Identical Solar Collectors in Series: Combined FR(τα) and FRUL

Equivalent heat removal parameters of N identical solar collectors connected in series, from the single-collector FR(τα), FRUL, area and the flow rate.

Input parameters

Unit system: SI

Parameter	Value	Unit
Collectors in series	4.0000	
Area of one collector	2.5000	m²
Single collector F_R(τα)	75.000	%
Single collector F_R U_L	4.5000	W/(m²·K)
Flow through the string	0.050000	kg/s
Fluid specific heat	4.1800	kJ/(kg·K)

Calculated results

Parameter	Value	Unit
Single-collector parameter A₁F_RU_L/ṁc_p	0.053828	
Series reduction factor	92.212	%
Combined F_R(τα)	69.159	%
Combined F_R U_L	4.1495	W/(m²·K)
Total area	10.000	m²

Notes for this case

- The single-collector parameters must be for the flow that actually passes through the string. Series connection raises the outlet temperature but lowers F_R; it pays when a high delivery temperature or low flow is wanted.

Formula and method

$$K = \frac{A_1 F_R U_L}{\dot{m} c_p}, \quad F_R(\tau\alpha)_N = F_R(\tau\alpha)_1 \frac{1-(1-K)^N}{NK}, \quad F_R U_{L,N} = F_R U_{L,1} \frac{1-(1-K)^N}{NK}$$

Variables

N	Collectors in series	-
A_1	Area of one collector	m²
$F_R(\tau\alpha)$	Single collector F_R(τα)	-
$F_R U_L$	Single collector F_R U_L	W/(m²·K)
$\dot{m}$	Flow through the string	kg/s
c_p	Fluid specific heat	J/(kg·K)
K	Single-collector parameter A₁F_RU_L/ṁc_p	-
$\frac{1-(1-K)^N}{NK}$	Series reduction factor	-
$F_R(\tau\alpha)_{series}$	Combined F_R(τα)	-
$F_R U_{L,series}$	Combined F_R U_L	W/(m²·K)
A	Total area	m²

Method and standards

Series combination of identical linear collectors.

Assumptions and limits

- Identical collectors, linear efficiency, same flow through all.

Report details

Report reference	FCC-S6GY-XDCB (the same inputs always give the same reference)
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Release checks	3 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/environmental/solar-thermal/collectors-in-series-performance

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.