# BioSIM' Development Rate Models

## Standardized Parameters

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|---|---|
| Scale factor | $\psi$ |
| General Parameters | $k, k_0, k_1, k_2, k_3, k_4$ |
| Sharpe&all Parameters | $H_A, H_L, T_L, T_{k_L}, H_H, T_H, T_{k_H}$ |
| Temperature | $T\ °C \quad \left(\text{or } T_k \text{ in Kelvin}\right)$ |
| Lower | $T_b\ °C$ |
| Optimum | $T_o\ °C$ |
| Upper | $T_m\ °C$ |
| Others | $T_\omega$ |
| Temperature scale | $\Delta_T,\ \Delta_{T_b},\ \Delta_{T_m}$ |
| Intermediate computation | $\beta,\ \beta_1,\ \beta_2,\ \Omega$ |

01• Allahyari ( 2005 )

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

02• Analytis ( 1977 )

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

03• Angilletta ( 2006 )

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

04• Bieri ( 1983 )

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

05• Briere1 ( 1999 )

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

06• Briere2 ( 1999 )

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

07• Damos ( 2008 )

$$\psi\left(k-\frac{T}{10}\right)\left(\frac{T}{10}\right)^{k}$$

08• Damos ( 2011 )

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

09• Deutsch ( 2008 )

$$\begin{cases} \psi\left[e^{-k\,(T-T_o)^2}\right] & T \le T_o \\ \psi\left[1-\left(\frac{T-T_o}{T_o-T_m}\right)^2\right] & T > T_o \end{cases}$$

10• Deva&Higgis

$$\psi\left[10^{-\Omega}\left(1-k_2+k_2\,\Omega\right)\right],\quad \Omega=\left(\frac{\beta_1+e^{k_1\beta_1}}{\beta_2}\right)^2,\quad \beta_1=\left(\frac{T-T_m}{T_m-T_b}\right)-\left(\frac{1}{1+0.28\,k_1+0.72\ln\left(1+k_1\right)}\right),\quad \beta_2=\frac{1+k_1}{1+1.5\,k_1+0.39\,k_1^2}$$

11• Hansen ( 2011 )

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

12• Hilbert&Logan ( 1983 )

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

13• Hilbert&LoganIII

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

14• Huey&Stevenson ( 1979 )

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

15• Janisch1 ( 1932 )

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

16• Janisch2 ( 1932 )

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

17• Johnson ( 1974 )

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

18• Kontodimas ( 2004 )

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

19• Lactin1 ( 1995 )

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

20• Lactin2 ( 1995 )

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

21• Lamb ( 1992 )

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

22• Lobry&Rosso&Flandrois ( 1993 )

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

23• Logan10 ( 1976 )

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

24• Logan6 ( 1976 )

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

25• LoganTb

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

26• ONeill ( 1972 )

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

27• Poly1

$$k_0 + k_1\, T$$

28• Poly2

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

29• Poly3

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

30• Poly4

$$k_0 + k_1\, T + k_2\, T^2 + k_3\, T^3 + k_4\, T^4$$

31• Pradham ( 1946 )

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

32• Ratkowsky ( 1983 )

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

33• Regniere ( 1982 )

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

34• Regniere ( 1987 )

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

35• Regniere ( 2012 )

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

36• Room ( 1986 )

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

37• Saint–Amant ( 2019 )

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

38• Schoolfield ( 1981 )

$$\frac{\rho_{25}\left[\frac{T_k}{298}\right]e^{\left(\frac{H_A}{1.987}\right)\left(\frac{1}{298}-\frac{1}{T_k}\right)}}{1+e^{\left(\frac{H_L}{1.987}\right)\left(\frac{1}{T_L}-\frac{1}{T_k}\right)}+e^{\left(\frac{H_H}{1.987}\right)\left(\frac{1}{T_H}-\frac{1}{T_k}\right)}}$$

39• Sharpe&DeMichele ( 1977 )

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

40• Shi ( 2011 )

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

41• Shi ( 2016 )

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

42• Stinner ( 1974 )

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

43• Taylor ( 1981 )

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

44• Wagner ( 1988 )

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

45• Wang&Engel ( 1998 )

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

46• Wang&Lan&Ding ( 1982 )

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

47• Yan&Hunt ( 1999 )

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

48• Yin ( 1995 )

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