

Forced Convection Cheat Sheet

Fundamentals and the stirring-rate experiment

ENGINEERING
CHEAT SHEET

Key equations

Quantity	Equation	Notes
Overall heat transfer	$Q = U A \Delta T$	ΔT = log-mean temperature difference (LMTD)
Experimental U	$U = Q / (A \Delta T_{lm})$	The article's area definition is inconsistent between abstract and calculations
Hot-water heat rate	$Q = \dot{m} c_p (T_{in} - T_{out})$	Standard form; the article shows its version as an image
Nusselt number	$Nu = h L / k$	
Correlation	$Nu = C Re^n Pr^m$	Constants vary with geometry and regime
Convection coefficient	$h = Nu k / L$	

Key takeaways

- Setup: HT30X unit; hot water through a coil heats cold water held at 1 GPM in a stirred vessel; stirring varied 0–100% in 20% steps.
- Hot flow rates tested: 0.01913 and 0.03088 kg/s.
- U rose linearly with stirring: $y = 0.0151x + 1.5943$ ($R^2 = 0.9623$) at 0.03088 kg/s; $y = 0.0137x + 1.2295$ ($R^2 = 0.9531$) at 0.01913 kg/s.
- FLAG: the article reports higher U at the lower hot flow rate, which is the opposite of the usual expectation. Check against the raw data before relying on it.
- Measured U is an overall coefficient that includes conduction through the coil, not a pure convective h.
- Typical h (W/m²·K): gases forced 10–1,000; liquids forced 50–10,000; liquid metals 5,000–40,000; liquids natural 50–3,000.