Ultrafiltration Limiting Flux by the Gel-Polarisation Model

Limiting flux of an ultrafiltration membrane from the mass-transfer coefficient and gel and bulk concentrations, and at a volume reduction factor.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Mass-transfer coefficient	2.0000e-05	m/s
Gel (wall) concentration	250.00	g/L
Bulk concentration	30.000	g/L
Volume reduction factor (feed/retentate)	4.0000	

Calculated results

Parameter	Value	Unit
Limiting flux at the bulk concentration (L/(m²·h))	152.66	
Retentate concentration at the VRF	120.00	g/L
Limiting flux at the end of concentration (L/(m²·h))	52.846	

Notes for this case

• Fully retained solute assumed. k rises with cross-flow velocity (k ∝ u^0.8 in turbulent channels); the gel concentration is a property of the solute, e.g. about 250 g/L for whey protein.

Formula and method

$$J_{lim} = k \ln \frac{C_g}{C_b}, \quad C_r = C_b \cdot VRF$$

Variables

k	Mass-transfer coefficient	m/s
C_g	Gel (wall) concentration	kg/m³
C_b	Bulk concentration	kg/m³
VRF	Volume reduction factor (feed/retentate)	-
J_{lim}	Limiting flux at the bulk concentration (L/(m²·h))	-
C_r	Retentate concentration at the VRF	kg/m³
$J_{lim,r}$	Limiting flux at the end of concentration (L/(m²·h))	-

Method and standards

Gel-polarisation model.

Assumptions and limits

- Full rejection; film model.
- A volume reduction that would take the retentate to the gel concentration is unreachable; it is flagged and the retentate is capped just below C_g.

References

• Perry's Chemical Engineers' Handbook
• 9th ed. (McGraw-Hill, 2019)
• sec. 20 (ultrafiltration, gel-polarisation model J = k ln(C_g/C_b))

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/unit-operations/ultrafiltration-flux-polarisation

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.