Model parameters

Diffusivities

* Radial and axial diffusivity of oxygen in pear tissue

$$D_{u_r} = 2.8 \times 10^{-10}\ \mathrm{m^2/s} \quad , \quad D_{u_z} = 1.10 \times 10^{-9}\ \mathrm{m^2/s}$$

* Radial and axial diffusivity of carbon dioxide in pear tissue

$$D_{v_r} = 2.32 \times 10^{-9}\ \mathrm{m^2/s} \quad , \quad D_{v_z} = 6.97 \times 10^{-9}\ \mathrm{m^2/s}$$

Respiration kinetic parameters

* Maximum oxygen consumption rate

$$V_{mu} = V_{mu,ref} \exp\left[\frac{E_{a,vmu,ref}}{R_g}\left(\frac{1}{T_{ref}} - \frac{1}{T}\right)\right]$$

  with T_{ref} a reference temperature (in degree Kelvin), T the actual temperature (in degree Kelvin) and $R_g = 8.314$ J/(mol K) the universal gas constant.

  - Maximum oxygen consumption rate at $T_{ref} = 293.15$ K (= 20^{o}C):

    $V_{mu,ref}$: 2.39×10^{-4} mol/(m^3 s).
  - Activation energy for oxygen consumption:

    $E_{a,vmu,ref}$: 80200 J/mol.

* Maximum fermentative carbon dioxide production rate:

$$V_{mfv} = V_{mfv,ref} \exp\left[\frac{E_{a,vmfv,ref}}{R_g}\left(\frac{1}{T_{ref}} - \frac{1}{T}\right)\right].$$

  - Maximum fermentative carbon dioxide production rate at $T_{ref} = 293.15$K:

    $V_{mfv,ref}$: 1.61×10^{-4} mol/(m^3 s).
  - Activation energy for fermentative carbon dioxide production:

    $E_{a,vmfv,ref}$: 56700 J/mol.

* Michaelis-Menten constants and respiration quotient.

  - Michaelis-Menten constant for oxygen consumption:

    K_{mu}: 0.4103 mol/m^3.
  - Michaelis-Menten constant for non-competitive carbon dioxide inhibition:

    K_{mv}: 27.2438 mol/m^3.
  - Michaelis-Menten constant of oxygen inhibition on fermentative carbon dioxide production:

    K_{mfu}: 0.1149 mol/m^3.
  - The respiration quotient:

    r_q: 0.97.

Convective mass transfer coefficients

$h_u = 7 \times 10^{-7}$ m/s , $h_v = 7.5 \times 10^{-7}$ m/s.

Ambient conditions

* Atmospheric pressure

  $p_{atm} = 101300$ Pa.

* Temperature

  $T = T_{cel} + 273.15$
  with T the temperature in degree Kelvin (K) and T_{cel} the temperature in degree Celsius (^{o} C).

* Ambient oxygen and carbon dioxide concentrations

$$\begin{aligned} C_{uamb} &= \frac{p_{atm}\ \eta_u}{R_g T} \\ C_{vamb} &= \frac{p_{atm}\ \eta_v}{R_g T} \end{aligned}$$

  with p_{atm} (Pa) the atmospheric pressure, η_u and η_v the fraction (percentage) oxygen and carbon dioxide in the (controlled) atmosphere, respectively; R_g the universal gas constant (J/(mol K)); and T the ambient temperature in degree Kelvin (K).

  Note: $0 \leq \eta_u \leq 1$, $0 \leq \eta_v \leq 1$.

Simulations

Compute steady-state oxygen and carbon dioxide concentration profiles for the following storage conditions.

Storage description	T_{cel}(^{o}C)	η_u (%)	η_v (%)
Orchard	25	20.8	0.04
Shelf life	20	20.8	0
Refrigerator	7	20.8	0
Precooling	-1	20.8	0
Disorder innducing	-1	2	5
Optimal CA	-1	2	0.7

Note: To compute C_{uamb} and C_{vamb} the fractions η_u and η_v should be numbers between 0 and 1.