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Volume Fraction of Fiber Formulas

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List of 18 Volume Fraction of Fiber Formulas

Volume Fraction of Fiber

1) Critical Fiber Length

$$fx \quad l_c = \sigma_f \cdot \frac{d}{2 \cdot \tau_c}$$

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

$$ex \quad 10.5897\text{mm} = 6.375\text{MPa} \cdot \frac{10\text{mm}}{2 \cdot 3.01\text{MPa}}$$

2) Fiber Diameter given Critical Fiber Length

$$fx \quad d = \frac{l_c \cdot 2 \cdot \tau}{\sigma_f}$$

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

$$ex \quad 10\text{mm} = \frac{10.625\text{mm} \cdot 2 \cdot 3\text{MPa}}{6.375\text{MPa}}$$

3) Fiber-Matrix Bonding Strength given Critical Length of Fiber

$$fx \quad \tau = \frac{\sigma_f \cdot d}{2 \cdot l_c}$$

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

$$ex \quad 3\text{MPa} = \frac{6.375\text{MPa} \cdot 10\text{mm}}{2 \cdot 10.625\text{mm}}$$



4) Longitudinal Strength of Composite

$$fx \quad \sigma_{cl} = \tau_m \cdot (1 - V_f) + \sigma_f \cdot V_f$$

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

$$ex \quad 31.865MPa = 70.1MPa \cdot (1 - 0.6) + 6.375MPa \cdot 0.6$$

5) Tensile Strength of Fiber from Longitudinal Tensile Strength of Composite

$$fx \quad \sigma_f = \frac{\sigma_{cl} - \sigma_m \cdot (1 - V_f)}{V_f}$$

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

$$ex \quad 6.375MPa = \frac{31.825MPa - 70MPa \cdot (1 - 0.6)}{0.6}$$

6) Tensile Strength of Fiber given Critical Fiber Length

$$fx \quad \sigma_f = \frac{2 \cdot l_c \cdot \tau}{d}$$

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

$$ex \quad 6.375MPa = \frac{2 \cdot 10.625mm \cdot 3MPa}{10mm}$$

7) Tensile Strength of Matrix given Longitudinal Tensile Strength of Composite

$$fx \quad \sigma_m = \frac{\sigma_{cl} - \sigma_f \cdot V_f}{1 - V_f}$$

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

$$ex \quad 70MPa = \frac{31.825MPa - 6.375MPa \cdot 0.6}{1 - 0.6}$$



8) Volume Fraction of Fiber from EM of Composite (Longitudinal Direction)



$$fx \quad V_f = \frac{E_{CL} - E_m \cdot V_m}{E_f}$$

Open Calculator

$$ex \quad 0.6 = \frac{200MPa - 200MPa \cdot 0.4}{200MPa}$$

9) Volume Fraction of Fiber from EM of Composite (Transverse Direction)



$$fx \quad V_f = \frac{E_f}{E_{CT}} - \frac{V_m \cdot E_f}{E_m}$$

Open Calculator

$$ex \quad 0.6 = \frac{200MPa}{200MPa} - \frac{0.4 \cdot 200MPa}{200MPa}$$

10) Volume Fraction of Fiber from Longitudinal Tensile Strength of Composite

$$fx \quad V_f = \frac{\sigma_m - \sigma_{cl}}{\sigma_m - \sigma_f}$$

Open Calculator

$$ex \quad 0.6 = \frac{70MPa - 31.825MPa}{70MPa - 6.375MPa}$$



11) Volume Fraction of Matrix from E of Composite (Longitudinal Direction)

$$\text{fx } V_m = \frac{E_{CL} - E_f \cdot V_f}{E_m}$$

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

$$\text{ex } 0.4 = \frac{200\text{MPa} - 200\text{MPa} \cdot 0.6}{200\text{MPa}}$$

12) Volume Fraction of Matrix from EM of Composite (Transverse direction)

$$\text{fx } V_m = \frac{E_m}{E_{CT}} - \frac{E_m \cdot V_f}{E_f}$$

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

$$\text{ex } 0.4 = \frac{200\text{MPa}}{200\text{MPa}} - \frac{200\text{MPa} \cdot 0.6}{200\text{MPa}}$$

Elastic Modulus

13) Elastic Modulus of Composite in Longitudinal Direction

$$\text{fx } E_{CL} = E_m \cdot V_m + E_f \cdot V_f$$

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

$$\text{ex } 200\text{MPa} = 200\text{MPa} \cdot 0.4 + 200\text{MPa} \cdot 0.6$$



14) Elastic Modulus of Composite in Transverse Direction

$$\text{fx } E_{CT} = \frac{E_m \cdot E_f}{V_m \cdot E_f + V_f \cdot E_m}$$

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

$$\text{ex } 200\text{MPa} = \frac{200\text{MPa} \cdot 200\text{MPa}}{0.4 \cdot 200\text{MPa} + 0.6 \cdot 200\text{MPa}}$$

15) Elastic Modulus of Fiber using Composite (Transverse Direction)

$$\text{fx } E_f = \frac{E_{CT} \cdot E_m \cdot V_f}{E_m - E_{CT} \cdot V_m}$$

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

$$\text{ex } 200\text{MPa} = \frac{200\text{MPa} \cdot 200\text{MPa} \cdot 0.6}{200\text{MPa} - 200\text{MPa} \cdot 0.4}$$

16) Elastic Modulus of Fiber using Composite's Longitudinal Direction

$$\text{fx } E_f = \frac{E_{CL} - E_m \cdot V_m}{V_f}$$

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

$$\text{ex } 200\text{MPa} = \frac{200\text{MPa} - 200\text{MPa} \cdot 0.4}{0.6}$$

17) Elastic Modulus of Matrix using Composite (Transverse Direction)

$$\text{fx } E_m = \frac{E_{CT} \cdot E_f \cdot V_m}{E_f - E_{CT} \cdot V_f}$$

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

$$\text{ex } 200\text{MPa} = \frac{200\text{MPa} \cdot 200\text{MPa} \cdot 0.4}{200\text{MPa} - 200\text{MPa} \cdot 0.6}$$



18) Elastic Modulus of Matrix using Composite's Longitudinal Direction **Open Calculator** 

$$\text{fx } E_m = \frac{E_{CL} - E_f \cdot V_f}{V_m}$$

$$\text{ex } 200\text{MPa} = \frac{200\text{MPa} - 200\text{MPa} \cdot 0.6}{0.4}$$





Variables Used

- d Fiber Diameter (Millimeter)
- E_{CL} Elastic Modulus Composite (Longitudinal Direction) (Megapascal)
- E_{CT} Elastic Modulus Composite (Transverse Direction) (Megapascal)
- E_f Elastic Modulus of Fiber (Megapascal)
- E_m Elastic Modulus of Matrix (Megapascal)
- l_c Critical Fiber Length (Millimeter)
- V_f Volume Fraction of Fiber
- V_m Volume Fraction of Matrix
- σ_{cl} Longitudinal Strength of Composite (Megapascal)
- σ_f Tensile Strength of Fiber (Megapascal)
- σ_m Tensile Strength of Matrix (Megapascal)
- T Fiber-Matrix Bonding Strength (Megapascal)
- T_c Critical Shear Stress (Megapascal)
- T_m Stress in Matrix (Megapascal)



Constants, Functions, Measurements used

- **Measurement: Length** in Millimeter (mm)
Length Unit Conversion 
- **Measurement: Pressure** in Megapascal (MPa)
Pressure Unit Conversion 



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