List of Symbols

a Unit of length in simulations (eqs. 14, 15)

A Area of the membrane

a_p Parameter defined in Equation 13

B_j Body force in direction j

c Concentration of defects in the space of their radii

C Change of specific capacitance in the region of the defect, specific heat, capacitance of discharge capacitor (from Hulsheger et al., 1983)

C_0 Specific capacitance of the membrane

C_n Concentration of species n

D Diffusion coefficient, D-value, or time required for a one log cycle reduction in microbiological population

d_c Diameter of cell (Lebovka and Vorobiev model)

$\overline{d_c}$ Mean diameter of cell (Lebovka and Vorobiev model)

D_i Diffusion coefficient of species i

D_n Diffusion coefficient of species n

E Young's modulus (eqs. 1 through 3); energy of the defect (eqs. 6, 10), electric field strength

E_* Energy of the critical defect, or height of energy barrier

E_a Activation energy

E_c Critical electric field strength required for microorganism inactivation.

E_{crit} Critical electric field strength required for microorganism inactivation.

E_{c0} Constant in Peleg's model

E_0 Defect energy in the absence of electric field

$\boldsymbol{E}$ Electric field strength

f fraction of microbial population of a particular resistance

F Faraday's constant (=96.487 As/mol)

f_{rep} Pulse repetition frequency

h Thickness of bilayer lipid membrane (BLM)

H Hamiltonian function

$H(r)$ Heaviside step function, reflecting the fact that only nonconducting pores ($r < r_*$) are being destroyed.

$\boldsymbol{J}$ Current density

$\boldsymbol{J_i}$ Current density due to flow of species i

k Boltzmann constant, thermal conductivity (in transport equation)

k_1 Constant in Peleg equation

k_2 Constant in Peleg equation

k_1' Constant in Peleg equation

k_2' Constant in Peleg equation

k_c Constant in eqs. 38, 40

k_{c0} Constant in Peleg's model

k_{max} reaction rate constant for microbial inactivation (log linear model with tailing)

k_{max1} reaction rate constant for microbial inactivation for fraction 1

k_{max2} reaction rate constant for microbial inactivation for fraction 2

k_t Constant in equation 37

L Length of material

$\langle L \rangle$ Average perimeter length of all pores

n Number of pulses

n_j Number of pores of radius r_j

N Number of pores, number of microorganisms

N_{ni} Molar flux of charged species.

N_0 Initial population of microorganisms

N_t Population of microorganisms after a process time t

$N(t)$ Population of microorganisms after a process time t

$\langle N \rangle$ Average number of pores in a membrane

N_{res} Residual number of microorganisms in a process with tailing (log linear model with tail)

p Pressure, shape parameter in Weibull model (eq. 45)

r Defect radius

r_0 Minimum pore radius

r_* Critical defect radius

r_j Radius of pore j in membrane (equation 11)

R Resistance of the filled treatment cell, Universal Gas Constant

R_n Reaction rate of species n

$S(r)$ Source term for creation and destruction of pores

S_1 duration of shouldering phase in microbial survivor curve

t time

T Temperature, absolute temperature

T_c Critical temperature when 50% of the population is inactivated (Gauss-Eyring model)

u''' Volumetric internal energy generation rate

$u_{m,n}$ Ionic mobility of charged species n

v_c Attempt rate density.

v_i Velocity in i direction

V Voltage, voltage across bilayer lipid membrane (capacitor)

V_* Breakdown voltage across membrane

x_i Coordinate direction

Y Fractional survival of microbial population, or fractional retention of constituent

Z Partition function for pores

z_n Charge number of ionic species n

Greek letters

β $1/kT$

γ Linear tension

δ Shape parameter in Weibull model (Eq. 45)

Δ Deformation (change in length) of material

Δ Standard deviation of cell diameter (Lebovka and Vorobiev model)

ε Electrical permittivity

ε_0 Electrical permittivity of vacuum

κ_m Dielectric constant of membrane

κ_w Dielectric constant of water

μ Chemical potential of pore gas (eq. 12)

ν_d Frequency of lipid fluctuations

ρ Density, charge density

ρ_i Charge density of species i

σ Surface tension, electrical conductivity

σ Width of the temperature distribution (interpreted as a measure of heterogeneity in sensitivity towards temperature resistance) in Gauss-Eyring model.

σ_i Electrical conductivity of species i

τ Pulse duration, time constant in Eq. 39

τ_{ij} Stress tensor

φ Pore energy in the presence of an external potential

φ_n Electric potential through the electrolyte