Diffusivity in Water: Hayduk–Laudie and Nernst–Haskell

Diffusion coefficient of a small neutral molecule in water by Hayduk–Laudie and of a dissolved electrolyte at infinite dilution by Nernst–Haskell.

Input parameters

Unit system: SI

Parameter	Value	Unit
Water viscosity	1.0000	mPa·s
Molar volume at the normal boiling point	96.000	cm³/mol
Temperature	20.000	°C
Cation charge	1.0000	
Anion charge	1.0000	
Cation limiting ionic conductance, cm²·S/eq	50.100	
Anion limiting ionic conductance, cm²·S/eq	76.400	

Calculated results

Parameter	Value	Unit
Hayduk–Laudie diffusivity (neutral solute)	9.0154e-06	cm²/s
Nernst–Haskell diffusivity (electrolyte)	1.5844e-05	cm²/s

Notes for this case

• Hayduk–Laudie: D = 13.26 × 10⁻⁹/(μ^1.14 V_b^0.589) m²/s with μ in cP and V_b in cm³/mol (Le Bas increments: C 14.8, H 3.7, Cl 21.6, six-membered ring −15), usually within 10 %. Nernst–Haskell applies at infinite dilution; the temperature enters through RT and the conductances, which are tabulated at 25 °C.

Formula and method

$$D_{HL} = \frac{13.26 \times 10^{-9}}{\mu_w^{1.14} V_b^{0.589}} \ \mathrm{m^2/s} \quad (\mu_w \text{ in cP},\ V_b \text{ in cm}^3/\mathrm{mol})$$

$$D_{NH} = \frac{RT}{F^2} \frac{1/|z_+| + 1/|z_-|}{1/\lambda_+ + 1/\lambda_-}$$

Variables

μ_w	Water viscosity	Pa·s
V_b	Molar volume at the normal boiling point	m³/mol
T	Temperature	K
	z_+	$
	z_-	$
λ_+	Cation limiting ionic conductance, cm²·S/eq	-
λ_-	Anion limiting ionic conductance, cm²·S/eq	-
D_{HL}	Hayduk–Laudie diffusivity (neutral solute)	m²/s
D_{NH}	Nernst–Haskell diffusivity (electrolyte)	m²/s

Method and standards

Empirical diffusivity of neutral solutes in water and the Nernst–Haskell limit for electrolytes.

Assumptions and limits

- Dilute aqueous solutions.

Report details

Report reference	FCC-RZS3-0FET (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/chemical/physical-properties/liquid-diffusivity-hayduk-laudie

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Reopens the calculator with the inputs of this report.