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AC Machines Formulas

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List of 28 AC Machines Formulas

AC Machines

Electrical Parameters

1) Apparent Power

$$fx \quad S = \frac{P_{\text{rated}}}{PF}$$

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2_img.jpg\)](#)

$$ex \quad 48.01556kVA = \frac{21.607kW}{0.45}$$

2) Current in Conductor

$$fx \quad I_z = \frac{I_{ph}}{n_{||}}$$

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

$$ex \quad 10A = \frac{20A}{2}$$

3) Current per Phase

$$fx \quad I_{ph} = \frac{S \cdot 1000}{E_{ph} \cdot 3}$$

[Open Calculator !\[\]\(f1c5da15572e3e09d343161be98f508d_img.jpg\)](#)

$$ex \quad 20A = \frac{48kVA \cdot 1000}{800kV \cdot 3}$$



4) Field Coil Voltage

$$fx \quad E_f = I_f \cdot R_f$$

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

$$ex \quad 42.4983V = 83.33A \cdot 0.51\Omega$$

5) Field Current

$$fx \quad I_f = \frac{E_f}{R_f}$$

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

$$ex \quad 83.33333A = \frac{42.5V}{0.51\Omega}$$

6) Field Resistance

$$fx \quad R_f = \frac{T_c \cdot \rho \cdot L_{mt}}{A_f}$$

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

$$ex \quad 0.51\Omega = \frac{204 \cdot 2.5e-5\Omega \cdot m \cdot 0.25m}{0.0025m^2}$$

7) Output Coefficient using Output Equation

$$fx \quad C_{o(ac)} = \frac{P_o}{L_a \cdot D_a^2 \cdot N_s \cdot 1000}$$

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

$$ex \quad 0.848826 = \frac{600kW}{0.3m \cdot (0.5m)^2 \cdot 1500rev/s \cdot 1000}$$



8) Output Power of Synchronous Machine

$$fx \quad P_o = C_{o(ac)} \cdot 1000 \cdot D_a^2 \cdot L_a \cdot N_s$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$ex \quad 600.8296kW = 0.85 \cdot 1000 \cdot (0.5m)^2 \cdot 0.3m \cdot 1500rev/s$$

9) Short Circuit Ratio

$$fx \quad SCR = \frac{1}{X_s}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$ex \quad 2.5 = \frac{1}{0.4\Omega}$$

10) Specific Electric Loading

$$fx \quad q_{av} = \frac{I_a \cdot Z}{\pi \cdot n_{||} \cdot D_a}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 187.4845Ac/m = \frac{1.178A \cdot 500}{\pi \cdot 2 \cdot 0.5m}$$

11) Specific Electric Loading using Output Coefficient AC

$$fx \quad q_{av} = \frac{C_{o(ac)} \cdot 1000}{11 \cdot B_{av} \cdot K_w}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 187.4642Ac/m = \frac{0.85 \cdot 1000}{11 \cdot 0.458Wb/m^2 \cdot 0.9}$$



12) Synchronous Speed using Output Equation

$$fx \quad N_s = \frac{P_o}{C_{o(ac)} \cdot 1000 \cdot D_a^2 \cdot L_a}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 1497.929 \text{ rev/s} = \frac{600 \text{ kW}}{0.85 \cdot 1000 \cdot (0.5 \text{ m})^2 \cdot 0.3 \text{ m}}$$

13) Winding Factor using Output Coefficient AC

$$fx \quad K_w = \frac{C_{o(ac)} \cdot 1000}{11 \cdot B_{av} \cdot q_{av}}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 0.900001 = \frac{0.85 \cdot 1000}{11 \cdot 0.458 \text{ Wb/m}^2 \cdot 187.464 \text{ Ac/m}}$$

Magnetic Parameters

14) Flux per Pole using Pole Pitch

$$fx \quad \Phi = B_{av} \cdot Y_p \cdot L_{limit}$$

[Open Calculator !\[\]\(0fb13ad0bfa3d86868cdd3883e5665b3_img.jpg\)](#)

$$ex \quad 0.054004 \text{ Wb} = 0.458 \text{ Wb/m}^2 \cdot 0.392 \text{ m} \cdot 0.3008 \text{ m}$$

15) Full Load Field MMF

$$fx \quad MMF_f = I_f \cdot T_c$$

[Open Calculator !\[\]\(e50091943b385fe16d3277389202856f_img.jpg\)](#)

$$ex \quad 16999.32 \text{ AT} = 83.33 \text{ A} \cdot 204$$



16) Magnetic Loading 

$$fx \quad B = n \cdot \Phi$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)


$$ex \quad 0.216\text{Wb} = 4 \cdot 0.054\text{Wb}$$

17) MMF of Damper Winding 

$$fx \quad \text{MMF}_d = 0.143 \cdot q_{av} \cdot Y_p$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$ex \quad 10.50848\text{AT} = 0.143 \cdot 187.464\text{Ac}/\text{m} \cdot 0.392\text{m}$$

18) Pole Arc 

$$fx \quad \theta = n_d \cdot 0.8 \cdot Y_s$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)


$$ex \quad 257.6\text{m} = 10 \cdot 0.8 \cdot 32.2\text{m}$$

19) Pole Pitch 

$$fx \quad Y_p = \frac{\pi \cdot D_a}{n}$$

[Open Calculator !\[\]\(5abce1a84a655b073239ab33e1199487_img.jpg\)](#)

$$ex \quad 0.392699\text{m} = \frac{\pi \cdot 0.5\text{m}}{4}$$

20) Specific Magnetic Loading 

$$fx \quad B_{av} = \frac{n \cdot \Phi}{\pi \cdot D_a \cdot L_a}$$

[Open Calculator !\[\]\(111c5272ee3f91361f0d2e3665dd6ad0_img.jpg\)](#)

$$ex \quad 0.458366\text{Wb}/\text{m}^2 = \frac{4 \cdot 0.054\text{Wb}}{\pi \cdot 0.5\text{m} \cdot 0.3\text{m}}$$



21) Specific Magnetic Loading using Output Coefficient AC

$$\text{fx } B_{av} = \frac{C_{o(ac)} \cdot 1000}{11 \cdot q_{av} \cdot K_w}$$

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

$$\text{ex } 0.458 \text{Wb/m}^2 = \frac{0.85 \cdot 1000}{11 \cdot 187.464 \text{Ac/m} \cdot 0.9}$$

Mechanical Parameters

22) Area of Field Conductor

$$\text{fx } A_f = \frac{\text{MMF}_f \cdot \rho \cdot L_{mt}}{E_f}$$

[Open Calculator !\[\]\(3cb60d42b10e53f9522bb0b392c1c4cd_img.jpg\)](#)

$$\text{ex } 0.0025 \text{m}^2 = \frac{17000 \text{AT} \cdot 2.5 \text{e-}5 \Omega \cdot \text{m} \cdot 0.25 \text{m}}{42.5 \text{V}}$$

23) Armature Core Length using Output Equation

$$\text{fx } L_a = \frac{P_o}{C_{o(ac)} \cdot 1000 \cdot D_a^2 \cdot N_s}$$

[Open Calculator !\[\]\(0d7ca0919e6c47bbd874bfa0189fe22e_img.jpg\)](#)

$$\text{ex } 0.299586 \text{m} = \frac{600 \text{kW}}{0.85 \cdot 1000 \cdot (0.5 \text{m})^2 \cdot 1500 \text{rev/s}}$$



24) Armature Diameter using Output Equation

[Open Calculator !\[\]\(3d8c13c92b853674f749aac6fa869926_img.jpg\)](#)

$$fx \quad D_a = \sqrt{\frac{P_o}{C_{o(ac)} \cdot 1000 \cdot N_s \cdot L_a}}$$

$$ex \quad 0.499655m = \sqrt{\frac{600kW}{0.85 \cdot 1000 \cdot 1500rev/s \cdot 0.3m}}$$

25) Cross Sectional Area of Damper Winding

[Open Calculator !\[\]\(17acf1afa8cdf0b67c53d4865a5ed469_img.jpg\)](#)

$$fx \quad \sigma_d = \frac{A_d}{n_d}$$

$$ex \quad 0.565m^2 = \frac{5.65m^2}{10}$$

26) Diameter of Damper Bar

[Open Calculator !\[\]\(d8ab143e904bfa3467271eec5af75a9b_img.jpg\)](#)

$$fx \quad D_d = \sqrt{\frac{4 \cdot A_d}{\pi}}$$

$$ex \quad 2.682127m = \sqrt{\frac{4 \cdot 5.65m^2}{\pi}}$$

27) Length of Damper Bar

[Open Calculator !\[\]\(2b17f17ebbacc911bb0ff784ab641779_img.jpg\)](#)

$$fx \quad L_d = 1.1 \cdot L_a$$

$$ex \quad 0.33m = 1.1 \cdot 0.3m$$



28) Number of Damper Bars

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

$$\text{fx } n_d = \frac{\theta}{0.8 \cdot Y_s}$$

$$\text{ex } 10 = \frac{257.6\text{m}}{0.8 \cdot 32.2\text{m}}$$



Variables Used












- A_d Area of Damper Winding (Square Meter)
- A_f Area of Field Conductor (Square Meter)
- B Magnetic Loading (Weber)
- B_{av} Specific Magnetic Loading (Weber per Square Meter)
- $C_{o(ac)}$ Output Coefficient AC
- D_a Armature Diameter (Meter)
- D_d Diameter of Damper Bar (Meter)
- E_f Field Coil Voltage (Volt)
- E_{ph} Induced Emf per Phase (Kilovolt)
- I_a Armature Current (Ampere)
- I_f Field Current (Ampere)
- I_{ph} Current per Phase (Ampere)
- I_z Current in Conductor (Ampere)
- K_w Winding Factor
- L_a Armature Core Length (Meter)
- L_d Length of Damper Bar (Meter)
- L_{limit} Limiting Value of Core Length (Meter)
- L_{mt} Length of Mean Turn (Meter)
- MMF_d MMF of Damper Winding (Ampere-Turn)
- MMF_f Full Load Field MMF (Ampere-Turn)
- n Number of Poles



- $n_{||}$ Number of Parallel Paths
- n_d Number of Damper Bar
- N_s Synchronous Speed (*Revolution per Second*)
- P_o Output Power (*Kilowatt*)
- P_{rated} Rated Real Power (*Kilowatt*)
- **PF** Power Factor
- q_{av} Specific Electric Loading (*Ampere Conductor per Meter*)
- R_f Field Resistance (*Ohm*)
- **S** Apparent Power (*Kilovolt Ampere*)
- **SCR** Short Circuit Ratio
- T_c Turns per Coil
- X_s Synchronous Reactance (*Ohm*)
- Y_p Pole Pitch (*Meter*)
- Y_s Slot Pitch (*Meter*)
- **Z** Number of Conductors
- θ Pole Arc (*Meter*)
- ρ Resistivity (*Ohm Meter*)
- σ_d Cross-Sectional Area of Damper Winding (*Square Meter*)
- Φ Flux per Pole (*Weber*)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Measurement:** **Length** in Meter (m)
Length Unit Conversion 
- **Measurement:** **Electric Current** in Ampere (A)
Electric Current Unit Conversion 
- **Measurement:** **Area** in Square Meter (m²)
Area Unit Conversion 
- **Measurement:** **Power** in Kilovolt Ampere (kVA), Kilowatt (kW)
Power Unit Conversion 
- **Measurement:** **Magnetic Flux** in Weber (Wb)
Magnetic Flux Unit Conversion 
- **Measurement:** **Electric Resistance** in Ohm (Ω)
Electric Resistance Unit Conversion 
- **Measurement:** **Magnetic Flux Density** in Weber per Square Meter (Wb/m²)
Magnetic Flux Density Unit Conversion 
- **Measurement:** **Magnetomotive Force** in Ampere-Turn (AT)
Magnetomotive Force Unit Conversion 
- **Measurement:** **Electric Potential** in Kilovolt (kV), Volt (V)
Electric Potential Unit Conversion 
- **Measurement:** **Electric Resistivity** in Ohm Meter ($\Omega \cdot m$)
Electric Resistivity Unit Conversion 
- **Measurement:** **Angular Velocity** in Revolution per Second (rev/s)
Angular Velocity Unit Conversion 




- **Measurement: Specific Electrical Loading** in Ampere Conductor per Meter (Ac/m)

Specific Electrical Loading Unit Conversion 



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