Unconfined Flow Formulas

List of 27 Unconfined Flow Formulas

Unconfined Flow

1) Coefficient of Permeability when Equilibrium Equation for Well in Unconfined Aquifer

Open Calculator

fx $$K = \frac{Q_u}{\pi \cdot \frac{H_2^2 - H_1^2}{\ln\left(\frac{r_2}{r_1}\right)}}$$

ex $$8.148474\text{cm/s} = \frac{65\text{m}^3/\text{s}}{\pi \cdot \frac{(45\text{m})^2 - (43\text{m})^2}{\ln\left(\frac{10.0\text{m}}{5.0\text{m}}\right)}}$$

2) Depth of Water in Pumping Well when Steady Flow in Unconfined Aquifer is Considered

Open Calculator

fx $$h_w = \sqrt{(H)^2 - \left(\frac{Q_u \cdot \ln\left(\frac{r}{R_w}\right)}{\pi \cdot K}\right)}$$

ex $$29.94862\text{m} = \sqrt{(35\text{m})^2 - \left(\frac{65\text{m}^3/\text{s} \cdot \ln\left(\frac{25\text{m}}{6\text{m}}\right)}{\pi \cdot 9\text{cm/s}}\right)}$$

3) Discharge at Edge of Zone of Influence

Open Calculator

fx $$Q_u = \pi \cdot K \cdot \frac{H^2 - h_w^2}{\ln\left(\frac{r}{R_w}\right)}$$

ex $$64.38969\text{m}^3/\text{s} = \pi \cdot 9\text{cm/s} \cdot \frac{(35\text{m})^2 - (30\text{m})^2}{\ln\left(\frac{25\text{m}}{6\text{m}}\right)}$$

4) Equilibrium Equation for Well in Unconfined Aquifer

Open Calculator

fx $$Q_u = \pi \cdot K \cdot \frac{H_2^2 - H_1^2}{\ln\left(\frac{r_2}{r_1}\right)}$$

ex $$71.79258\text{m}^3/\text{s} = \pi \cdot 9\text{cm/s} \cdot \frac{(45\text{m})^2 - (43\text{m})^2}{\ln\left(\frac{10.0\text{m}}{5.0\text{m}}\right)}$$

5) Saturated Thickness of Aquifer when Steady Flow of Unconfined Aquifer is Considered

Open Calculator

fx $$H = \sqrt{\frac{Q_u \cdot \ln\left(\frac{r}{R_w}\right)}{\pi \cdot K} + h_w^2}$$

ex $$35.04398\text{m} = \sqrt{\frac{65\text{m}^3/\text{s} \cdot \ln\left(\frac{25\text{m}}{6\text{m}}\right)}{\pi \cdot 9\text{cm/s}} + (30\text{m})^2}$$

Approximate Equations

6) Discharge when Drawdown at Pumping Well is Considered

Open Calculator

fx $$Q_u = 2 \cdot \pi \cdot T \cdot \frac{s_W}{\ln\left(\frac{r}{R_w}\right)}$$

ex $$64.99727\text{m}^3/\text{s} = 2 \cdot \pi \cdot 0.703\text{m}^2/\text{s} \cdot \frac{21\text{m}}{\ln\left(\frac{25\text{m}}{6\text{m}}\right)}$$

7) Drawdown at Pumping Well

Open Calculator

fx $$s_W = (H - h_w)$$

ex $$5\text{m} = (35\text{m} - 30\text{m})$$

8) Drawdown when Steady Flow of Unconfined Aquifer

Open Calculator

fx $$s_W = \frac{Q_u \cdot \ln\left(\frac{r}{R_w}\right)}{2 \cdot \pi \cdot T}$$

ex $$21.00088\text{m} = \frac{65\text{m}^3/\text{s} \cdot \ln\left(\frac{25\text{m}}{6\text{m}}\right)}{2 \cdot \pi \cdot 0.703\text{m}^2/\text{s}}$$

9) Transmissivity when Discharge at Drawdown is Considered

Open Calculator

fx $$T = \frac{Q_u \cdot \ln\left(\frac{r}{R_w}\right)}{2 \cdot \pi \cdot s_W}$$

ex $$0.70303\text{m}^2/\text{s} = \frac{65\text{m}^3/\text{s} \cdot \ln\left(\frac{25\text{m}}{6\text{m}}\right)}{2 \cdot \pi \cdot 21\text{m}}$$

Unconfined Flow by Dupit's Assumption

10) Change in Drawdown given Discharge

Open Calculator

fx $$s = Q \cdot \frac{\ln\left(\frac{r_2}{r_1}\right)}{2} \cdot \pi \cdot T$$

ex $$0.995048\text{m} = 1.3\text{m}^3/\text{s} \cdot \frac{\ln\left(\frac{10.0\text{m}}{5.0\text{m}}\right)}{2} \cdot \pi \cdot 0.703\text{m}^2/\text{s}$$

11) Discharge per Unit Width of Aquifer considering Permeability

Open Calculator

fx $$Q = \frac{\left(h_o^2 - h_1^2\right) \cdot K}{2 \cdot L_{stream}}$$

ex $$1.309291\text{m}^3/\text{s} = \frac{\left((12\text{m})^2 - (5\text{m})^2\right) \cdot 9\text{cm/s}}{2 \cdot 4.09\text{m}}$$

12) Length about Discharge per Unit Width of Aquifer

Open Calculator

fx $$L_{stream} = \left(h_o^2 - h_1^2\right) \cdot \frac{K}{2 \cdot Q}$$

ex $$4.119231\text{m} = \left((12\text{m})^2 - (5\text{m})^2\right) \cdot \frac{9\text{cm/s}}{2 \cdot 1.3\text{m}^3/\text{s}}$$

13) Length when Discharge entering per Unit Length of Drain is Considered

Open Calculator

fx $$L = \frac{Q}{R}$$

ex $$0.08125\text{m} = \frac{1.3\text{m}^3/\text{s}}{16\text{m}^3/\text{s}}$$

14) Length when Maximum Height of Water Table is Considered

Open Calculator

fx $$L = 2 \cdot \frac{h_m}{\sqrt{\frac{R}{K}}}$$

ex $$6\text{m} = 2 \cdot \frac{40\text{m}}{\sqrt{\frac{16\text{m}^3/\text{s}}{9\text{cm/s}}}}$$

15) Mass Flux Entering Element

Open Calculator

fx $M_{x1} = \rho_{water} \cdot V_x \cdot H_w \cdot \Delta y$

ex $255000 = 1000\text{kg/m³} \cdot 10 \cdot 2.55\text{m} \cdot 10$

16) Maximum Height of Water Table

Open Calculator

fx $h_m = \left(\frac{L}{2}\right) \cdot \sqrt{\frac{R}{K}}$

ex $40\text{m} = \left(\frac{6\text{m}}{2}\right) \cdot \sqrt{\frac{16\text{m³/s}}{9\text{cm/s}}}$

17) Natural Recharge given Total Head

Open Calculator

fx $R = \frac{h^2 \cdot K}{(L - x) \cdot x}$

ex $18\text{m³/s} = \frac{(4\text{m})^2 \cdot 9\text{cm/s}}{(6\text{m} - 2.0\text{m³/s}) \cdot 2.0\text{m³/s}}$

18) Recharge when Maximum Height of Water Table

Open Calculator

fx $R = \left(\frac{h_m}{\frac{L}{2}}\right)^2 \cdot K$

ex $16\text{m³/s} = \left(\frac{40\text{m}}{\frac{6\text{m}}{2}}\right)^2 \cdot 9\text{cm/s}$

19) Water Table Profile Neglecting Depths of Water in Drains

Open Calculator

fx $h = \sqrt{\left(\frac{R}{K}\right) \cdot (L - x) \cdot x}$

ex $3.771236\text{m} = \sqrt{\left(\frac{16\text{m³/s}}{9\text{cm/s}}\right) \cdot (6\text{m} - 2.0\text{m³/s}) \cdot 2.0\text{m³/s}}$

One Dimensional Dupit's Flow with Recharge

20) Coefficient of Aquifer Permeability considering Discharge per Unit Width of Aquifer

Open Calculator

fx $$K = \frac{Q \cdot 2 \cdot L_{stream}}{(h_o^2) - (h_1^2)}$$

ex $$8.936134\text{cm/s} = \frac{1.3\text{m}^3/\text{s} \cdot 2 \cdot 4.09\text{m}}{\left((12\text{m})^2\right) - \left((5\text{m})^2\right)}$$

21) Coefficient of Aquifer Permeability given Maximum Height of Water Table

Open Calculator

fx $$K = \frac{R \cdot L^2}{(2 \cdot h_m)^2}$$

ex $$9\text{cm/s} = \frac{16\text{m}^3/\text{s} \cdot (6\text{m})^2}{(2 \cdot 40\text{m})^2}$$

22) Coefficient of Aquifer Permeability given Water Table Profile

Open Calculator

fx $$K = \left(\left(\frac{R}{h^2}\right) \cdot (L - x) \cdot x\right)$$

ex $$8\text{cm/s} = \left(\left(\frac{16\text{m}^3/\text{s}}{(4\text{m})^2}\right) \cdot (6\text{m} - 2.0\text{m}^3/\text{s}) \cdot 2.0\text{m}^3/\text{s}\right)$$

23) Discharge at Downstream Water Body of Catchment

Open Calculator

fx $$q_1 = \left(\frac{R \cdot L_{stream}}{2}\right) + \left(\left(\frac{K}{2 \cdot L_{stream}}\right) \cdot (h_o^2 - h_1^2)\right)$$

ex $$34.02929\text{m}^3/\text{s} = \left(\frac{16\text{m}^3/\text{s} \cdot 4.09\text{m}}{2}\right) + \left(\left(\frac{9\text{cm/s}}{2 \cdot 4.09\text{m}}\right) \cdot \left((12\text{m})^2 - (5\text{m})^2\right)\right)$$

24) Discharge Entering Drain per Unit Length of Drain

Open Calculator

fx $$q_d = 2 \cdot \left(R \cdot \left(\frac{L}{2}\right)\right)$$

ex $$96\text{m}^3/\text{s} = 2 \cdot \left(16\text{m}^3/\text{s} \cdot \left(\frac{6\text{m}}{2}\right)\right)$$

25) Discharge per Unit Width of Aquifer at any Location x

Open Calculator

fx $$q_x = R \cdot \left(x - \left(\frac{L_{stream}}{2} \right) \right) + \left(\frac{K}{2} \cdot L_{stream} \right) \cdot \left(h_o^2 - h_1^2 \right)$$

ex $$21.18195\text{m}^3/\text{s} = 16\text{m}^3/\text{s} \cdot \left(2.0\text{m}^3/\text{s} - \left(\frac{4.09\text{m}}{2} \right) \right) + \left(\frac{9\text{cm/s}}{2} \cdot 4.09\text{m} \right) \cdot \left((12\text{m})^2 - (5\text{m})^2 \right)$$

26) Equation for Water Divide

Open Calculator

fx $$a = \left(\frac{L_{stream}}{2} \right) - \left(\frac{K}{R} \right) \cdot \left(\frac{h_o^2 - h_1^2}{2} \cdot L_{stream} \right)$$

ex $$0.676128 = \left(\frac{4.09\text{m}}{2} \right) - \left(\frac{9\text{cm/s}}{16\text{m}^3/\text{s}} \right) \cdot \left(\frac{(12\text{m})^2 - (5\text{m})^2}{2} \cdot 4.09\text{m} \right)$$

27) Equation of Head for Unconfined Aquifer on Horizontal Impervious Base

Open Calculator

fx $$h = \sqrt{ \left(\frac{-R \cdot x^2}{K} \right) - \left(\left(\frac{h_o^2 - h_1^2 - \left(\frac{R \cdot L_{stream}^2}{K} \right)}{L_{stream}} \right) \cdot x \right) + h_o^2 }$$

ex $$28.79098\text{m} = \sqrt{ \left(\frac{-16\text{m}^3/\text{s} \cdot (2.0\text{m}^3/\text{s})^2}{9\text{cm/s}} \right) - \left(\left(\frac{(12\text{m})^2 - (5\text{m})^2 - \left(\frac{16\text{m}^3/\text{s} \cdot (4.09\text{m})^2}{9\text{cm/s}} \right)}{4.09\text{m}} \right) \cdot 2.0\text{m}^3/\text{s} \right) + (12\text{m})^2 }$$

Variables Used

- **a** Water Divide
- **h** Water Table Profile *(Meter)*
- **H** Saturated Thickness of the Aquifer *(Meter)*
- **h_1** Piezometric Head at Downstream End *(Meter)*
- **H_1** Water Table Depth *(Meter)*
- **H_2** Water Table Depth 2 *(Meter)*
- **h_m** Maximum Height of Water Table *(Meter)*
- **h_o** Piezometric Head at Upstream End *(Meter)*
- **h_w** Depth of Water in the Pumping Well *(Meter)*
- **H_w** Head *(Meter)*
- **K** Coefficient of Permeability *(Centimeter per Second)*
- **L** Length between Tile Drain *(Meter)*
- **L_{stream}** Length between Upstream and Downstream *(Meter)*
- **M_{x1}** Mass Flux Entering the Element
- **Q** Discharge *(Cubic Meter per Second)*
- **q_1** Discharge at Downstream Side *(Cubic Meter per Second)*
- **q_d** Discharge per unit Length of the Drain *(Cubic Meter per Second)*
- **Q_u** Steady Flow of an Unconfined Aquifer *(Cubic Meter per Second)*
- **q_x** Discharge of Aquifer at any Location x *(Cubic Meter per Second)*
- **r** Radius at the Edge of Zone of Influence *(Meter)*
- **R** Natural Recharge *(Cubic Meter per Second)*
- **r_1** Radial Distance at Observation Well 1 *(Meter)*
- **r_2** Radial Distance at Observation Well 2 *(Meter)*
- **R_w** Radius of the Pumping Well *(Meter)*
- **s** Change in Drawdown *(Meter)*
- **s_w** Drawdown at the Pumping Well *(Meter)*
- **T** Transmissivity of an Unconfined Aquifer *(Square Meter per Second)*
- **V_x** Gross Velocity of Groundwater
- **x** Flow in 'x' Direction *(Cubic Meter per Second)*
- **Δy** Change in 'y' Direction
- **ρ_{water}** Water Density *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- 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 Meter (m)
  Length Unit Conversion
- Measurement: **Speed** in Centimeter per Second (cm/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)
  Kinematic Viscosity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m^3)
  Density Unit Conversion

Check other formula lists

- Aquifer Analysis and Properties Formulas
- Coefficient of Permeability Formulas
- Distance-Drawdown Analysis Formulas
- Open Wells Formulas
- Steady Flow into a Well Formulas
- Unconfined Flow Formulas
- Unsteady Flow in a Confined Aquifer Formulas