Ion-to-Droplet Thermodynamic Mapping and Physics Validation

Mapping S → D = (v, r, σ, T, φ, θ)
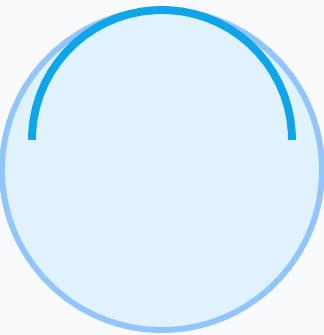
$v = v_{min} + S_k \cdot (v_{max} - v_{min})$

$r = r_{min} + S_e \cdot (r_{max} - r_{min})$

$\sigma = \sigma_{max} - S_t \cdot (\sigma_{max} - \sigma_{min})$

$T = T_{min} + \log(1+I)/\log(1+I_{max}) \cdot (T_{max} - T_{min})$

$\varphi = \exp(-||S - s_0||^2)$, $\theta = 45° \cdot S_k \cdot S_e$

Ranges: $v \in [1,5]$ m/s, $r \in [0.3,3]$ mm, $\sigma \in [0.02,0.08]$ N/m, $T \in [273,373]$ K

r, σ, T, φ, θ

Dimensionless Numbers (validation)

$We = \rho v^2 r / \sigma$ → valid: 1 We 100

$Re = \rho v r / \mu$ → valid: 10 Re 10^4

$Oh = \mu / \sqrt{(\rho \sigma r)} = \sqrt{We} / Re$ → valid: Oh 1

$Q_{physics} = \exp(-(\chi_{We}^2 + \chi_{Re}^2 + \chi_{Oh}^2)/3)$

$Q_{physics}$ = 0.86 (pass)

$Q_{physics}$ = 0.28 (filter)

Acts as a quality filter for implausible ions