [g] \cdot 24\text{mm} + (58.03\text{m/s})^2}$$



Pitot Tube

12) Actual Velocity of Flowing Stream

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0_img.jpg\)](#)

$$\text{fx } v = C_v \cdot \sqrt{2 \cdot [g] \cdot H_f}$$

$$\text{ex } 14.17281 \text{ m/s} = 0.92 \cdot \sqrt{2 \cdot [g] \cdot 12.10}$$

13) Height of Fluid raised in Tube given Actual Velocity of Flowing Stream

[Open Calculator !\[\]\(17413706fd4997a1a4bdf85c6864eee1_img.jpg\)](#)

$$\text{fx } H_f = \frac{\left(\frac{V_{\text{theoretical}}}{C_v} \right)^2}{2} \cdot [g]$$

$$\text{ex } 13.0346 = \frac{\left(\frac{1.5 \text{ m/s}}{0.92} \right)^2}{2} \cdot [g]$$

14) Height of Fluid raised in Tube given Theoretical Velocity of Flowing Stream

[Open Calculator !\[\]\(4b7a79268f6ba26c1471d4232fffa85a_img.jpg\)](#)

$$\text{fx } H_f = \frac{V_{\text{theoretical}}^2}{2} \cdot [g]$$

$$\text{ex } 11.03248 = \frac{(1.5 \text{ m/s})^2}{2} \cdot [g]$$



15) Theoretical Velocity of Flowing Stream

$$\text{fx } V_{\text{theoretical}} = \sqrt{2 \cdot [g] \cdot H_f}$$

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0_img.jpg\)](#)

$$\text{ex } 15.40522\text{m/s} = \sqrt{2 \cdot [g] \cdot 12.10}$$

Venturi Meter

16) Actual Discharge given Coefficient of Discharge

$$\text{fx } Q_{\text{actual}} = V_{\text{theoretical}} \cdot C_d$$

[Open Calculator !\[\]\(faf942dc3e59ce8eb64b4ac481eca7e0_img.jpg\)](#)

$$\text{ex } 0.99\text{m}^3/\text{s} = 1.5\text{m/s} \cdot 0.66$$

17) Coefficient of Discharge given Discharges

$$\text{fx } C_d = \frac{Q_{\text{actual}}}{V_{\text{theoretical}}}$$

[Open Calculator !\[\]\(95b425611cbd2b8716a140cf67c81822_img.jpg\)](#)

$$\text{ex } 0.391333 = \frac{0.587\text{m}^3/\text{s}}{1.5\text{m/s}}$$

18) Density of Liquid in Pipe given Venturi Head

$$\text{fx } \gamma_f = \frac{w}{\frac{h_{\text{venturi}}}{L} + 1}$$

[Open Calculator !\[\]\(56549452e01ca28bdf2500ced9653143_img.jpg\)](#)

$$\text{ex } 9.810357\text{kN/m}^3 = \frac{9888.84\text{N/m}^3}{\frac{24\text{mm}}{3\text{m}} + 1}$$



19) Density of Manometric Liquid given Venturi Head

[Open Calculator !\[\]\(666e09182d4cd268646ea700ea60dcdf_img.jpg\)](#)

$$\text{fx } w = \gamma_f \cdot \left(\frac{h_{\text{venturi}}}{L} + 1 \right)$$

$$\text{ex } 9888.48\text{N/m}^3 = 9.81\text{kN/m}^3 \cdot \left(\frac{24\text{mm}}{3\text{m}} + 1 \right)$$

20) Inlet Area given Theoretical Discharge

[Open Calculator !\[\]\(003082e50e3009141f59bd5df831749f_img.jpg\)](#)

$$\text{fx } A_i = \sqrt{\frac{(Q_{\text{th}} \cdot A_f)^2}{(Q_{\text{th}})^2 - (A_f^2 \cdot 2 \cdot [g] \cdot h_{\text{venturi}})}}$$

$$\text{ex } 7.073493\text{m}^2 = \sqrt{\frac{(1.277\text{m}^3/\text{s} \cdot 1.8\text{m}^2)^2}{(1.277\text{m}^3/\text{s})^2 - ((1.8\text{m}^2)^2 \cdot 2 \cdot [g] \cdot 24\text{mm})}}$$

21) Theoretical Discharge given Coefficient of Discharge

[Open Calculator !\[\]\(d3102649f02e825ddb76dc3de0190154_img.jpg\)](#)

$$\text{fx } Q_{\text{th}} = \frac{Q_{\text{actual}}}{C_d}$$

$$\text{ex } 0.889394\text{m}^3/\text{s} = \frac{0.587\text{m}^3/\text{s}}{0.66}$$



22) Theoretical Discharge through Pipe

[Open Calculator !\[\]\(666e09182d4cd268646ea700ea60dcdf_img.jpg\)](#)

fx

$$Q_{th} = \frac{A_i \cdot A_f \cdot \left(\sqrt{2 \cdot [g] \cdot h_{venturi}} \right)}{\sqrt{(A_i)^2 - (A_f)^2}}$$

ex

$$1.276671 \text{ m}^3/\text{s} = \frac{7.1 \text{ m}^2 \cdot 1.8 \text{ m}^2 \cdot \left(\sqrt{2 \cdot [g] \cdot 24 \text{ mm}} \right)}{\sqrt{(7.1 \text{ m}^2)^2 - (1.8 \text{ m}^2)^2}}$$

23) Throat Area given Theoretical Discharge

[Open Calculator !\[\]\(faf942dc3e59ce8eb64b4ac481eca7e0_img.jpg\)](#)

fx

$$A_f = \sqrt{\frac{(A_i \cdot Q_{th})^2}{(A_i^2 \cdot 2 \cdot [g] \cdot h_{venturi}) + Q_{th}^2}}$$

ex

$$1.800435 \text{ m}^2 = \sqrt{\frac{(7.1 \text{ m}^2 \cdot 1.277 \text{ m}^3/\text{s})^2}{((7.1 \text{ m}^2)^2 \cdot 2 \cdot [g] \cdot 24 \text{ mm}) + (1.277 \text{ m}^3/\text{s})^2}}$$

24) Venturi Head given Difference in Levels of Manometric Liquid in Two Limbs

[Open Calculator !\[\]\(4f6bf54ae7e4144a72d78316053e412d_img.jpg\)](#)

fx

$$h_{venturi} = L \cdot \left(\frac{w}{\gamma_f} - 1 \right)$$

ex

$$24.11009 \text{ mm} = 3 \text{ m} \cdot \left(\frac{9888.84 \text{ N/m}^3}{9.81 \text{ kN/m}^3} - 1 \right)$$



25) Venturi Head given Theoretical Discharge through Pipe

fx

Open Calculator 

$$h_{\text{venturi}} = \left(\left(\frac{Q_{\text{th}}}{A_i \cdot A_f} \right) \cdot \left(\sqrt{\frac{(A_i)^2 - (A_f)^2}{2 \cdot [g]}} \right) \right)^2$$

$$\text{ex } 24.01238\text{mm} = \left(\left(\frac{1.277\text{m}^3/\text{s}}{7.1\text{m}^2 \cdot 1.8\text{m}^2} \right) \cdot \left(\sqrt{\frac{(7.1\text{m}^2)^2 - (1.8\text{m}^2)^2}{2 \cdot [g]}} \right) \right)^2$$



Variables Used






- A_f Cross Section Area 2 (Square Meter)
- A_i Cross Section Area 1 (Square Meter)
- a_o Area of Orifice (Square Meter)
- C_c Coefficient of Contraction
- C_d Coefficient of Discharge
- C_v Coefficient of Velocity
- H Difference in Liquid Level (Meter)
- H_{Bottom} Height of Liquid Bottom Edge (Meter)
- H_f Height of Fluid
- H_{Top} Height of Liquid Top Edge (Meter)
- h_{venturi} Venturi Head (Millimeter)
- L Length of Venturi meter (Meter)
- Q_{actual} Actual Discharge (Cubic Meter per Second)
- Q_o Discharge through Orifice (Cubic Meter per Second)
- Q_{th} Theoretical Discharge (Cubic Meter per Second)
- v Actual Velocity (Meter per Second)
- V_1 Velocity at Point 1 (Meter per Second)
- V_{p2} Velocity at Point 2 (Meter per Second)
- $V_{\text{theoretical}}$ Theoretical Velocity (Meter per Second)
- W Width of Pipe (Meter)
- γ_f Specific Weight of Liquid (Kilonewton per Cubic Meter)



- w Weight per unit Volume of Manometer Fluid (*Newton per Cubic Meter*)






















Constants, Functions, Measurements used

- **Constant:** **[g]**, 9.80665
Gravitational acceleration on Earth
- **Function:** **sqrt**, sqrt(Number)
A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- **Measurement:** **Length** in Millimeter (mm), Meter (m)
Length Unit Conversion 
- **Measurement:** **Area** in Square Meter (m²)
Area Unit Conversion 
- **Measurement:** **Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement:** **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
Volumetric Flow Rate Unit Conversion 
- **Measurement:** **Specific Weight** in Kilonewton per Cubic Meter (kN/m³),
Newton per Cubic Meter (N/m³)
Specific Weight Unit Conversion 



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