Important Specific Energy and Critical Depth Formulas PDF

Formulas
Examples
with Units

List of 23
Important Specific Energy and Critical Depth Formulas

1) Area of Section Considering Condition of Maximum Discharge Formula

Evaluate Formula

Formula

$$A_{cs} = \left(Q \cdot Q \cdot \frac{T}{[g]} \right)^{\frac{1}{3}}$$

Example with Units

$$3.4752\,\text{m}^2 = \left(14\,\text{m}^3/\text{s} \cdot 14\,\text{m}^3/\text{s} \cdot \frac{2.1\,\text{m}}{9.8066\,\text{m/s}^2} \right)^{\frac{1}{3}}$$

2) Area of Section given Discharge Formula

Evaluate Formula

Formula

$$A_{cs} = \frac{Q}{\sqrt{2 \cdot [g] \cdot \left(E_{total} - d_f \right)}}$$

Example with Units

$$1.3731\,\text{m}^2 = \frac{14\,\text{m}^3/\text{s}}{\sqrt{2 \cdot 9.8066\,\text{m/s}^2 \cdot \left(8.6\,\text{J} - 3.3\,\text{m} \right)}}$$

3) Area of Section of Open Channel Considering Condition of Minimum Specific Energy Formula

Evaluate Formula

Formula

$$A_{cs} = \left(Q \cdot \frac{T}{[g]} \right)^{\frac{1}{3}}$$

Example with Units

$$1.4419\,\text{m}^2 = \left(14\,\text{m}^3/\text{s} \cdot \frac{2.1\,\text{m}}{9.8066\,\text{m/s}^2} \right)^{\frac{1}{3}}$$

4) Datum Height for Total Energy per unit Weight of Water in Flow Section Formula

Evaluate Formula

Formula

$$y = E_{total} - \left(\left(\frac{V_{mean}^2}{2 \cdot [g]} \right) + d_f \right)$$

Example with Units

$$98.9375\,\text{mm} = 8.6\,\text{J} - \left(\left(\frac{10.1\,\text{m/s}^2}{2 \cdot 9.8066\,\text{m/s}^2} \right) + 3.3\,\text{m} \right)$$

5) Depth of Flow given Discharge Formula

Evaluate Formula

Formula

$$d_f = E_{total} - \left(\frac{\left(\frac{Q}{A_{cs}} \right)^2}{2 \cdot [g]} \right)$$

Example with Units

$$7.7355\,\text{m} = 8.6\,\text{J} - \left(\frac{\left(\frac{14\,\text{m}^3/\text{s}}{3.4\,\text{m}^2} \right)^2}{2 \cdot 9.8066\,\text{m/s}^2} \right)$$

6) Depth of Flow given Total Energy in Flow Section taking Bed Slope as Datum Formula

Evaluate Formula

Formula

$$d_f = E_{total} - \left(\left(\frac{V_{mean}^2}{2 \cdot [g]}\right)\right)$$

Example with Units

$$3.3989\,\text{m} = 8.6\,\text{J} - \left(\left(\frac{10.1\,\text{m/s}^2}{2 \cdot 9.8066\,\text{m/s}^2}\right)\right)$$

7) Depth of Flow given Total Energy per Unit Weight of Water in Flow Section Formula

Evaluate Formula

Formula

$$d_f = E_{total} - \left(\left(\frac{V_{mean}^2}{2 \cdot [g]}\right) + y\right)$$

Example with Units

$$3.3589\,\text{m} = 8.6\,\text{J} - \left(\left(\frac{10.1\,\text{m/s}^2}{2 \cdot 9.8066\,\text{m/s}^2}\right) + 40\,\text{mm}\right)$$

8) Diameter of Section given Froude Number Formula

Evaluate Formula

Formula

$$d_{section} = \frac{\left(\frac{V_{FN}}{Fr}\right)^2}{[g]}$$

Example with Units

$$4.9966\,\text{m} = \frac{\left(\frac{70\,\text{m/s}}{10}\right)^2}{9.8066\,\text{m/s}^2}$$

9) Diameter of Section through Section Considering Condition of Minimum Specific Energy Formula

Evaluate Formula

Formula

$$d_{section} = \frac{V_{mean}^2}{[g]}$$

Example with Units

$$10.4021\,\text{m} = \frac{10.1\,\text{m/s}^2}{9.8066\,\text{m/s}^2}$$

10) Discharge through Area Formula

Evaluate Formula

Formula

$$Q = \sqrt{2 \cdot [g] \cdot A_{cs}^2 \cdot \left(E_{total} - d_f\right)}$$

Example with Units

$$34.6651\,\text{m}^3\text{/s} = \sqrt{2 \cdot 9.8066\,\text{m/s}^2 \cdot 3.4\,\text{m}^2{}^2 \cdot \left(8.6\,\text{J} - 3.3\,\text{m}\right)}$$

11) Discharge through Section Considering Condition of Maximum Discharge Formula

Evaluate Formula

Formula

$$Q = \sqrt{\left(A_{cs}^3\right) \cdot \frac{[g]}{T}}$$

Example with Units

$$13.5478\,\text{m}^3\text{/s} = \sqrt{\left(3.4\,\text{m}^2{}^3\right) \cdot \frac{9.8066\,\text{m/s}^2}{2.1\,\text{m}}}$$

12) Discharge through Section Considering Condition of Minimum Specific Energy Formula

Evaluate Formula

Formula

$$Q = \sqrt{\left(A_{cs}^{3}\right) \cdot \frac{[g]}{T}}$$

Example with Units

$$13.5478\,\text{m}^3/\text{s} = \sqrt{\left(3.4\,\text{m}^2{}^{3}\right) \cdot \frac{9.8066\,\text{m/s}^2}{2.1\,\text{m}}}$$

13) Froude Number given Velocity Formula

Evaluate Formula

Formula

$$Fr = \frac{V_{FN}}{\sqrt{[g] \cdot d_{section}}}$$

Example with Units

$$9.9966 = \frac{70\,\text{m/s}}{\sqrt{9.8066\,\text{m/s}^2 \cdot 5\,\text{m}}}$$

14) Mean Velocity of Flow for Total Energy per Unit Weight of Water in Flow Section Formula

Evaluate Formula

Formula

$$V_{mean} = \sqrt{\left(E_{total} - \left(d_f + y\right)\right) \cdot 2 \cdot [g]}$$

Example with Units

$$10.1571\,\text{m/s} = \sqrt{\left(8.6\,\text{J} - \left(3.3\,\text{m} + 40\,\text{mm}\right)\right) \cdot 2 \cdot 9.8066\,\text{m/s}^2}$$

15) Mean Velocity of Flow given Froude Number Formula

Evaluate Formula

Formula

$$V_{FN} = Fr \cdot \sqrt{d_{section} \cdot [g]}$$

Example with Units

$$70.0237\,\text{m/s} = 10 \cdot \sqrt{5\,\text{m} \cdot 9.8066\,\text{m/s}^2}$$

16) Mean Velocity of flow given Total Energy in flow section taking Bed Slope as Datum Formula

Evaluate Formula

Formula

$$V_{mean} = \sqrt{\left(E_{total} - \left(d_f\right)\right) \cdot 2 \cdot [g]}$$

Example with Units

$$10.1956\,\text{m/s} = \sqrt{\left(8.6\,\text{J} - \left(3.3\,\text{m}\right)\right) \cdot 2 \cdot 9.8066\,\text{m/s}^2}$$

17) Mean Velocity of Flow through Section Considering Condition of Minimum Specific Energy Formula

Evaluate Formula

Formula

$$V_{mean} = \sqrt{[g] \cdot d_{section}}$$

Example with Units

$$7.0024\,\text{m/s} = \sqrt{9.8066\,\text{m/s}^2 \cdot 5\,\text{m}}$$

18) Top Width of Section Considering Condition of Maximum Discharge Formula

Evaluate Formula

Formula

$$T = \sqrt{\left(A_{cs}^{3}\right) \cdot \frac{[g]}{Q}}$$

Example with Units

$$5.247\,\text{m} = \sqrt{\left(3.4\,\text{m}^2{}^{3}\right) \cdot \frac{9.8066\,\text{m/s}^2}{14\,\text{m}^3/\text{s}}}$$

19) Top Width of Section through Section Considering Condition of Minimum Specific Energy Formula

Evaluate Formula

Formula

$$T = \left(\left(A_{cs}^{3}\right) \cdot \frac{[g]}{Q}\right)$$

Example with Units

$$27.5315\,\text{m} = \left(\left(3.4\,\text{m}^2{}^{3}\right) \cdot \frac{9.8066\,\text{m/s}^2}{14\,\text{m}^3/\text{s}}\right)$$

20) Total Energy per unit Weight of Water in Flow Section Formula

Evaluate Formula

Formula

$$E_{total} = \left(\frac{V_{mean}^{2}}{2 \cdot [g]}\right) + d_f + y$$

Example with Units

$$8.5411\,\text{J} = \left(\frac{10.1\,\text{m/s}^{2}}{2 \cdot 9.8066\,\text{m/s}^2}\right) + 3.3\,\text{m} + 40\,\text{mm}$$

21) Total Energy per unit Weight of Water in Flow Section considering Bed Slope as Datum Formula

Evaluate Formula

Formula

$$E_{total} = \left(\frac{V_{FN}^{2}}{2 \cdot [g]}\right) + d_f$$

Example with Units

$$253.1305\,\text{J} = \left(\frac{70\,\text{m/s}^{2}}{2 \cdot 9.8066\,\text{m/s}^2}\right) + 3.3\,\text{m}$$

22) Total Energy per unit Weight of Water in Flow Section given Discharge Formula

Evaluate Formula

Formula

$$E_{total} = d_f + \left(\frac{\left(\frac{Q}{A_{cs}}\right)^{2}}{2 \cdot [g]}\right)$$

Example with Units

$$4.1645\,\text{J} = 3.3\,\text{m} + \left(\frac{\left(\frac{14\,\text{m}^3/\text{s}}{3.4\,\text{m}^2}\right)^{2}}{2 \cdot 9.8066\,\text{m/s}^2}\right)$$

23) Volume of Liquid Considering Condition of Maximum Discharge Formula

Evaluate Formula

Formula

$$Vw = \sqrt{\left(A_{cs}^{3}\right) \cdot \frac{[g]}{T}} \cdot \Delta t$$

Example with Units

$$16.9348\,\text{m}^3 = \sqrt{\left(3.4\,\text{m}^2{}^{3}\right) \cdot \frac{9.8066\,\text{m/s}^2}{2.1\,\text{m}}} \cdot 1.25\,\text{s}$$

Variables used in list of Specific Energy and Critical Depth Formulas above

- A_{cs} Cross-Sectional Area of Channel *(Square Meter)*
- d_f Depth of Flow *(Meter)*
- $d_{section}$ Diameter of Section *(Meter)*
- E_{total} Total Energy *(Joule)*
- **Fr** Froude Number
- **Q** Discharge of Channel *(Cubic Meter per Second)*
- **T** Top Width *(Meter)*
- V_{FN} Mean Velocity for Froude Number *(Meter per Second)*
- V_{mean} Mean Velocity *(Meter per Second)*
- **Vw** Volume of Water *(Cubic Meter)*
- **y** Height above Datum *(Millimeter)*
- **Δt** Time Interval *(Second)*

Constants, Functions, Measurements used in list of Specific Energy and Critical Depth Formulas above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- Functions: **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 Meter (m), Millimeter (mm)
  Length Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m^3/s)
  Volumetric Flow Rate Unit Conversion

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