Single-Stage and Cross-Current Liquid Extraction

Fraction of solute left in the raffinate after one extraction stage and after n cross-current stages with equal solvent, for a constant distribution coefficient.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Distribution coefficient (extract/raffinate, same basis)	3.0000	
Total solvent-to-feed ratio	1.0000	
Number of cross-current stages	3.0000	

Calculated results

Parameter	Value	Unit
Extraction factor, single stage	3.0000	
Fraction left after one stage (all solvent)	25.000	%
Fraction left after n cross-current stages	12.500	%
Recovery with n stages	87.500	%

Notes for this case

- Immiscible solvents and a constant K_D on a solute-free basis. Counter-current stages (Kremser) use the same solvent more effectively.

Formula and method

$$E = K_D \frac{S}{F}, \quad r_1 = \frac{1}{1+E}, \quad r_n = \left(1 + \frac{E}{n}\right)^{-n}$$

Variables

K_D	Distribution coefficient (extract/raffinate, same basis)	-
S/F	Total solvent-to-feed ratio	-
n	Number of cross-current stages	-
E	Extraction factor, single stage	-
r_1	Fraction left after one stage (all solvent)	-
r_n	Fraction left after n cross-current stages	-
$1 - r_n$	Recovery with n stages	-

Method and standards

Stage balances.

Assumptions and limits

- Immiscible phases; equilibrium stages.
- The total solvent is divided equally among the n stages (S/n each), which is what the form (1 + E/n)^−n assumes; unequal splits extract less.

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 15 (extraction factor; cross-current extraction)

Report details

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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/separation/crosscurrent-extraction

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.