Recycle and Purge Balance with an Inert

Reactor feed, recycle and purge flows and overall conversion for a reactor with single-pass conversion, full product separation and a purge to remove inerts.

Method: Steady-state balances on reactant and inert around reactor; separator and purge (Felder and Rousseau)

Input parameters

Unit system: SI

Parameter	Value	Unit
Fresh feed (reactant plus inert)	100.00	kmol/h
Inert mole fraction in the fresh feed	1.0000	%
Single-pass conversion	25.000	%
Purge share of the separator gas	5.0000	%

Calculated results

Parameter	Value	Unit
Reactant in the reactor feed	344.35	kmol/h
Inert in the reactor feed	20.000	kmol/h
Recycle flow	264.35	kmol/h
Purge flow	13.913	kmol/h
Overall conversion	86.957	%
Inert fraction in the recycle	7.1875	%

Notes for this case

- Total reactor feed (reactant plus inert) R_F + I_F = 364.3 kmol/h.
- Product fully removed in the separator; unreacted reactant and inert recycled; purge taken from the recycle gas.

Formula and method

$$R_F = \frac{F_0(1-x_{I0})}{1-(1-p)(1-X)}, \quad I_F = \frac{F_0 x_{I0}}{p}, \quad X_o = 1 - \frac{pR_F(1-X)}{F_0(1-x_{I0})}$$

Variables

F_0	Fresh feed (reactant plus inert)	mol/s
x_{I0}	Inert mole fraction in the fresh feed	-
X	Single-pass conversion	-
p	Purge share of the separator gas	-
R_F	Reactant in the reactor feed	mol/s
I_F	Inert in the reactor feed	mol/s
$\dot{R}$	Recycle flow	mol/s
$\dot{P}$	Purge flow	mol/s
X_o	Overall conversion	-
y_I	Inert fraction in the recycle	-

Method and standards

Loop balances.

Assumptions and limits

- Complete product separation, steady state.
- R_F is the reactant only; the total reactor feed R_F + I_F is given in the note.

References

• Steady-state balances on reactant and inert around reactor
• separator and purge (Felder and Rousseau)

Report details

Report reference	FCC-5EBR-EMC9 (the same inputs always give the same reference)
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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/mass-energy-balance/recycle-purge-balance

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.