Important Formulas on Surface Tension PDF

Formulas
Examples
with Units

List of 17
Important Formulas on Surface Tension

1) Force given Surface Tension using Wilhelmy-Plate Method Formula

Evaluate Formula

Formula

$$F = \left(\rho_p \cdot [g] \cdot \left(L \cdot B \cdot t\right)\right) + \left(2 \cdot \gamma \cdot \left(t + B\right) \cdot \left(\cos\left(\theta\right)\right)\right) - \left(\rho_{fluid} \cdot [g] \cdot t \cdot B \cdot h_p\right)$$

Example with Units

$$4.2E{+}9\,\text{N} = \left(12.2\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2 \cdot \left(50\,\text{mm} \cdot 200\,\text{mm} \cdot 5000\,\text{mm}\right)\right) + \left(2 \cdot 73\,\text{mN/m} \cdot \left(5000\,\text{mm} + 200\,\text{mm}\right) \cdot \left(\cos\left(15.1^\circ\right)\right)\right) - \left(14.9\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2 \cdot 5000\,\text{mm} \cdot 20\right.$$

2) Height of Magnitude of Capillary Rise Formula

Evaluate Formula

Formula

$$h_c = \frac{\gamma}{\left(\frac{1}{2}\right) \cdot \left(R \cdot \rho_{fluid} \cdot [g]\right)}$$

Example with Units

$$12.1852\,\text{mm} = \frac{73\,\text{mN/m}}{\left(\frac{1}{2}\right) \cdot \left(82\,\text{mm} \cdot 14.9\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2\right)}$$

3) Parachor given Surface Tension Formula

Evaluate Formula

Formula

$$P_s = \left(\frac{M_{molar}}{\rho_{liq} - \rho_v}\right) \cdot \left(\gamma\right)^{\frac{1}{4}}$$

Example with Units

$$2E{-}5\,\text{m}^3\text{/mol*(J/m}^2\text{)\^(1/4)} = \left(\frac{44.01\,\text{g/mol}}{1141\,\text{kg/m}^3 - 0.5\,\text{kg/m}^3}\right) \cdot \left(73\,\text{mN/m}\right)^{\frac{1}{4}}$$

4) Surface Pressure Formula

Evaluate Formula

Formula

$$\Pi = \gamma_o - \gamma$$

Example with Units

$$0.001\,\text{Pa} = 74\,\text{mN/m} - 73\,\text{mN/m}$$

5) Surface Pressure using Wilhelmy-Plate Method Formula

Evaluate Formula

Formula

$$\Pi = -\left(\frac{\Delta F}{2 \cdot \left(t + W_{plate}\right)}\right)$$

Example with Units

$$0.0015\,\text{Pa} = -\left(\frac{-0.015\,\text{N}}{2 \cdot \left(5000\,\text{mm} + 16.9\,\text{g}\right)}\right)$$

6) Surface Tension for very Thin Plate using Wilhelmy-Plate Method Formula

Evaluate Formula

Formula

$$\gamma = \frac{F_{thin\ plate}}{2 \cdot W_{plate}}$$

Example with Units

$$73.9645\,\text{mN/m} = \frac{0.0025\,\text{N}}{2 \cdot 16.9\,\text{g}}$$

7) Surface Tension Force given Density of Fluid Formula

Evaluate Formula

Formula

$$\gamma = \left(\frac{1}{2}\right) \cdot \left(R \cdot \rho_{fluid} \cdot [g] \cdot h_c\right)$$

Example with Units

$$59.9088\,\text{mN/m} = \left(\frac{1}{2}\right) \cdot \left(82\,\text{mm} \cdot 14.9\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2 \cdot 10\,\text{mm}\right)$$

8) Surface Tension given Contact Angle Formula

Evaluate Formula

Formula

$$\gamma = \left(2 \cdot R_{curvature} \cdot \rho_{fluid} \cdot [g] \cdot h_c\right) \cdot \left(\frac{1}{\cos\left(\theta\right)}\right)$$

Example with Units

$$75.6723\,\text{mN/m} = \left(2 \cdot 25\,\text{mm} \cdot 14.9\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2 \cdot 10\,\text{mm}\right) \cdot \left(\frac{1}{\cos\left(15.1^\circ\right)}\right)$$

9) Surface Tension given Correction Factor Formula

Evaluate Formula

Formula

$$\gamma = \frac{m \cdot [g]}{2 \cdot \pi \cdot r_{cap} \cdot f}$$

Example with Units

$$75.3316\,\text{mN/m} = \frac{0.8\,\text{g} \cdot 9.8066\,\text{m/s}^2}{2 \cdot 3.1416 \cdot 32.5\,\text{mm} \cdot 0.51}$$

10) Surface Tension given Critical Temperature Formula

Evaluate Formula

Formula

$$\gamma_{Tc} = k_o \cdot \left(1 - \left(\frac{T}{T_c}\right)\right)^{k_1}$$

Example with Units

$$39487.2323\,\text{mN/m} = 55 \cdot \left(1 - \left(\frac{45\,\text{K}}{190.55\,\text{K}}\right)\right)^{1.23}$$

11) Surface Tension given Molar Volume Formula

Evaluate Formula

Formula

$$\gamma_{MV} = [EOTVOS\_C] \cdot \frac{T_c - T}{\left(V_m\right)^{\frac{2}{3}}}$$

Example with Units

$$0.0038\,\text{mN/m} = 2.1E\text{-}7 \cdot \frac{190.55\,\text{K} - 45\,\text{K}}{\left(22.4\,\text{m}^3\text{/mol}\right)^{\frac{2}{3}}}$$

12) Surface Tension given Molecular Weight Formula

Evaluate Formula

Formula

$$\gamma = [EOTVOS\_C] \cdot \frac{T_c - T - 6}{\left(\frac{MW}{\rho_{liq}}\right)^{\frac{2}{3}}}$$

Example with Units

$$50.3956\,\text{mN/m} = 2.1E\text{-}7 \cdot \frac{190.55\,\text{K} - 45\,\text{K} - 6}{\left(\frac{16\,\text{g}}{1141\,\text{kg/m}^3}\right)^{\frac{2}{3}}}$$

13) Surface Tension given Temperature Formula

Evaluate Formula

Formula

$$\gamma_T = 75.69 - \left(0.1413 \cdot T\right) - \left(0.0002985 \cdot \left(T\right)^2\right)$$

Example with Units

$$92389.9469\,\text{mN/m} = 75.69 - \left(0.1413 \cdot 45\,\text{K}\right) - \left(0.0002985 \cdot \left(45\,\text{K}\right)^2\right)$$

14) Surface Tension of Pure Water Formula

Evaluate Formula

Formula

$$\gamma_w = 235.8 \cdot \left(1 - \left(\frac{T}{T_c}\right)\right)^{1.256} \cdot \left(1 - \left(0.625 \cdot \left(1 - \left(\frac{T}{T_c}\right)\right)\right)\right)$$

Example with Units

$$87854.6012\,\text{mN/m} = 235.8 \cdot \left(1 - \left(\frac{45\,\text{K}}{190.55\,\text{K}}\right)\right)^{1.256} \cdot \left(1 - \left(0.625 \cdot \left(1 - \left(\frac{45\,\text{K}}{190.55\,\text{K}}\right)\right)\right)\right)$$

15) Total Weight of Plate using Wilhelmy-Plate Method Formula

Evaluate Formula

Formula

$$W_{tot} = W_{plate} + \gamma \cdot \left(P\right) - U_{drift}$$

Example with Units

$$0.0202\,\text{N} = 16.9\,\text{g} + 73\,\text{mN/m} \cdot \left(250\,\text{mm}\right) - 15\,\text{mN/m}$$

16) Total Weight of Ring using Ring-Detachment Method Formula

Evaluate Formula

Formula

$$W_{tot} = W_{ring} + \left(4 \cdot \pi \cdot r_{ring} \cdot \gamma\right)$$

Example with Units

$$0.0511\,\text{N} = 5\,\text{g} + \left(4 \cdot 3.1416 \cdot 0.502\,\text{mm} \cdot 73\,\text{mN/m}\right)$$

17) Work of Cohesion given Surface Tension Formula

Evaluate Formula

Formula

$$W_{Coh} = 2 \cdot \gamma \cdot [Avaga\text{-}no]^{\frac{1}{3}} \cdot \left(V_m\right)^{\frac{2}{3}}$$

Example with Units

$$9.8E{+}7\,\text{J/m}^2 = 2 \cdot 73\,\text{mN/m} \cdot 6E{+}23^{\frac{1}{3}} \cdot \left(22.4\,\text{m}^3\text{/mol}\right)^{\frac{2}{3}}$$

Variables used in list of Important Formulas on Surface Tension above

- **B** Width of Full Size Bearing Plate *(Millimeter)*
- **f** Correction Factor
- **F** Force *(Newton)*
- $F_{thin\ plate}$ Force on very Thin Plate *(Newton)*
- h_c Height of Capillary Rise/Fall *(Millimeter)*
- h_p Depth of Plate *(Millimeter)*
- k_1 Empirical Factor
- k_o Constant for each Liquid
- **L** Length of Plate *(Millimeter)*
- **m** Drop Weight *(Gram)*
- M_{molar} Molar Mass *(Gram Per Mole)*
- **MW** Molecular Weight *(Gram)*
- **P** Perimeter *(Millimeter)*
- P_s Parachor *(Cubic Meter per Mole (Joule per Square Meter)^(0.25))*
- **R** Radius of Tubing *(Millimeter)*
- r_{cap} Capillary Radius *(Millimeter)*
- $R_{curvature}$ Radius of Curvature *(Millimeter)*
- r_{ring} Radius of Ring *(Millimeter)*
- **t** Thickness of Plate *(Millimeter)*
- **T** Temperature *(Kelvin)*
- T_c Critical Temperature *(Kelvin)*
- U_{drift} Upward Drift *(Millinewton per Meter)*
- V_m Molar Volume *(Cubic Meter per Mole)*
- W_{Coh} Work of Cohesion *(Joule per Square Meter)*
- W_{plate} Weight of Plate *(Gram)*
- W_{ring} Weight of Ring *(Gram)*
- W_{tot} Total Weight of Solid Surface *(Newton)*
- **γ** Surface Tension of Fluid *(Millinewton per Meter)*
- γ_{MV} Surface Tension of Fluid given Molar Volume *(Millinewton per Meter)*
- γ_o Surface Tension of Clean Water Surface *(Millinewton per Meter)*
- γ_T Surface Tension of Fluid given Temperature *(Millinewton per Meter)*
- γ_{Tc} Surface Tension of Fluid given Critical Temp *(Millinewton per Meter)*
- γ_w Surface Tension of Pure Water *(Millinewton per Meter)*
- **ΔF** Change in Force *(Newton)*
- **θ** Contact Angle *(Degree)*
- **Π** Surface Pressure of Thin Film *(Pascal)*
- ρ_{fluid} Density of Fluid *(Kilogram per Cubic Meter)*
- ρ_{liq} Density of Liquid *(Kilogram per Cubic Meter)*
- ρ_p Density of Plate *(Kilogram per Cubic Meter)*
- ρ_v Density of Vapor *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used in list of Important Formulas on Surface Tension above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- constant(s): **[Avaga-no]**, 6.02214076E+23
  Avogadro's number
- constant(s): **[EOTVOS_C]**, 0.00000021
  Eotvos constant
- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- Functions: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Weight** in Gram (g)
  Weight Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Heat Density** in Joule per Square Meter (J/m²)
  Heat Density Unit Conversion
- Measurement: **Surface Tension** in Millinewton per Meter (mN/m)
  Surface Tension Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Molar Mass** in Gram Per Mole (g/mol)
  Molar Mass Unit Conversion
- Measurement: **Molar Magnetic Susceptibility** in Cubic Meter per Mole (m³/mol)
  Molar Magnetic Susceptibility Unit Conversion
- Measurement: **Parachor** in Cubic Meter per Mole (Joule per Square Meter)^(0.25) (m³/mol*(J/m²)^(1/4))
  Parachor Unit Conversion

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