Important Aquifer Analysis and Properties Formulas PDF

Formulas
Examples
with Units

List of 27
Important Aquifer Analysis and Properties Formulas

1) Analysis of Aquifer-Test Data Formulas

1.1) Elevation Head using Total Head Formula

Evaluate Formula

Formula

$$z = H_t - h_p$$

Example with Units

$$38.2\,\text{mm} = 12.02\,\text{cm} - 82\,\text{mm}$$

1.2) Pressure Head for given Total Head Formula

Evaluate Formula

Formula

$$h_p = H_t - z$$

Example with Units

$$82.2\,\text{mm} = 12.02\,\text{cm} - 38\,\text{mm}$$

1.3) Storage Coefficient from Theis Equation of Transmissivity Formula

Evaluate Formula

Formula

$$S = \frac{Q \cdot W_u}{T \cdot 4 \cdot \pi}$$

Example with Units

$$0.1013 = \frac{7\,\text{m}^3/\text{s} \cdot 2}{11\,\text{m}^2/\text{s} \cdot 4 \cdot 3.1416}$$

1.4) Theis Equation to determine Storage Coefficient Formula

Evaluate Formula

Formula

$$S' = \frac{4 \cdot T \cdot t \cdot u}{r^2}$$

Example with Units

$$16.0533 = \frac{4 \cdot 11\,\text{m}^2/\text{s} \cdot 4\,\text{s} \cdot 0.81}{2.98\,\text{m}^2}$$

1.5) Theis equation to determine transmissivity Formula

Evaluate Formula

Formula

$$T = \frac{Q \cdot W_u}{4 \cdot \pi \cdot S}$$

Example with Units

$$11.0305\,\text{m}^2/\text{s} = \frac{7\,\text{m}^3/\text{s} \cdot 2}{4 \cdot 3.1416 \cdot 0.101}$$

1.6) Total Head Formula

Evaluate Formula

Formula

$$H_t = z + h_p$$

Example with Units

$$12\,\text{cm} = 38\,\text{mm} + 82\,\text{mm}$$

1.7) Transmissivity given Storage Coefficient from Theis Equation Formula

Evaluate Formula

Formula

$$T = \frac{S' \cdot r^2}{4 \cdot t \cdot u}$$

Example with Units

$$10.9977\,\text{m}^2/\text{s} = \frac{16.05 \cdot 2.98\,\text{m}^2}{4 \cdot 4\,\text{s} \cdot 0.81}$$

2) Aquifer Properties Formulas

2.1) Compressibility of Aquifers Formulas

2.1.1) Barometric Efficiency given Compressibility Parameters Formula

Evaluate Formula

Formula

$$BE = \left(\frac{\eta \cdot \beta}{\alpha} + \eta \cdot \beta\right)$$

Example

$$2.32 = \left(\frac{0.32 \cdot 4.35}{1.5} + 0.32 \cdot 4.35\right)$$

2.1.2) Coefficient of Storage for Unconfined Aquifer Formula

Evaluate Formula

Formula

$$S'' = S_y + \left(\frac{\gamma}{1000}\right) \cdot (\alpha + \eta \cdot \beta) \cdot B_s$$

Example with Units

$$85.2855 = 0.2 + \left(\frac{9.807\,\text{kN/m}^3}{1000}\right) \cdot (1.5 + 0.32 \cdot 4.35) \cdot 3$$

2.1.3) Discharge per Unit Width of Aquifer Formula

Evaluate Formula

Formula

$$q = (h_o - h_1) \cdot K' \cdot \frac{b}{L}$$

Example with Units

$$0.1346\,\text{m}^3/\text{s} = (12\,\text{m} - 5\,\text{m}) \cdot 0.5\,\text{cm/s} \cdot \frac{15.0\,\text{m}}{3.9\,\text{m}}$$

2.1.4) Saturated Thickness of Aquifer when Coefficient of Storage for Unconfined Aquifer is Considered Formula

Evaluate Formula

Formula

$$B_s = \frac{S'' - S_y}{\left(\frac{\gamma}{1000}\right) \cdot (\alpha + \eta \cdot \beta)}$$

Example with Units

$$2.9899 = \frac{85 - 0.2}{\left(\frac{9.807\,\text{kN/m}^3}{1000}\right) \cdot (1.5 + 0.32 \cdot 4.35)}$$

2.2) Darcy's Law Formulas

2.2.1) Apparent Velocity and Bulk Pore Velocity Relationship Formula

Evaluate Formula

Formula

$$V = V_a \cdot \eta$$

Example with Units

$$24\,\text{m/s} = 75\,\text{m/s} \cdot 0.32$$

2.2.2) Apparent Velocity of Seepage Formula

Evaluate Formula

Formula

$$V = K'' \cdot dhds$$

Example with Units

$$24\,\text{m/s} = 10\,\text{m/s} \cdot 2.4$$

2.2.3) Apparent Velocity of Seepage given Reynolds Number of Value Unity Formula

Evaluate Formula

Formula

$$V = \frac{Re \cdot \nu_{stokes}}{d_a}$$

Example with Units

$$24.0066\,\text{m/s} = \frac{5000 \cdot 7.25\,\text{St}}{0.151\,\text{m}}$$

2.2.4) Apparent Velocity of Seepage when Discharge and Cross-Sectional Area are considered Formula

Evaluate Formula

Formula

$$V = \frac{Q'}{A}$$

Example with Units

$$24\,\text{m/s} = \frac{3.0\,\text{m}^3/\text{s}}{0.125\,\text{m}^2}$$

2.2.5) Bulk Pore Velocity Formula

Evaluate Formula

Formula

$$V_a = \frac{V}{\eta}$$

Example with Units

$$74.9688\,\text{m/s} = \frac{23.99\,\text{m/s}}{0.32}$$

2.2.6) Coefficient of Permeability when Apparent Velocity of Seepage is considered Formula

Evaluate Formula

Formula

$$K'' = \frac{V}{dhds}$$

Example with Units

$$9.9958\,\text{m/s} = \frac{23.99\,\text{m/s}}{2.4}$$

2.2.7) Darcy's Law Formula

Evaluate Formula

Formula

$$q_{flow} = K \cdot A_{cs} \cdot dhds$$

Example with Units

$$24.024\,\text{m}^3/\text{s} = .77\,\text{m/s} \cdot 13\,\text{m}^2 \cdot 2.4$$

2.2.8) Hydraulic Gradient when Apparent Velocity of Seepage is considered Formula

Evaluate Formula

Formula

$$dhds = \frac{V}{K''}$$

Example with Units

$$2.399 = \frac{23.99\,\text{m/s}}{10\,\text{m/s}}$$

2.2.9) Kinematic Viscosity of Water given Reynolds Number of Value Unity Formula

Evaluate Formula

Formula

$$\nu_{stokes} = \frac{V \cdot d_a}{Re}$$

Example with Units

$$7.245\,\text{St} = \frac{23.99\,\text{m/s} \cdot 0.151\,\text{m}}{5000}$$

2.2.10) Representative Particle Size given Reynolds Number of Value Unity Formula

Evaluate Formula

Formula

$$d_a = \frac{Re \cdot \upsilon}{V}$$

Example with Units

$$0.2084\,\text{m} = \frac{5000 \cdot 0.001\,\text{m}^2/\text{s}}{23.99\,\text{m/s}}$$

2.2.11) Reynolds Number of Value Unity Formula

Evaluate Formula

Formula

$$Re = \frac{V \cdot d_a}{\nu_{stokes}}$$

Example with Units

$$4996.5379 = \frac{23.99\,\text{m/s} \cdot 0.151\,\text{m}}{7.25\,\text{St}}$$

2.3) Porosity Formulas

2.3.1) Porosity Formula

Evaluate Formula

Formula

$$\eta = \frac{V_t - V_s}{V_t}$$

Example with Units

$$0.3213 = \frac{22.1\,\text{m}^3 - 15\,\text{m}^3}{22.1\,\text{m}^3}$$

2.3.2) Porosity given Bulk Pore Velocity Formula

Evaluate Formula

Formula

$$\eta = \frac{V}{V_a}$$

Example with Units

$$0.3199 = \frac{23.99\,\text{m/s}}{75\,\text{m/s}}$$

2.3.3) Porosity given Specific Yield and Specific Retention Formula

Evaluate Formula

Formula

$$\eta = S_y + S_r$$

Example

$$0.35 = 0.2 + 0.15$$

2.3.4) Total Volume of Soil or Rock Sample given Porosity Formula

Evaluate Formula

Formula

$$V_t = \left(\frac{V_v}{\eta_v}\right) \cdot 100$$

Example with Units

$$22.4\,\text{m}^3 = \left(\frac{5.6\,\text{m}^3}{25}\right) \cdot 100$$

2.3.5) Volume of Solids given Porosity Formula

Evaluate Formula

Formula

$$V_s = \left(V_t \cdot \left(1 - \eta\right)\right)$$

Example with Units

$$15.028\,\text{m}^3 = \left(22.1\,\text{m}^3 \cdot \left(1 - 0.32\right)\right)$$

Variables used in list of Aquifer Analysis and Properties Formulas above

- **A** Cross Section Area of Porous Medium *(Square Meter)*
- **A_{cs}** Cross Sectional Area *(Square Meter)*
- **b** Aquifer Thickness *(Meter)*
- **B_s** Saturated Thickness of Aquifer
- **BE** Barometric Efficiency
- **d_a** Representative Particle Size *(Meter)*
- **dhds** Hydraulic Gradient
- **h_1** Piezometric Head at Downstream End *(Meter)*
- **h_o** Piezometric Head at Upstream End *(Meter)*
- **h_p** Pressure Head *(Millimeter)*
- **H_t** Total Head *(Centimeter)*
- **K** Hydraulic Conductivity *(Meter per Second)*
- **K'** Permeability Coefficient *(Centimeter per Second)*
- **K''** Coefficient of Permeability *(Meter per Second)*
- **L** Length of Permeameter *(Meter)*
- **q** Discharge per Unit Width of Aquifer *(Cubic Meter per Second)*
- **Q** Pumping Rate *(Cubic Meter per Second)*
- **Q'** Discharge *(Cubic Meter per Second)*
- **q_{flow}** Flow Rate *(Cubic Meter per Second)*
- **r** Distance from Pumping Well *(Meter)*
- **Re** Reynolds Number
- **S** Storage Coefficient (Theis Equation)
- **S'** Storage Coefficient
- **S''** Coefficient of Storage for Unconfined Aquifer
- **S_r** Specific Retention
- **S_y** Specific Yield
- **t** Pumping Time *(Second)*
- **T** Transmissivity *(Square Meter per Second)*
- **u** Varying Dimensionless Group
- **V** Apparent Velocity of Seepage *(Meter per Second)*

Constants, Functions, Measurements used in list of Aquifer Analysis and Properties Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Measurement: **Length** in Millimeter (mm), Centimeter (cm), Meter (m)
  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 Centimeter per Second (cm/s), Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m^3/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Kinematic Viscosity** in Square Meter per Second (m^2/s), Stokes (St)
  Kinematic Viscosity Unit Conversion
- Measurement: **Specific Weight** in Kilonewton per Cubic Meter (kN/m^3)
  Specific Weight Unit Conversion

- V_a Bulk Pore Velocity *(Meter per Second)*
- V_s Volume of Solids *(Cubic Meter)*
- V_t Total Volume of Soil or Rock Sample *(Cubic Meter)*
- V_v Volume of Voids *(Cubic Meter)*
- W_u Well Function of U
- **z** Elevation Head *(Millimeter)*
- **α** Compressibility
- **β** Compressibility of Water
- **γ** Unit Weight of Fluid *(Kilonewton per Cubic Meter)*
- **η** Porosity of Soil
- η_v Volume Percent of Porosity
- v_{stokes} Kinematic Viscosity in Stokes *(Stokes)*
- **υ** Kinematic Viscosity *(Square Meter per Second)*

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