Batch Dyeing: Liquor Ratio, Dye and Chemicals

Water, dye and chemicals for batch dyeing from fabric mass, liquor ratio, dye % on weight of fabric and auxiliaries in g/L, with the heat to raise the bath.

Method: Definitions and mass and energy balances; fabric specific heat taken as 1.3 kJ/(kg·K)

Input parameters

Unit system: SI

Parameter	Value	Unit
Fabric (dry)	500.00	kg
Liquor ratio (L of bath per kg fabric)	8.0000	
Dye on weight of fabric	2.0000	%
Salt	60.000	g/L
Soda ash or alkali	15.000	g/L
Bath fill temperature	25.000	°C
Dyeing temperature	60.000	°C

Calculated results

Parameter	Value	Unit
Bath volume	4,000.0	L
Dye	10.000	kg
Salt	240.00	kg
Alkali	60.000	kg
Heat to raise the bath	608.90	MJ

Notes for this case

- Low-liquor-ratio machines (1:4–1:6) save water, salt and heat in proportion to the bath volume.

Formula and method

$$V = M \cdot MLR, \quad m_d = d\,M, \quad m_s = c_s V, \quad m_a = c_a V, \quad Q = V\rho c_w (T_2 - T_1) + M c_f (T_2 - T_1)$$

Variables

M	Fabric (dry)	kg
MLR	Liquor ratio (L of bath per kg fabric)	-
d	Dye on weight of fabric	-
c_s	Salt	kg/m³
c_a	Soda ash or alkali	kg/m³
T_1	Bath fill temperature	K
T_2	Dyeing temperature	K
V	Bath volume	m³
m_d	Dye	kg
m_s	Salt	kg
m_a	Alkali	kg
Q	Heat to raise the bath	J
ρ	Bath density, 1000 kg/m³	kg/m³
c_w	Specific heat of the bath, 4.1868 kJ/(kg·K)	J/(kg·K)
c_f	Specific heat of the fabric, 1.3 kJ/(kg·K)	J/(kg·K)

Method and standards

Recipe definitions and sensible heat.

Assumptions and limits

- Bath density 1 kg/L and water specific heat constant.
- The heat is for the bath and fabric only: the machine's own heat capacity, radiation losses and, for high-temperature polyester dyeing up to 140 °C, the slightly higher specific heat of hot water are not counted, so the real steam demand is higher.

References

- Definitions and mass and energy balances; fabric specific heat taken as 1.3 kJ/(kg·K)

Report details

Report reference	FCC-P3YQ-9RWX (the same inputs always give the same reference)
Generated	17 November 2026, 19:37 UTC
Calculator	Batch Dyeing: Liquor Ratio, Dye and Chemicals
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 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/textile-rice-oil/dyeing-liquor-ratio

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.