Important Formulas in Drying Mass Transfer Operation PDF

Formulas
Examples
with Units

List of 33
Important Formulas in Drying Mass Transfer Operation

1) Constant Drying Time from Initial to Critical Moisture Content Formula

Evaluate Formula

Formula

$$t_c = W_S \cdot \frac{\left(X_{i(Constant)} - X_c \right)}{\left(A \cdot N_c \right)}$$

Example with Units

$$190\,s = 100\,kg \cdot \frac{\left(0.49 - 0.11 \right)}{\left(0.1\,m^2 \cdot 2\,kg/s/m^2 \right)}$$

2) Constant Drying Time from Initial to Critical Weight of Moisture Formula

Evaluate Formula

Formula

$$t_c = \frac{M_{i(Constant)} - M_c}{A \cdot N_c}$$

Example with Units

$$190\,s = \frac{49\,kg - 11\,kg}{0.1\,m^2 \cdot 2\,kg/s/m^2}$$

3) Constant Drying Time from Initial to Final Moisture Content Formula

Evaluate Formula

Formula

$$t_c = W_S \cdot \frac{X_{i(Constant)} - X_{f(Constant)}}{A \cdot N_c}$$

Example with Units

$$170\,s = 100\,kg \cdot \frac{0.49 - 0.15}{0.1\,m^2 \cdot 2\,kg/s/m^2}$$

4) Constant Drying Time from Initial to Final Weight of Moisture Formula

Evaluate Formula

Formula

$$t_c = \frac{M_{i(Constant)} - M_{f(Constant)}}{A \cdot N_c}$$

Example with Units

$$170\,s = \frac{49\,kg - 15\,kg}{0.1\,m^2 \cdot 2\,kg/s/m^2}$$

5) Critical Moisture Content based on Initial Moisture Content for Constant Rate Period Formula

Evaluate Formula

Formula

$$X_c = X_{i(Constant)} - \left(\frac{A \cdot t_c \cdot N_c}{W_S} \right)$$

Example with Units

$$0.11 = 0.49 - \left(\frac{0.1\,m^2 \cdot 190\,s \cdot 2\,kg/s/m^2}{100\,kg} \right)$$

6) Dry Weight of Solid based on Critical to Final Moisture Content for Falling Rate Period Formula

Evaluate Formula

Formula

$$W_S = \frac{A \cdot t_f}{\left(\frac{X_c - X_{Eq}}{N_c}\right) \cdot \left(\ln\left(\frac{X_c - X_{Eq}}{X_{f(Falling)} - X_{Eq}}\right)\right)}$$

Example with Units

$$88.9662\,\text{kg} = \frac{0.1\,\text{m}^2 \cdot 37\,\text{s}}{\left(\frac{0.11 - 0.05}{2\,\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{0.11 - 0.05}{0.065 - 0.05}\right)\right)}$$

7) Dry Weight of Solid based on Initial to Final Moisture Content for Falling Rate Period Formula

Evaluate Formula

Formula

$$W_S = \frac{A \cdot t_f}{\left(\frac{X_{i(Falling)} - X_{Eq}}{N_c}\right) \cdot \left(\ln\left(\frac{X_{i(Falling)} - X_{Eq}}{X_{f(Falling)} - X_{Eq}}\right)\right)}$$

Example with Units

$$122.9264\,\text{kg} = \frac{0.1\,\text{m}^2 \cdot 37\,\text{s}}{\left(\frac{0.10 - 0.05}{2\,\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{0.10 - 0.05}{0.065 - 0.05}\right)\right)}$$

8) Dry Weight of Solid from Initial to Critical Moisture Content for Constant Rate Period Formula

Evaluate Formula

Formula

$$W_S = \frac{t_c \cdot A \cdot N_c}{X_{i(Constant)} - X_c}$$

Example with Units

$$100\,\text{kg} = \frac{190\,\text{s} \cdot 0.1\,\text{m}^2 \cdot 2\,\text{kg/s/m}^2}{0.49 - 0.11}$$

9) Dry Weight of Solid from Initial to Final Moisture Content for Constant Rate Period Formula

Evaluate Formula

Formula

$$W_S = \frac{t_c \cdot A \cdot N_c}{X_{i(Constant)} - X_{f(Constant)}}$$

Example with Units

$$111.7647\,\text{kg} = \frac{190\,\text{s} \cdot 0.1\,\text{m}^2 \cdot 2\,\text{kg/s/m}^2}{0.49 - 0.15}$$

10) Drying Surface Area based on Critical to Final Moisture Content for Falling Rate Period Formula

Evaluate Formula

Formula

$$A = \left(\frac{W_S}{t_f}\right) \cdot \left(\frac{X_c - X_{Eq}}{N_c}\right) \cdot \left(\ln\left(\frac{X_c - X_{Eq}}{X_{f(Falling)} - X_{Eq}}\right)\right)$$

Example with Units

$$0.1124\,\text{m}^2 = \left(\frac{100\,\text{kg}}{37\,\text{s}}\right) \cdot \left(\frac{0.11 - 0.05}{2\,\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{0.11 - 0.05}{0.065 - 0.05}\right)\right)$$

11) Drying Surface Area based on Critical to Final Weight of Moisture for Falling Rate Period Formula

Evaluate Formula

Formula

$$A = \left(\frac{M_c - M_{Eq}}{t_f \cdot N_c}\right) \cdot \left(\ln\left(\frac{M_c - M_{Eq}}{M_{f(Falling)} - M_{Eq}}\right)\right)$$

Example with Units

$$0.1124\,\text{m}^2 = \left(\frac{11\,\text{kg} - 5\,\text{kg}}{37\,\text{s} \cdot 2\,\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{11\,\text{kg} - 5\,\text{kg}}{6.5\,\text{kg} - 5\,\text{kg}}\right)\right)$$

12) Drying Surface Area based on Initial to Critical Moisture Content for Constant Rate Period Formula

Evaluate Formula

Formula

$$A = W_S \cdot \frac{X_{i(Constant)} - X_c}{t_c \cdot N_c}$$

Example with Units

$$0.1\,\text{m}^2 = 100\,\text{kg} \cdot \frac{0.49 - 0.11}{190\,\text{s} \cdot 2\,\text{kg/s/m}^2}$$

13) Drying Surface Area based on Initial to Critical Weight of Moisture for Constant Rate Period Formula

Evaluate Formula

Formula

$$A = \frac{M_{i(Constant)} - M_c}{t_c \cdot N_c}$$

Example with Units

$$0.1\,\text{m}^2 = \frac{49\,\text{kg} - 11\,\text{kg}}{190\,\text{s} \cdot 2\,\text{kg/s/m}^2}$$

14) Drying Surface Area based on Initial to Final Moisture Content for Constant Rate Period Formula

Evaluate Formula

Formula

$$A = W_S \cdot \frac{X_{i(Constant)} - X_{f(Constant)}}{t_c \cdot N_c}$$

Example with Units

$$0.0895\,\text{m}^2 = 100\,\text{kg} \cdot \frac{0.49 - 0.15}{190\,\text{s} \cdot 2\,\text{kg/s/m}^2}$$

15) Drying Surface Area based on Initial to Final Moisture Content for Falling Rate Period Formula

Evaluate Formula

Formula

$$A = \left(\frac{W_S}{t_f}\right) \cdot \left(\frac{X_{i(Falling)} - X_{Eq}}{N_c}\right) \cdot \left(\ln\left(\frac{X_{i(Falling)} - X_{Eq}}{X_{f(Falling)} - X_{Eq}}\right)\right)$$

Example with Units

$$0.0813\,\text{m}^2 = \left(\frac{100\,\text{kg}}{37\,\text{s}}\right) \cdot \left(\frac{0.10 - 0.05}{2\,\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{0.10 - 0.05}{0.065 - 0.05}\right)\right)$$

16) Drying Surface Area based on Initial to Final Weight of Moisture for Constant Rate Period Formula

Evaluate Formula

Formula

$$A = \frac{M_{i(Constant)} - M_{f(Constant)}}{t_c \cdot N_c}$$

Example with Units

$$0.0895\,\text{m}^2 = \frac{49\,\text{kg} - 15\,\text{kg}}{190\,\text{s} \cdot 2\,\text{kg/s/m}^2}$$

17) Drying Surface Area based on Initial to Final Weight of Moisture for Falling Rate Period Formula

Evaluate Formula

Formula

$$A = \left(\frac{M_{i(Falling)} - M_{Eq}}{t_f \cdot N_c}\right) \cdot \left(\ln\left(\frac{M_{i(Falling)} - M_{Eq}}{M_{f(Falling)} - M_{Eq}}\right)\right)$$

Example with Units

$$0.0813\,\text{m}^2 = \left(\frac{10\,\text{kg} - 5\,\text{kg}}{37\,\text{s} \cdot 2\,\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{10\,\text{kg} - 5\,\text{kg}}{6.5\,\text{kg} - 5\,\text{kg}}\right)\right)$$

18) Falling Rate Drying Time from Critical to Final Moisture Formula

Evaluate Formula

Formula

$$t_f = \left(\frac{W_S}{A}\right) \cdot \left(\frac{X_c - X_{Eq}}{N_c}\right) \cdot \left(\ln\left(\frac{X_c - X_{Eq}}{X_{f(Falling)} - X_{Eq}}\right)\right)$$

Example with Units

$$41.5888\,\text{s} = \left(\frac{100\,\text{kg}}{0.1\,\text{m}^2}\right) \cdot \left(\frac{0.11 - 0.05}{2\,\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{0.11 - 0.05}{0.065 - 0.05}\right)\right)$$

19) Falling Rate Drying Time from Critical to Final Weight of Moisture Formula

Evaluate Formula

Formula

$$t_f = \left(\frac{M_c - M_{Eq}}{A \cdot N_c}\right) \cdot \left(\ln\left(\frac{M_c - M_{Eq}}{M_{f(Falling)} - M_{Eq}}\right)\right)$$

Example with Units

$$41.5888\,s = \left(\frac{11\,kg - 5\,kg}{0.1\,m^2 \cdot 2\,kg/s/m^2}\right) \cdot \left(\ln\left(\frac{11\,kg - 5\,kg}{6.5\,kg - 5\,kg}\right)\right)$$

20) Falling Rate Drying Time from Initial to Final Moisture Formula

Evaluate Formula

Formula

$$t_f = \left(\frac{W_S}{A}\right) \cdot \left(\frac{X_{i(Falling)} - X_{Eq}}{N_c}\right) \cdot \left(\ln\left(\frac{X_{i(Falling)} - X_{Eq}}{X_{f(Falling)} - X_{Eq}}\right)\right)$$

Example with Units

$$30.0993\,s = \left(\frac{100\,kg}{0.1\,m^2}\right) \cdot \left(\frac{0.10 - 0.05}{2\,kg/s/m^2}\right) \cdot \left(\ln\left(\frac{0.10 - 0.05}{0.065 - 0.05}\right)\right)$$

21) Falling Rate Drying Time from Initial to Final Weight of Moisture Formula

Evaluate Formula

Formula

$$t_f = \left(\frac{M_{i(Falling)} - M_{Eq}}{A \cdot N_c}\right) \cdot \left(\ln\left(\frac{M_{i(Falling)} - M_{Eq}}{M_{f(Falling)} - M_{Eq}}\right)\right)$$

Example with Units

$$30.0993\,s = \left(\frac{10\,kg - 5\,kg}{0.1\,m^2 \cdot 2\,kg/s/m^2}\right) \cdot \left(\ln\left(\frac{10\,kg - 5\,kg}{6.5\,kg - 5\,kg}\right)\right)$$

22) Final Moisture Content based on Critical to Final Moisture Content for Falling Rate Period Formula

Evaluate Formula

Formula

$$X_{f(Falling)} = \left(\frac{X_c - X_{Eq}}{\exp\left(\frac{A \cdot t_f \cdot N_c}{W_S \cdot \left(X_c - X_{Eq}\right)}\right)}\right) + X_{Eq}$$

Example with Units

$$0.0675 = \left(\frac{0.11 - 0.05}{\exp\left(\frac{0.1\,m^2 \cdot 37\,s \cdot 2\,kg/s/m^2}{100\,kg \cdot \left(0.11 - 0.05\right)}\right)}\right) + 0.05$$

23) Final Moisture Content based on Initial Moisture Content for Constant Rate Period Formula

Evaluate Formula

Formula

$$X_{f(Constant)} = X_{i(Constant)} - \left(\frac{A \cdot t_c \cdot N_c}{W_S}\right)$$

Example with Units

$$0.11 = 0.49 - \left(\frac{0.1\,m^2 \cdot 190\,s \cdot 2\,kg/s/m^2}{100\,kg}\right)$$

24) Final Moisture Content based on Initial to Final Moisture Content for Falling Rate Period Formula

Evaluate Formula

Formula

$$X_{f(Falling)} = \left(\frac{X_{i(Falling)} - X_{Eq}}{\exp\left(\frac{A \cdot t_f \cdot N_c}{W_S \cdot \left(X_{i(Falling)} - X_{Eq}\right)}\right)}\right) + X_{Eq}$$

Example with Units

$$0.0614 = \left(\frac{0.10 - 0.05}{\exp\left(\frac{0.1\,m^2 \cdot 37\,s \cdot 2\,kg/s/m^2}{100\,kg \cdot \left(0.10 - 0.05\right)}\right)}\right) + 0.05$$

25) Initial Moisture Content based on Critical Moisture Content for Constant Rate Period Formula

Evaluate Formula

Formula

$$X_{i(Constant)} = \left(\frac{A \cdot t_c \cdot N_c}{W_S}\right) + X_c$$

Example with Units

$$0.49 = \left(\frac{0.1\,m^2 \cdot 190\,s \cdot 2\,kg/s/m^2}{100\,kg}\right) + 0.11$$

26) Initial Moisture Content based on Final Moisture Content for Constant Rate Period Formula

Evaluate Formula

Formula

$$X_{i(Constant)} = \left(\frac{A \cdot t_c \cdot N_c}{W_S}\right) + X_{f(Constant)}$$

Example with Units

$$0.53 = \left(\frac{0.1\,m^2 \cdot 190\,s \cdot 2\,kg/s/m^2}{100\,kg}\right) + 0.15$$

27) Rate of Constant Drying Period based on Critical Moisture Content Formula

Evaluate Formula

Formula

$$N_c = W_S \cdot \frac{X_{i(Constant)} - X_c}{A \cdot t_c}$$

Example with Units

$$2\,kg/s/m^2 = 100\,kg \cdot \frac{0.49 - 0.11}{0.1\,m^2 \cdot 190\,s}$$

28) Rate of Constant Drying Period based on Critical to Final Moisture Content for Falling Rate Period Formula

Evaluate Formula

Formula

$$N_c = \left(\frac{W_S}{t_f}\right) \cdot \left(\frac{X_c - X_{Eq}}{A}\right) \cdot \left(\ln\left(\frac{X_c - X_{Eq}}{X_{f(Falling)} - X_{Eq}}\right)\right)$$

Example with Units

$$2.248\,\text{kg/s/m}^2 = \left(\frac{100\,\text{kg}}{37\,\text{s}}\right) \cdot \left(\frac{0.11 - 0.05}{0.1\,\text{m}^2}\right) \cdot \left(\ln\left(\frac{0.11 - 0.05}{0.065 - 0.05}\right)\right)$$

29) Rate of Constant Drying Period based on Critical to Final Weight of Moisture for Falling Rate Period Formula

Evaluate Formula

Formula

$$N_c = \left(\frac{M_c - M_{Eq}}{t_f \cdot A}\right) \cdot \left(\ln\left(\frac{M_c - M_{Eq}}{M_{f(Falling)} - M_{Eq}}\right)\right)$$

Example with Units

$$2.248\,\text{kg/s/m}^2 = \left(\frac{11\,\text{kg} - 5\,\text{kg}}{37\,\text{s} \cdot 0.1\,\text{m}^2}\right) \cdot \left(\ln\left(\frac{11\,\text{kg} - 5\,\text{kg}}{6.5\,\text{kg} - 5\,\text{kg}}\right)\right)$$

30) Rate of Constant Drying Period based on Final Moisture Content Formula

Evaluate Formula

Formula

$$N_c = W_S \cdot \frac{X_{i(Constant)} - X_{f(Constant)}}{A \cdot t_c}$$

Example with Units

$$1.7895\,\text{kg/s/m}^2 = 100\,\text{kg} \cdot \frac{0.49 - 0.15}{0.1\,\text{m}^2 \cdot 190\,\text{s}}$$

31) Rate of Constant Drying Period based on Initial to Final Moisture Content for Falling Rate Period Formula

Evaluate Formula

Formula

$$N_c = \left(\frac{W_S}{t_f}\right) \cdot \left(\frac{X_{i(Falling)} - X_{Eq}}{A}\right) \cdot \left(\ln\left(\frac{X_{i(Falling)} - X_{Eq}}{X_{f(Falling)} - X_{Eq}}\right)\right)$$

Example with Units

$$1.627\,\text{kg/s/m}^2 = \left(\frac{100\,\text{kg}}{37\,\text{s}}\right) \cdot \left(\frac{0.10 - 0.05}{0.1\,\text{m}^2}\right) \cdot \left(\ln\left(\frac{0.10 - 0.05}{0.065 - 0.05}\right)\right)$$

32) Rate of Constant Drying Period based on Initial to Final Weight of Moisture for Falling Rate Period Formula

Evaluate Formula

Formula

$$N_c = \left(\frac{M_{i(Falling)} - M_{Eq}}{t_f \cdot A}\right) \cdot \left(\ln\left(\frac{M_{i(Falling)} - M_{Eq}}{M_{f(Falling)} - M_{Eq}}\right)\right)$$

Example with Units

$$1.627\,\text{kg/s/m}^2 = \left(\frac{10\,\text{kg} - 5\,\text{kg}}{37\,\text{s} \cdot 0.1\,\text{m}^2}\right) \cdot \left(\ln\left(\frac{10\,\text{kg} - 5\,\text{kg}}{6.5\,\text{kg} - 5\,\text{kg}}\right)\right)$$

33) Total Drying Time based on Constant Drying Time and Falling Drying Time Formula

Evaluate Formula

Formula

$$t = t_c + t_f$$

Example with Units

$$227\,\text{s} = 190\,\text{s} + 37\,\text{s}$$

Variables used in list of Important Formulas in Drying Mass Transfer Operation above

- **A** Drying Surface Area *(Square Meter)*
- M_c Critical Weight of Moisture *(Kilogram)*
- M_{Eq} Equilibrium Weight of Moisture *(Kilogram)*
- $M_{f(Constant)}$ Final Weight of Moisture for Constant Rate Period *(Kilogram)*
- $M_{f(Falling)}$ Final Weight of Moisture for Falling Rate Period *(Kilogram)*
- $M_{i(Constant)}$ Initial Weight of Moisture for Constant Rate *(Kilogram)*
- $M_{i(Falling)}$ Initial Weight of Moisture for Falling Rate Period *(Kilogram)*
- N_c Rate of Constant Drying Period *(Kilogram per Second per Square Meter)*
- **t** Total Drying Time *(Second)*
- t_c Constant Rate Drying Time *(Second)*
- t_f Falling Rate Drying Time *(Second)*
- W_S Dry Weight of Solid *(Kilogram)*
- X_c Critical Moisture Content
- X_{Eq} Equilibrium Moisture Content
- $X_{f(Constant)}$ Final Moisture Content for Constant Rate Period
- $X_{f(Falling)}$ Final Moisture Content for Falling Rate Period
- $X_{i(Constant)}$ Initial Moisture Content for Constant Rate Period
- $X_{i(Falling)}$ Initial Moisture Content for Falling Rate Period

Constants, Functions, Measurements used in list of Important Formulas in Drying Mass Transfer Operation above

- Functions: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Functions: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Mass Flux** in Kilogram per Second per Square Meter ($kg/s/m^2$)
  Mass Flux Unit Conversion

Download other Important Drying PDFs

- Important Moisture Content Formulas
- Important Ratio of Moisture Content Formulas
- Important Weight of Moisture Formulas

Try our Unique Visual Calculators

- Percentage error
- LCM of three numbers
- Subtract fraction

Please SHARE this PDF with someone who needs it!

This PDF can be downloaded in these languages

English Spanish French German Russian Italian Portuguese Polish Dutch

7/9/2024 | 1:30:52 PM UTC