Rheological Properties of biscuit dough

Temperature dependence: polynomial fitting of s from oscillatory data

$$s(T) = exp\left(A_{Esse} + B_{Esse} \cdot T + C_{Esse} \cdot T^2 + D_{Esse} \cdot T^3 + E_{Esse} \cdot T^4 + F_{Esse} \cdot T^5\right)$$

$A_{Esse} = 39.10635203$

$B_{Esse} = -2.29384768$

$C_{Esse} = 0.070502236$

$D_{Esse} = -0.001074$

$E_{Esse} = 0.00000808715$

$F_{Esse} = -0.000000023735$

Temperature dependence: polynomial fitting of α from oscillatory data

$$\alpha = exp\left(A_{Alfa} + B_{Alfa} \cdot T + C_{Alfa} \cdot T^2 + D_{Alfa} \cdot T^3 + E_{Alfa} \cdot T^4\right)$$

$A_{Alfa} = -2.868703$

$B_{Alfa} = 0.104545$

$C_{Alfa} = -0.001971$

$D_{Alfa} = 0.0000127$

$E_{Alfa} = -0.0000000262$

Effect of the heating rate on Weak Gel parameters

$$G = s \cdot (Hs) \cdot t^{-\alpha \cdot (H\alpha)}$$

Heating rate effect on stress Hs

$42°C < T \leq 84°C$ and $dT/dt>1$

$$Hs = \left(a_{2s} \cdot T + a_{3s}\right) \cdot log\left(\frac{dT}{dt}\right) + 1$$

$84°C < T \le 110°C$ and $dT/dt>1$

$$Hs = (-0.1962) \cdot log\left(\frac{dT}{dt}\right) + 1$$

$T > 110°C$

$$Hs = 1$$

$a_{2s} = -0.0025$

$a_{3s} = 0.0177$

<u>Heating rate effect on the power index $H\alpha$</u>

$42°C < T \le 110°C$ and $dT/dt>1$

$$H\alpha = (a_{1n} \cdot T + a_{2n}) \cdot log\left(\frac{dT}{dt}\right) + 1$$

$T > 110°C$

$$H\alpha = 1$$

$\alpha_{1\alpha} = 0.0057$

$\alpha_{2\alpha} = -0.2181$

Rupture work from Bi-axial extension measurements

$$W_{rupt} = 64000 \ Watt/m$$

Elastic recovery from creep measurements

Flour 1:

$J_0 = 0.593$

$J_1 = 0.139$

$J_2 = 0.133$

$J_3 = 0.133$

$\tau_1 = 3.833$

$\tau_2 = 58.1$

$\tau_3 = 395.202$

Flour 2:

$J_0 = 0.5693$

$J_1 = 0.1531$

$J_2 = 0.1327$

$J_3 = 0.1446$

$\tau_1 = 3.783$

$\tau_2 = 58.92$

$\tau_3 = 402.5133$

The data for the memory are obtained through the following equation:

$$t^* = t_c - (A \cdot t_c + B) \cdot (1 + a \cdot \varepsilon^3)^{1/2}$$

Flour1:

$A = 0.1778$

$B = 5.4734$

$a = 7805.6$

Flour2:

$A = 0.1659$

$B = 5.2781$

$a = 7805.6$

Heat and Mass transport coefficients.

Heat transport coefficient

$h_{ext} = 5$ [W/m^2]

Mass transport coefficient

Water in air [mole/(s·m^2)]:

$$K_{yW} = \frac{h_{ext} \cdot 1000}{MW_{Air} \cdot C_{PAir}} \cdot \left(\frac{C_{PAir} \cdot P_{atm} \cdot MW_{Air}}{101325 \cdot 0.0821 \cdot T} \cdot \frac{D_{W/A}}{K_{Air}} \right)^{2/3}$$

Ammonia in air [mole/(s·m^2)]:

$$K_{yNH_3} = \frac{h_{ext} \cdot 1000}{MW_{Air} \cdot C_{PAir}} \cdot \left(\frac{C_{PAir} \cdot P_{atm} \cdot MW_{Air}}{101325 \cdot 0.0821 \cdot T} \cdot \frac{D_{NH_3/A}}{K_{Air}} \right)^{2/3}$$

Carbon Dioxide in air [mole/(s·m^2)]:

$$K_{yCO_2} = \frac{h_{ext} \cdot 1000}{MW_{Air} \cdot C_{PAir}} \cdot \left(\frac{C_{PAir} \cdot P_{atm} \cdot MW_{Air}}{101325 \cdot 0.0821 \cdot T} \cdot \frac{D_{CO_2/Air}}{K_{Air}} \right)^{2/3}$$