Liquid–Liquid Extraction Stages (Kremser)

Theoretical stages of a counter-current extractor from the extraction factor KS/F, feed and raffinate concentrations and solute in the solvent (Perry's sec. 15).

Method: Perry's Chemical Engineers' Handbook; 9th ed. (McGraw-Hill, 2019); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Solute in the feed (solute-free ratio, kg per kg carrier)	5.0000	%
Solute in the raffinate (solute-free ratio)	0.20000	%
Solute in the entering solvent (solute-free ratio)	0	%
Distribution ratio y/x	2.5000	
Solvent to feed ratio (solute-free basis)	0.80000	

Calculated results

Parameter	Value	Unit
Extraction factor K S/F	2.0000	
Theoretical stages	3.7004	
Solute extracted	96.000	%

Formula and method

$$N = \frac{\ln\left[\frac{x_F - y_S/K}{x_R - y_S/K}\left(1 - \frac{1}{E}\right) + \frac{1}{E}\right]}{\ln E}, \quad E = \frac{KS}{F}$$

Variables

x_F	Solute in the feed	-
x_R	Solute in the raffinate	-
y_S	Solute in the entering solvent	-
K	Distribution ratio y/x	-
S/F	Solvent to feed ratio (solute-free basis)	-
E	Extraction factor K S/F	-
N	Theoretical stages	-
η	Solute extracted	-

Method and standards

Kremser equation for extraction.

Assumptions and limits

- Dilute; immiscible solvents; constant K.
- Concentrations are solute-free ratios X = x/(1 − x) (kg solute per kg carrier or solvent), consistent with S/F on a solute-free basis. Entering mass fractions instead is close only when dilute: at 5 % the difference is about 5 %.

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 15 (liquid–liquid extraction): Kremser equation with the extraction factor

Report details

Report reference	FCC-B1RR-VC48 (the same inputs always give the same reference)
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Calculator	Liquid–Liquid Extraction Stages (Kremser)
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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/unit-operations/kremser-extraction-stages

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.