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Important Formulas in Drying Mass Transfer Operation

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List of 33 Important Formulas in Drying Mass Transfer Operation

Important Formulas in Drying Mass Transfer Operation

1) Constant Drying Time from Initial to Critical Moisture Content

Open Calculator

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

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

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

Open Calculator

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

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

3) Constant Drying Time from Initial to Final Moisture Content

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

ex $$88.96619kg = \frac{0.1m^2 \cdot 37s}{\left(\frac{0.11-0.05}{2kg/s/m^2}\right) \cdot \left(\ln\left(\frac{0.11-0.05}{0.065-0.05}\right)\right)}$$

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

ex $$0.112402\text{m}^2 = \left(\frac{100\text{kg}}{37\text{s}}\right) \cdot \left(\frac{0.11 - 0.05}{2\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{0.11 - 0.05}{0.065 - 0.05}\right)\right)$$

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

Open Calculator

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

ex $$0.112402\text{m}^2 = \left(\frac{11\text{kg} - 5\text{kg}}{37\text{s} \cdot 2\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{11\text{kg} - 5\text{kg}}{6.5\text{kg} - 5\text{kg}}\right)\right)$$

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

$$0.089474\text{m}^2 = 100\text{kg} \cdot \frac{0.49 - 0.15}{190\text{s} \cdot 2\text{kg/s/m}^2}$$

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

Open Calculator

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

$$0.08135\text{m}^2 = \left(\frac{100\text{kg}}{37\text{s}}\right) \cdot \left(\frac{0.10 - 0.05}{2\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{0.10 - 0.05}{0.065 - 0.05}\right)\right)$$

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

Open Calculator

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

ex $$0.089474\text{m}^2 = \frac{49\text{kg} - 15\text{kg}}{190\text{s} \cdot 2\text{kg/s/m}^2}$$

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

Open Calculator

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

ex $$0.08135\text{m}^2 = \left(\frac{10\text{kg} - 5\text{kg}}{37\text{s} \cdot 2\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{10\text{kg} - 5\text{kg}}{6.5\text{kg} - 5\text{kg}}\right)\right)$$

18) Falling Rate Drying Time from Critical to Final Moisture

Open Calculator

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

ex $$41.58883\text{s} = \left(\frac{100\text{kg}}{0.1\text{m}^2}\right) \cdot \left(\frac{0.11 - 0.05}{2\text{kg/s/m}^2}\right) \cdot \left(\ln\left(\frac{0.11 - 0.05}{0.065 - 0.05}\right)\right)$$

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

Open Calculator

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

ex $$41.58883s = \left(\frac{11kg - 5kg}{0.1m^2 \cdot 2kg/s/m^2}\right) \cdot \left(\ln\left(\frac{11kg - 5kg}{6.5kg - 5kg}\right)\right)$$

20) Falling Rate Drying Time from Initial to Final Moisture

Open Calculator

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

ex $$30.09932s = \left(\frac{100kg}{0.1m^2}\right) \cdot \left(\frac{0.10 - 0.05}{2kg/s/m^2}\right) \cdot \left(\ln\left(\frac{0.10 - 0.05}{0.065 - 0.05}\right)\right)$$

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

Open Calculator

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

ex $$30.09932s = \left(\frac{10kg - 5kg}{0.1m^2 \cdot 2kg/s/m^2}\right) \cdot \left(\ln\left(\frac{10kg - 5kg}{6.5kg - 5kg}\right)\right)$$

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

Open Calculator

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

ex $$0.067479 = \left(\frac{0.11 - 0.05}{\exp\left(\frac{0.1\text{m}^2 \cdot 37\text{s} \cdot 2\text{kg/s/m}^2}{100\text{kg} \cdot (0.11 - 0.05)} \right)} \right) + 0.05$$

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

Open Calculator

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

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

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

Open Calculator

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

ex $$0.061382 = \left(\frac{0.10 - 0.05}{\exp\left(\frac{0.1\text{m}^2 \cdot 37\text{s} \cdot 2\text{kg/s/m}^2}{100\text{kg} \cdot (0.10 - 0.05)} \right)} \right) + 0.05$$

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

ex

$$2.248045\text{kg/s/m}^2 = \left(\frac{100\text{kg}}{37\text{s}}\right) \cdot \left(\frac{0.11 - 0.05}{0.1\text{m}^2}\right) \cdot \left(\ln\left(\frac{0.11 - 0.05}{0.065 - 0.05}\right)\right)$$

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

Open Calculator

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

ex $$2.248045\text{kg/s/m}^2 = \left(\frac{11\text{kg} - 5\text{kg}}{37\text{s} \cdot 0.1\text{m}^2}\right) \cdot \left(\ln\left(\frac{11\text{kg} - 5\text{kg}}{6.5\text{kg} - 5\text{kg}}\right)\right)$$

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

Open Calculator

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

ex $$1.789474\text{kg/s/m}^2 = 100\text{kg} \cdot \frac{0.49 - 0.15}{0.1\text{m}^2 \cdot 190\text{s}}$$

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

Open Calculator

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

ex $$1.62699\text{kg/s/m}^2 = \left(\frac{100\text{kg}}{37\text{s}}\right) \cdot \left(\frac{0.10 - 0.05}{0.1\text{m}^2}\right) \cdot \left(\ln\left(\frac{0.10 - 0.05}{0.065 - 0.05}\right)\right)$$

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

Open Calculator

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

ex $$1.62699\text{kg/s/m}^2 = \left(\frac{10\text{kg} - 5\text{kg}}{37\text{s} \cdot 0.1\text{m}^2}\right) \cdot \left(\ln\left(\frac{10\text{kg} - 5\text{kg}}{6.5\text{kg} - 5\text{kg}}\right)\right)$$

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

Open Calculator

$$t = t_c + t_f$$

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

Variables Used

- **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

- Function: **exp**, exp(Number)
  Exponential function
- Function: **ln**, ln(Number)
  Natural logarithm function (base e)
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Mass Flux** in Kilogram per Second per Square Meter (kg/s/m²)
  Mass Flux Unit Conversion

Check other formula lists

- **Important Formulas in Drying Mass Transfer Operation**
- **Moisture Content Formulas**
- **Ratio of Moisture Content Formulas**
- **Weight of Moisture Formulas**

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