

Solar Thermal Circulator Sizing Guide

For Bosch and Buderus Solar Thermal Systems



BOSCH

Introduction

The following shall be the method for the sizing and selection of the circulator for a closed loop, pressurized solar thermal system.

The circulator shall be sized to provide the mechanical head needed to overcome the total system resistance (r) at the system design flow-rate.

Design flow rate

The design flow-rate shall be calculated using the following formula:

Fig. 1

$$\text{System Flow} = (\# \text{ of Collectors}) \times (.22 \text{ gpm})$$

System resistance

The system resistance (r) shall be the sum total resistance of all piping, valves, heat-exchangers and collector row resistance in the solar thermal circuit as well as any additional components which will offer mechanical resistance to the heat transfer fluid.

It is recommended to use hydraulic sizing software for large scale systems in order to prevent over sizing of the circulator. In instances where hydraulic software is not available or in medium to smaller systems, a total equivalent length of the longest loop plus a factor of 30 – 50% may be added to the actual length of the piping to account for additional fittings and valves within that loop. (Note: the circuit offering the greatest pressure drop may not always be the longest length circuit due to differing collector counts per row). Using this method, the system resistance formula is as follows:

Fig. 2

$$r_{\text{system}} = (r_{\text{collector row}}) + (r_{\text{heat exchanger}}) + (r_{\text{piping}})$$

Collector row requirements and recommendations:

1. It is recommended to keep the average number of collectors per row in the overall system as high as possible, minimizing total number of rows and reducing the need for additional components.
2. Rows piped in parallel are always recommended when possible.
3. The number of collectors per row shall not exceed 10 collectors.
4. Two rows of collectors may be piped as series rows with the total number of collectors in each series row not to exceed 5 collectors.*
5. Three rows of collectors may be piped as series rows with the total number of collectors in each series row not to exceed 3 collectors.*
6. All rows piped in series must contain equal number of collectors

* Careful consideration should be given to collector layout as it will directly impact the pressure drop across the row. Two or three rows in series will double or triple the nominal design flow rate of 0.22 gpm per collector, significantly increasing the pressure drop of the system and the resulting circulator size.

For calculating the pressure drop of a single row the following formula shall be used:

Fig. 3

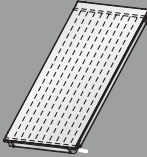
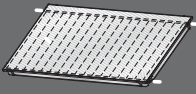
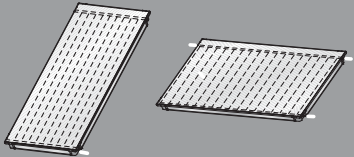
$$r_{\text{collector row}} = (r_{\text{collector @ actual flow}}) \times (\# \text{ of collectors in row})$$

For multiple rows in series the resistance for each row should be calculated first, then the sum of the resistance of all rows should be added together:

Fig. 4

$$r_{\text{series row}} = (r_{\text{collector row \#1}}) + (r_{\text{collector row \#2}}) + (r_{\text{collector row \#3}})$$

Table 1

Number of Collectors	Pressure Drop for a row of n collectors								
	Portrait (for SKN / FKC collectors)			Landscape (for SKN / FKC collectors)			Portrait and Landscape (for SKS / FKT collectors)		
									
	at a flow rate per collector (nominal flow rate 0.22 gpm)								
	Single row 0.22 gpm	2 rows in series 0.44 gpm	3 rows in series 0.66 gpm	Single row 0.22 gpm	2 rows in series 0.44 gpm	3 rows in series 0.66 gpm	Single row 0.22 gpm	2 rows in series 0.44 gpm	3 rows in series 0.66 gpm
n	in H ₂ O	in H ₂ O	in H ₂ O	in H ₂ O	in H ₂ O	in H ₂ O	in H ₂ O	in H ₂ O	in H ₂ O
1	0.44	1.89	4.09	0.16	0.68	1.72	12	28.5	52.59
2	0.60	2.6	5.23	0.76	2.77	5.78	12.45	29.3	53.39
3	0.84	5.42	10.56	2.25	7.27	14	12.85	32.92	61.43
4	2.6	8.87	-	3.73	11.92	-	15.66	38.54	-
5	4.45	13.85	-	5.94	18.79	-	17.66	46.17	-
6	6.1	-	-	8.55	-	-	19.67	-	-
7	8.43	-	-	11.6	-	-	24.48	-	-
8	11.2	-	-	15	-	-	29.30	-	-
9	14.4	-	-	19	-	-	34.93	-	-
10	18	-	-	23.52	-	-	40.55	-	-

Total System Flow

Table 2

	# of collectors per row									
	1	2	3	4	5	6	7	8	9	10
Flow/row (gpm)	0.22	0.44	0.66	0.88	1.10	1.32	1.54	1.76	1.98	2.20
# of rows										
1	0.22	0.44	0.66	0.88	1.10	1.32	1.54	1.76	1.98	2.20
2	0.44	0.88	1.32	1.76	2.20	2.64	3.08	3.52	3.96	4.40
3	0.66	1.32	1.98	2.64	3.30	3.96	4.62	5.28	5.94	6.60
4	0.88	1.76	2.64	3.52	4.40	5.28	6.16	7.04	7.92	8.80
5	1.10	2.20	3.30	4.40	5.50	6.60	7.70	8.80	9.90	11.00
6	1.32	2.64	3.96	5.28	6.60	7.92	9.24	10.56	11.88	13.20
7	1.54	3.08	4.62	6.16	7.70	9.24	10.78	12.32	13.86	15.40
8	1.76	3.52	5.28	7.04	8.80	10.56	12.32	14.08	15.84	17.60
9	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82	19.80
10	2.20	4.40	6.60	8.80	11.00	13.20	15.40	17.60	19.80	22.00



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