BioSIM' Development Rate Models

Standardized Parameters

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Scale factor	ψ
Sharpe&all parameters	$H_A, H_L, T_L, T_{k_L}, H_H, T_H, T_{k_H}, T_{k_o}$
Sharpe&all parameters scale factor	$F = 10\,000$
General parameters	$k, k_0, k_1, k_2, k_3, k_4$
Temperature	T °C $\left(\text{or } T_k \text{ in Kelvin}\right)$
Lower	T_b °C
Optimum	T_o °C
Upper	T_m °C
Others	T_ω
Temperature scale	$\Delta_T,\ \Delta_{T_b},\ \Delta_{T_m}$
Intermediate computation	$\beta,\ \beta_1,\ \beta_2,\ \Omega$

- Allahyari (2005)

$$\psi\left(\beta^{k_1}\right)\left(1-\beta^{k_2}\right), \quad \beta = \frac{T-T_b}{T_m-T_b}$$

- Analytis (1977)

$$\psi\left(T-T_b\right)^{k_1}\left(T_m-T\right)^{k_2}$$

- Angilletta (2006)

$$\psi\, e^{-\frac{1}{2}\left|\frac{T-T_o}{\Delta T}\right|^{k}}$$

- Bieri (1983)

$$\left[k_1\left(T-T_b\right)\right]-\left[k_2\, e^{T-T_\omega}\right]$$

- Boatman (2017)

$$\psi\sin\left[\pi\left(\frac{T-T_b}{T_m-T_b}\right)^{k_0}\right]^{k_1}$$

- Briere1 (1999)

$$\psi\, T\left(T-T_b\right)\left(T_m-T\right)^{\frac{1}{2}}$$

- Briere2 (1999)

$$\psi\, T\left(T - T_b\right)\left(T_m - T\right)^{\frac{1}{k}}$$

- Damos (2011)

$$\psi\left(\frac{1}{1 + k_1\, T + k_2\, T^2}\right)$$

- Deva&Higgis

$$\psi\left[10^{-\Omega}\left(1 - k_2 + k_2\,\Omega\right)\right],\;\; \Omega = \left(\frac{\beta_1 + e^{k_1\,\beta_1}}{\beta_2}\right)^2, \quad \beta_1 = \left(\frac{T - T_o}{T_o - T_b}\right) - \left(\frac{1}{1 + 0.28\,k_1 + 0.72\,\ln\left(1 + k_1\right)}\right)$$

$$\beta_2 = \frac{1 + k_1}{1 + 1.5\,k_1 + 0.39\,k_1^2}$$

- Hansen (2011)

$$\psi\left\{\left[e^{k\,(T - T_m)} - 1\right] - \left[e^{k\,(T_m - T_b)} - 1\right] e^{\left(\frac{T - T_m}{\Delta T}\right)}\right\}$$

- Hilbert&Logan (1983)

$$\psi\left[\frac{\left(T - T_b\right)^2}{\left(T - T_b\right)^{2 + k^2}} - e^{-\frac{T\omega - \left(T - T_b\right)}{\Delta T}}\right]$$

- Hilbert&LoganIII

$$\psi\left[\frac{T^2}{T^2 + k^2} - e^{-\frac{T_m - T}{\Delta T}}\right]$$

- Huey&Stevenson (1979)

$$\psi\left(T-T_b\right)\left(1-e^{k\,(T-T_m)}\right)$$

- Janisch1 (1932)

$$\frac{1}{\psi}\left(\frac{2}{e^{k\,(T-T_o)}+e^{-k\,(T-T_o)}}\right)$$

- Janisch2 (1932)

$$\frac{1}{\psi}\left(\frac{2}{k_1^{\left(T-T_o\right)}+k_2^{\left(T_o-T\right)}}\right)$$

- Johnson (1974)

$$\psi\left[\frac{\beta_1\,T_k\,e^{-\frac{k_1}{T_k}}}{1+e^{\left(\beta_2-\frac{k_2}{T_k}\right)}}\right],\ \beta_1=\frac{k_2}{\left(k_2-k_1\right)\,T_{k_o}\,e^{-\frac{k_1}{T_{k_o}}}},\ \beta_2=\frac{k_2}{T_{k_o}}-\ln\left(\frac{k_2}{k_1}-1\right)$$

- Kontodimas (2004)

$$\psi\left(T-T_b\right)^2\left(T_m-T\right)$$

- Lactin1 (1995)

$$e^{k\,T}-e^{\left(k\,T_m-\frac{T_m-T}{\Delta T}\right)}$$

• Lactin2 (1995)

$$k_1 + e^{k_2 T} - e^{\left(k_2 T_m - \frac{T_m - T}{\Delta T}\right)}$$

• Lamb (1992)

$$\psi\, e^{-\frac{1}{2}\left(\frac{T - T_o}{\Delta T_x}\right)^2}, \ \Delta_{T_x} = \begin{cases} \Delta T_1 & T \le T_o \\ \Delta T_2 & T > T_o \end{cases}$$

• Lobry&Rosso&Flandrois (1993)

$$\psi \frac{\left(T - T_m\right)\left(T - T_b\right)^2}{\left(T_o - T_b\right)\left[\left(T_o - T_b\right)\left(T - T_o\right) - \left(T_o - T_m\right)\left(T_o + T_b - 2\,T\right)\right]}$$

• Logan10 (1976)

$$\psi\left(\frac{1}{1 + k_1\, e^{-k_2 T}} - e^{-\frac{T_m - T}{\Delta T}}\right)$$

• Logan6 (1976)

$$\psi\left(e^{k\,T} - e^{\left(k\,T_m - \frac{T_m - T}{\Delta T}\right)}\right)$$

• LoganTb (1979)

$$\psi\, e^{\left(k\left(T - T_b\right) - e^{k\frac{T - T_b}{\Delta T}}\right)}$$

- ONeill (1972)

$$\psi\, \beta^{k}\, e^{k(1-\beta)}, \quad \beta = \frac{T_m - T}{T_m - T_o}$$

- Poly1

$$k_0 + k_1\, T$$

- Poly2

$$k_0 + k_1\, T + k_2\, T^2$$

- Poly3

$$k_0 + k_1\, T + k_2\, T^2 + k_3\, T^3$$

- Ratkowsky (1983)

$$\psi^2 \left[\left(T - T_b \right) \left(1 - e^{k\left(T - T_m\right)} \right) \right]^2$$

- Regniere (1982)

$$\psi \left[e^{k\,\beta} - e^{\left(k - \frac{1-\beta}{\Delta T} \right)} \right], \quad \beta = \frac{T - T_{\omega b}}{T_m - T_{\omega b}}$$

- Regniere (1987)

$$\psi\left[\left(\frac{1}{1+e^{\left(k_1 - k_2\,\beta\right)}}\right) - e^{\left(\frac{\beta-1}{\Delta T}\right)}\right], \qquad \beta = \frac{T - T_{\omega b}}{T_m - T_{\omega b}}$$

- Regniere (2012)

$$\psi\left[e^{k\left(T - T_b\right)} - \left(\left(\frac{T_m - T}{T_m - T_b}\right) e^{-k\left(\frac{T - T_b}{\Delta T_b}\right)}\right) - \left(\frac{T - T_b}{T_m - T_b}\right) e^{k\left(T_m - T_b\right) - \left(\frac{T_m - T}{\Delta T_m}\right)}\right]$$

- Room (1986)

$$\psi\, e^{-k_x\left(T - T_o\right)^2}, \qquad k_x = \begin{cases} k_1 & T \le T_o \\ k_2 & T > T_o \end{cases}$$

- Saint−Amant (2021)

$$\psi\, e^{\left[-k_1\left(T_{\omega_o} - T\right)^2 + \left(\frac{1}{-k_2\left(T_m - T\right)}\right)\right]}$$

- Saint−Amant (2022)

$$\psi\left[1 - e^{-k_1\left(T - T_b\right)^{kk_1}} - e^{-k_2\left(T_m - T\right)^{kk_2}}\right]$$

- Schoolfield (1981)

$$\frac{\rho_{25}\left[\frac{T_k}{298}\right] e^{\left(\frac{F\,H_A}{1.987}\right)\left(\frac{1}{298} - \frac{1}{T_k}\right)}}{1 + e^{\left(\frac{F\,H_L}{1.987}\right)\left(\frac{1}{T_{kL}} - \frac{1}{T_k}\right)} + e^{\left(\frac{F\,H_H}{1.987}\right)\left(\frac{1}{T_{kH}} - \frac{1}{T_k}\right)}}$$

- Sharpe&DeMichele (1977)

$$\frac{\rho_{25}\left[\frac{T_k}{T_{k_o}}\right] e^{\left(\frac{F\,H_A}{1.987}\right)\left(\frac{1}{T_{k_o}}-\frac{1}{T_k}\right)}}{1+e^{\left(\frac{F\,H_L}{1.987}\right)\left(\frac{1}{T_{kL}}-\frac{1}{T_k}\right)}+e^{\left(\frac{F\,H_H}{1.987}\right)\left(\frac{1}{T_{kH}}-\frac{1}{T_k}\right)}}$$

- Shi (2011)

$$\psi\left(1-e^{-k_1\left(T-T_b\right)}\right)\left(1-e^{k_2\left(T-T_m\right)}\right)$$

- Shi (2016)

$$\psi\left(\frac{T_m-T}{T_m-T_o}\right)\left(\frac{T-T_b}{T_o-T_b}\right)^{\left(\frac{T_o-T_b}{T_m-T_o}\right)}$$

- Stinner (1974)

$$\begin{cases} \psi\,\dfrac{1}{1+e^{k_1+k_2T}} & T<T_o \\ \psi\,\dfrac{1}{1+e^{k_1+k_2(2\cdot T_o-T)}} & T\geq T_o \end{cases}$$

- Taylor (1981)

$$\psi\, e^{-\frac{1}{2}\left(\frac{T-T_o}{\Delta T}\right)^2}$$

- Wagner (1988)

$$\frac{\rho_{25}\left(\frac{T_k}{298.15}\right) e^{\left(\frac{F\,H_A}{1.987}\right)\left(\frac{1}{298.15}-\frac{1}{T_k}\right)}}{1+e^{\left(\frac{F\,H_L}{1.987}\right)\left(\frac{1}{T_{kL}}-\frac{1}{T_k}\right)}}$$

- Wang&Engel (1998)

$$\psi\left[\frac{2\left(T-T_b\right)^{\beta}\left(T_o-T_b\right)^{\beta}-\left(T-T_b\right)^{2\cdot\beta}}{\left(T_o-T_b\right)^{2\cdot\beta}}\right], \quad \beta = \frac{\ln(2)}{\ln\left(\frac{T_m-T_b}{T_o-T_b}\right)}$$

- Wang&Lan&Ding (1982)

$$\psi\left(\frac{1}{1+e^{-k\left(T-T_o\right)}}\right)\left(1-e^{-\frac{T-T_b}{\Delta T}}\right)\left(1-e^{-\frac{T_m-T}{\Delta T}}\right)$$

- Yan&Hunt (1999)

$$\psi\left(\frac{T_m-T}{T_m-T_o}\right)\left(\frac{T}{T_o}\right)^{\frac{T_o}{T_m-T_o}}$$

- Yin (1995)

$$e^{\psi}\left(T-T_b\right)^{k_1}\left(T_m-T\right)^{k_2}$$

Reference

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