Heat Exchangers Coupled in Series: Overall Effectiveness

Overall temperature effectiveness and outlet temperatures of up to four exchangers coupled in overall counterflow or parallelflow, from each unit's effectiveness.

Input parameters

Unit system: SI

Parameter	Value	Unit
Effectiveness of exchanger 1	45.000	%
Effectiveness of exchanger 2 (0 if absent)	45.000	%
Effectiveness of exchanger 3 (0 if absent)	45.000	%
Effectiveness of exchanger 4 (0 if absent)	0	%
Heat capacity rate ratio C_1/C_2	0.60000	
Overall coupling	Overall counterflow	
Fluid 1 inlet temperature	150.00	°C
Fluid 2 inlet temperature	30.000	°C

Calculated results

Parameter	Value	Unit
Number of exchangers	3.0000	
Overall effectiveness (fluid 1)	76.988	%
Overall effectiveness (fluid 2) = P_1R_1	46.193	%
Fluid 1 outlet temperature	57.615	°C
Fluid 2 outlet temperature	85.431	°C

Notes for this case

• Fluids are mixed between exchangers; R_1 is the same for every exchanger. Each P is the temperature effectiveness of fluid 1 in that exchanger (from its own NTU, R and flow arrangement). A positive $T_{1,i} - T_{2,i}$ means fluid 1 is the hot fluid.

Formula and method

$$P_{cf} = \frac{\prod_i \frac{1-RP_i}{1-P_i} - 1}{\prod_i \frac{1-RP_i}{1-P_i} - R}, \quad P_{cf}(R=1) = \frac{\sum_i P_i/(1-P_i)}{1+\sum_i P_i/(1-P_i)}$$

$$P_{pf} = \frac{1}{1+R}\left\{1 - \prod_i [1-(1+R)P_i]\right\}$$

Variables

P_1	Effectiveness of exchanger 1	-
P_2	Effectiveness of exchanger 2 (0 if absent)	-
P_3	Effectiveness of exchanger 3 (0 if absent)	-
P_4	Effectiveness of exchanger 4 (0 if absent)	-
R_1	Heat capacity rate ratio C_1/C_2	-
$\mathrm{coupling}$	Overall coupling	-
$T_{1,i}$	Fluid 1 inlet temperature	K

$T_{2,i}$	Fluid 2 inlet temperature	K
n	Number of exchangers	-
$T_{1,o}$	Fluid 1 outlet temperature	K
$T_{2,o}$	Fluid 2 outlet temperature	K

Method and standards

Effectiveness of exchangers coupled in series in overall counterflow or parallelflow.

Assumptions and limits

- Same R for every unit; fluids mixed between units.

Report details

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Release checks	4 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/process-heat-exchangers/exchangers-in-series-overall-effectiveness

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.