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Hydroelectric Power Plant Formulas

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List of 23 Hydroelectric Power Plant Formulas

Hydroelectric Power Plant

1) Angular Velocity of Wheel

$$\text{fx } \omega = \frac{2 \cdot \pi \cdot N}{60}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$\text{ex } 3.838179\text{rad/s} = \frac{2 \cdot \pi \cdot 350\text{r/ min}}{60}$$

2) Diameter of Bucket

$$\text{fx } D_b = \frac{60 \cdot V_b}{\pi \cdot N}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$\text{ex } 1.22975\text{m} = \frac{60 \cdot 2.36\text{m/s}}{\pi \cdot 350\text{r/ min}}$$

3) Dimensionless Specific Speed

$$\text{fx } (N_s') = \frac{N \cdot \sqrt{\frac{P_h}{1000}}}{\sqrt{\rho_w} \cdot ([g] \cdot H)^{\frac{5}{4}}}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$\text{ex } 0.004819 = \frac{350\text{r/ min} \cdot \sqrt{\frac{5145\text{kW}}{1000}}}{\sqrt{1000\text{kg/m}^3} \cdot ([g] \cdot 250\text{m})^{\frac{5}{4}}}$$



4) Efficiency of Turbine given Energy

$$fx \quad \eta = \frac{E}{[g] \cdot \rho_w \cdot Q \cdot H \cdot t}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 0.799454 = \frac{36056MW \cdot h}{[g] \cdot 1000kg/m^3 \cdot 2.1m^3/s \cdot 250m \cdot 8760h}$$

5) Energy Produced by Hydroelectric Power Plant

$$fx \quad E = [g] \cdot \rho_w \cdot Q \cdot H \cdot \eta \cdot t$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 36080.63MW \cdot h = [g] \cdot 1000kg/m^3 \cdot 2.1m^3/s \cdot 250m \cdot 0.8 \cdot 8760h$$

6) Energy Produced by Hydroelectric Power Plant given Power

$$fx \quad E = P_h \cdot \eta \cdot t$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \quad 36056.16MW \cdot h = 5145kW \cdot 0.8 \cdot 8760h$$


7) Flow Rate of Water given Power

$$fx \quad Q = \frac{P_h}{[g] \cdot \rho_w \cdot H}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 2.098576m^3/s = \frac{5145kW}{[g] \cdot 1000kg/m^3 \cdot 250m}$$




8) Head or Height of Fall of Water given Power 

$$fx \quad H = \frac{P_h}{[g] \cdot \rho_w \cdot Q}$$

Open Calculator 

$$ex \quad 249.8305m = \frac{5145kW}{[g] \cdot 1000kg/m^3 \cdot 2.1m^3/s}$$

9) Height of Fall of Pelton Wheel Turbine Power Plant 

$$fx \quad H = \frac{V_J^2}{2 \cdot [g] \cdot C_v^2}$$

Open Calculator 

$$ex \quad 250.049m = \frac{(68.63m/s)^2}{2 \cdot [g] \cdot (0.98)^2}$$

10) Hydroelectric Power 

$$fx \quad P_h = [g] \cdot \rho_w \cdot Q \cdot H$$

Open Calculator 

$$ex \quad 5148.491kW = [g] \cdot 1000kg/m^3 \cdot 2.1m^3/s \cdot 250m$$


11) Jet Ratio of Hydroelectric Power Plant 

$$fx \quad J = \frac{D_b}{D_n}$$

Open Calculator 

$$ex \quad 15 = \frac{1.23m}{0.082m}$$




12) Number of Jets 

$$fx \quad n_J = \left(\frac{N_{SMJ}}{N_{SSJ}} \right)^2$$

Open Calculator 

$$ex \quad 6 = \left(73.49 \frac{r}{min} \frac{min}{30 \frac{r}{min}} \right)^2$$

13) Power given Unit Power 

$$fx \quad P_h = P_u \cdot 1000 \cdot H^{\frac{3}{2}}$$

Open Calculator 


$$ex \quad 5138.701 \text{ kW} = 1.3 \cdot 1000 \cdot (250 \text{ m})^{\frac{3}{2}}$$

14) Specific Speed of Multi Jet Machine 

$$fx \quad N_{SMJ} = \sqrt{n_J} \cdot N_{SSJ}$$

Open Calculator 

$$ex \quad 73.48469 \frac{r}{min} = \sqrt{6} \cdot 30 \frac{r}{min}$$

15) Specific Speed of Single Jet Machine 

$$fx \quad N_{SSJ} = \frac{N_{SMJ}}{\sqrt{n_J}}$$

Open Calculator 

$$ex \quad 30.00217 \frac{r}{min} = 73.49 \frac{r}{min} \frac{1}{\sqrt{6}}$$



16) Specific Speed of Turbine of Hydroelectric Power Plant [Open Calculator !\[\]\(eafc244b53721dd1ec133f0772f70fc7_img.jpg\)](#)


$$fx \quad N_s = \frac{N \cdot \sqrt{\frac{P_b}{1000}}}{H^{\frac{5}{4}}}$$

$$ex \quad 25.25432r/\text{min} = \frac{350r/\text{min} \cdot \sqrt{\frac{5145kW}{1000}}}{(250m)^{\frac{5}{4}}}$$

17) Speed of Bucket given Angular Velocity and Radius [Open Calculator !\[\]\(10f8862fc183b400327470ea85afe9ae_img.jpg\)](#)


$$fx \quad V_b = \omega \cdot \frac{D_b}{2}$$

$$ex \quad 2.35545m/s = 3.83rad/s \cdot \frac{1.23m}{2}$$

18) Speed of Bucket given Diameter and RPM [Open Calculator !\[\]\(35dc653d59570f8f891c312eeece91a2_img.jpg\)](#)

$$fx \quad V_b = \frac{\pi \cdot D_b \cdot N}{60}$$


$$ex \quad 2.36048m/s = \frac{\pi \cdot 1.23m \cdot 350r/\text{min}}{60}$$

19) Speed of Turbine given Unit Speed [Open Calculator !\[\]\(b538fe54c1f3a7343e37e85cc2d00497_img.jpg\)](#)

$$fx \quad N = N_u \cdot \sqrt{H}$$

$$ex \quad 348.7814r/\text{min} = 2.31 \cdot \sqrt{250m}$$



20) Tidal Energy 

$$fx \quad P_t = 0.5 \cdot A \cdot \rho_w \cdot [g] \cdot H^2$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$ex \quad 7.7E^8 kW = 0.5 \cdot 2500m^2 \cdot 1000kg/m^3 \cdot [g] \cdot (250m)^2$$

21) Unit Power of Hydroelectric Power Plant 

$$fx \quad P_u = \frac{\frac{P_h}{1000}}{H^{\frac{3}{2}}}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)


$$ex \quad 1.301593 = \frac{\frac{5145kW}{1000}}{(250m)^{\frac{3}{2}}}$$

22) Unit Speed of Turbine 

$$fx \quad N_u = \frac{N}{\sqrt{H}}$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2_img.jpg\)](#)

$$ex \quad 2.318071 = \frac{350r/min}{\sqrt{250m}}$$

23) Velocity of Jet from Nozzle 

$$fx \quad V_J = C_v \cdot \sqrt{2 \cdot [g] \cdot H}$$

[Open Calculator !\[\]\(06a315363e7801bba8c7489a6694af19_img.jpg\)](#)

$$ex \quad 68.62327m/s = 0.98 \cdot \sqrt{2 \cdot [g] \cdot 250m}$$



Variables Used










- **A** Area of Base (Square Meter)
- **C_v** Coefficient of Velocity
- **D_b** Bucket Circle Diameter (Meter)
- **D_n** Nozzle Diameter (Meter)
- **E** Energy (Megawatt-Hour)
- **H** Fall Height (Meter)
- **J** Jet Ratio
- **N** Working Speed (Revolution per Minute)
- **n_J** Number of Jets
- **N_S** Specific Speed (Revolution per Minute)
- **N_S'** Dimensionless Specific Speed
- **N_{SMJ}** Specific Speed of Multi Jet Machine (Revolution per Minute)
- **N_{SSJ}** Specific Speed of Single Jet Machine (Revolution per Minute)
- **N_u** Unit Speed
- **P_h** Hydroelectric Power (Kilowatt)
- **P_t** Tidal Power (Kilowatt)
- **P_u** Unit Power
- **Q** Flow Rate (Cubic Meter per Second)
- **t** Operating Time per Year (Hour)
- **V_b** Bucket Velocity (Meter per Second)
- **V_J** Velocity of Jet (Meter per Second)
- **η** Turbine Efficiency



- ρ_w Water Density (Kilogram per Cubic Meter)
- ω Angular Velocity (Radian per Second)






Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Constant:** **[g]**, 9.80665 Meter/Second²
Gravitational acceleration on Earth
- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Measurement:** **Length** in Meter (m)
Length Unit Conversion 
- **Measurement:** **Time** in Hour (h)
Time Unit Conversion 
- **Measurement:** **Area** in Square Meter (m²)
Area Unit Conversion 
- **Measurement:** **Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement:** **Energy** in Megawatt-Hour (MW*h)
Energy Unit Conversion 
- **Measurement:** **Power** in Kilowatt (kW)
Power Unit Conversion 
- **Measurement:** **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
Volumetric Flow Rate Unit Conversion 
- **Measurement:** **Angular Velocity** in Radian per Second (rad/s), Revolution per Minute (r/min)
Angular Velocity Unit Conversion 
- **Measurement:** **Density** in Kilogram per Cubic Meter (kg/m³)
Density Unit Conversion 



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