Technical Service Bulletin:

Solar Thermal Plate Heat Exchangers Sizing Guide

For Bosch and Buderus Solar Thermal Systems

BOSCH

Introduction

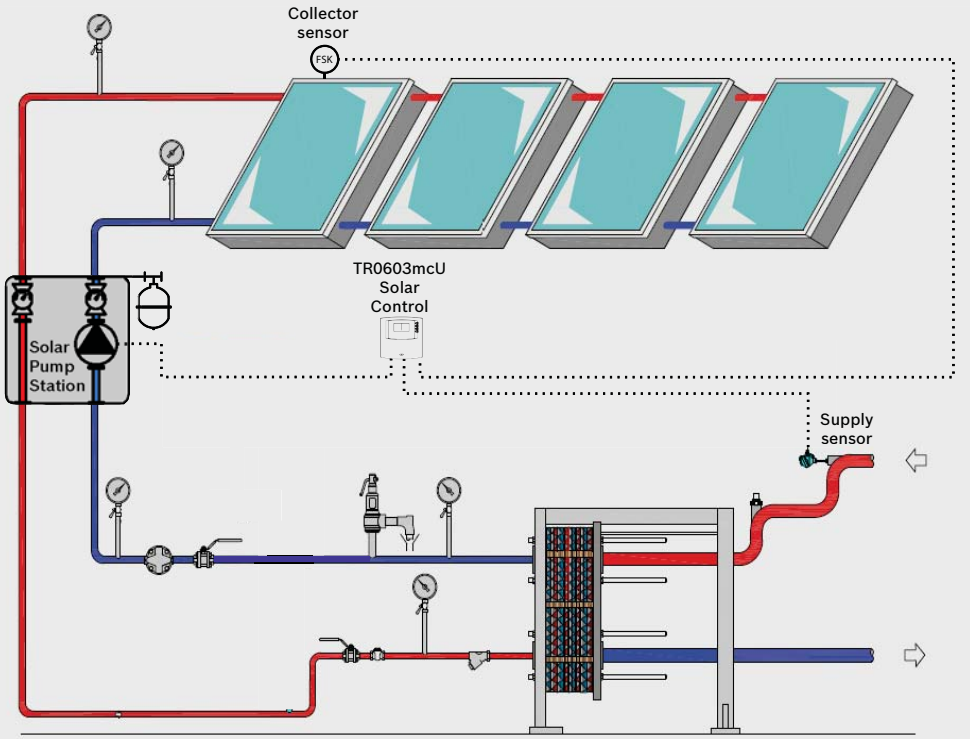
Bosch solar thermal heat transfer fluids contain dissolved chemicals such as Glycol-Propelene for anti-freeze and anti-corrosion purposes.
As a result, it is necessary to isolate the solar thermal fluid from the potable or buffer water, accomplished by a heat exchanger.

Plate heat exchanger are a relatively low pressure/low temperature devices. Current maximum design ratings for most manufacturers is a temperature of 400 Degrees F and pressure of 300 psig.

The actual limitations for a particular heat exchanger are a function of the materials selected for gaskets and plates.
Individual plate areas vary from about 0.3 to 21.5 sqft with a maximum heat transfer area for a single heat exchanger in range of 13,000 sqft.

The minimum plate size places a lower limit on applications of plate heat exchangers.
The largest units are capable of handling flow rates of 6000 gpm and the smallest units serviceable down to flows of apptoximately 5 gpm. Connection size range from 3/4 to 14 in.

Solar Thermal Plate Heat Exchanger Example **Figure 1**



Plates

Flat plate heat exchangers are available in a wide variety of corrosion resistant alloys.

In certain states, double wall flat plate heat exchangers are required. **The following are recommended for Solar Thermal Systems:**

- 304 Stainless Steel
- 316 Stainless Steel
- 317 Stainless Steel
- Hastelloy
- Aluminum Bronze
- Titanium
- Tantalum
- Incaloy 825
- Inconel
- Monel.

In addition to these, a larger number of optional alloys are available by special order.
Most manufacturers will quote either 304 or 316 stainless steel as the basic material recommended for chlorine and salt water.

Gaskets

As with plate materials, a variety of gasket materials are available. Plate Heat Exchanger Gasket Materials (APV, Alfa-Laval, Tranter)

Table 1

Material	Common Name	Temperature Limit (°F)
Ethylene/Propylene	EPDM	300
Fluorocarbon	Viton	300

Selection

Final selection of plate heat exchangers is done by the vendor using proprietary selection software. There are some general rules of thumb, however, which allow the designer values to the vendor.

Prior to discussing the selection of plate heat exchangers for solar thermal applications, it is useful to review heat exchanger calculations in general. Heat exchangers, parameter in the selection process is the heat transfer area required to accomplish this task. The general formula below describes this situation.

Q = U x A x LMTD x Cf

Q =	Heat load in Btu/hr
U =	Overall heat transfer coefficient in Btu/hr·ft2 ºF
A =	Area (ft2)
LMTD =	Log mean temperature difference (ºF)
Cf =	LMTD correction factor (0.85 - 1.0 for most solar thermal applications).

The log mean temperature difference is calculated using the difference between the entering and leaving temperatures of the two fluids according to the following relationship:

Fluid 1 tout1 ; tin1
Fluid 2 tin2 ; tout2

LMTD = Dt1 – Dt2 / [ln (Dt1/Dt2)]

where:
Dt1 = tout1 - tin2
Dt2 = tin1 - tout2

Although the final selection of plate heat exchangers is made by the vendor using proprietary software, in order to reduce the number of alternatives submitted to the vendor, preliminary calculations are generally made to refine the selection. The general procedure is to:

Calculate heat exchanger surface requirements for the heating load based on available solar thermal flow and temperature.
Compare with desired operating conditions. Re-select if necessary based on alternate pressure drop, approach temperature, etc.

Sizing Example **Table 2**

Case	Solar Thermal in / out (ºF)	Building in / out (ºF)	"U" - A Btu/hr • ft2 • ºF - ft2
1	170 / 130.6	115 / 132	1129 - 264
2	170 / 130.4	122 / 138.5	1151 - 369
3	170 / 130.1	125 / 141.6	1096 - 503
4	170 / 130.2	115 / 131.6	726 - 410

The following table provides the parameters for sizing heat exchangers for solar thermal systems. This table is based on common system parameters, and is to be used as a reference only. Sizing calculations should be performed to ensure that the heat exchanger is properly sized for the system.

Example: A 50 collector domestic hot water system requires a heat exchanger with a heat transfer capacity of 1350 kbtu/day at a solar loop delta T of 32 °F (18 °C), heat transfer fluid specific heat of 3.64 kJ / kg • °C and flow rate of 11.0 gpm. The secondary loop will have a delta T of 45 °F (25 °C), water specific heat of 4.18 kJ / kg • °C and flow rate of 6.9 gpm. Based on this information, the SWEP B10H-4, Zilmet ZB700/Z3 or GEA FG5X12-24 heat exchanger would be appropriate.

Heat Exchanger Sizing **Table 3**

Number of Collectors	Capacity (kBtu/day)	HEX Pressure Drop (kPa)	Solar Loop				Secondary Loop			
			Solar Fluid Specific Heat	Δ T	Flow Rate		Water Specific	Δ T	Flow Rate	
	(kBtu/day)	(kPa)	(kJ / kg • °C)	°F (°C)	L/h	gpm	kJ / kg • °C	°F (°C)	L/h	gpm
1	27	100	3.64	32 (18)	50	0.2	4.18	45 (25)	31	0.1
2	54	100	3.64	32 (18)	100	0.4	4.18	45 (25)	63	0.3
3	81	100	3.64	32 (18)	150	0.7	4.18	45 (25)	94	0.4
4	108	100	3.64	32 (18)	200	0.9	4.18	45 (25)	125	0.6
5	135	100	3.64	32 (18)	250	1.1	4.18	45 (25)	157	0.7
6	162	100	3.64	32 (18)	300	1.3	4.18	45 (25)	188	0.8
7	189	100	3.64	32 (18)	350	1.5	4.18	45 (25)	219	1.0
8	216	100	3.64	32 (18)	400	1.8	4.18	45 (25)	251	1.1
9	243	100	3.64	32 (18)	450	2.0	4.18	45 (25)	282	1.2
10	270	100	3.64	32 (18)	500	2.2	4.18	45 (25)	313	1.4
13	351	100	3.64	32 (18)	650	2.9	4.18	45 (25)	408	1.8
15	405	100	3.64	32 (18)	750	3.3	4.18	45 (25)	470	2.1
17	459	100	3.64	32 (18)	850	3.7	4.18	45 (25)	533	2.3
20	540	100	3.64	32 (18)	1000	4.4	4.18	45 (25)	627	2.8
25	675	100	3.64	32 (18)	1250	5.5	4.18	45 (25)	784	3.4
30	810	100	3.64	32 (18)	1500	6.6	4.18	45 (25)	940	4.1
35	945	100	3.64	32 (18)	1750	7.7	4.18	45 (25)	1097	4.8
40	1,080	100	3.64	32 (18)	2000	8.8	4.18	45 (25)	1254	5.5
45	1,215	100	3.64	32 (18)	2250	9.9	4.18	45 (25)	1411	6.2
50	1,350	100	3.64	32 (18)	2500	11.0	4.18	45 (25)	1567	6.9
60	1,620	100	3.64	32 (18)	3000	13.2	4.18	45 (25)	1881	8.3
70	1,890	100	3.64	32 (18)	3500	15.4	4.18	45 (25)	2194	9.7
80	2,160	100	3.64	32 (18)	4000	17.6	4.18	45 (25)	2508	11.0
90	2,430	100	3.64	32 (18)	4500	19.8	4.18	45 (25)	2821	12.4
100	2,700	100	3.64	32 (18)	5000	22.0	4.18	45 (25)	3135	13.8

Heat Exchanger Model SWEP **Table 4**

No. of Collectors	DHW-Tankless Only	Space Heating / DHW-Tank Systems	Pool Heating
1	SWEP B8H-10	SWEP B8H-30	SWEP B8H-20
2	SWEP B8H-10	SWEP B8H-40	SWEP B8H-30
3	SWEP B8H-10	SWEP B15H-30	SWEP B8H-40
4	SWEP B8H-10	SWEP B15H-40	SWEP B15H-30
5	SWEP B8H-10	SWEP B15H-40	SWEP B15H-30
6	SWEP B8H-10	SWEP B25H-30	SWEP B15H-40
7	SWEP B8H-20	SWEP B25H-30	SWEP B15H-40
8	SWEP B8H-20	SWEP B25H-30	SWEP B15H-40
9	SWEP B8H-20	SWEP B25H-30	SWEP B15H-40
10	SWEP B8H-20	SWEP B25H-30	SWEP B15H-40
13	SWEP B8H-20	SWEP B25H-40	SWEP B25H-30
15	SWEP B8H-30	SWEP B25H-40	SWEP B25H-30
17	SWEP B8H-30	SWEP B25H-50	SWEP B25H-40
20	SWEP B8H-30	SWEP B25H-60	SWEP B25H-50
25	SWEP B8H-30	SWEP B25H-70	SWEP B25H-60
30	SWEP B8H-40	SWEP B25H-90	SWEP B25H-70
35	SWEP B8H-40	SWEP B25H-90	SWEP B25H-90
40	SWEP B10H-3	SWEP B25H-100	SWEP B25H-100
45	SWEP B10H-3	–	–
50	SWEP B10H-4	–	–
60	SWEP B10H-5	–	–
70	SWEP B10H-5	–	–
80	–	–	–
90	–	–	–
100	–	–	–

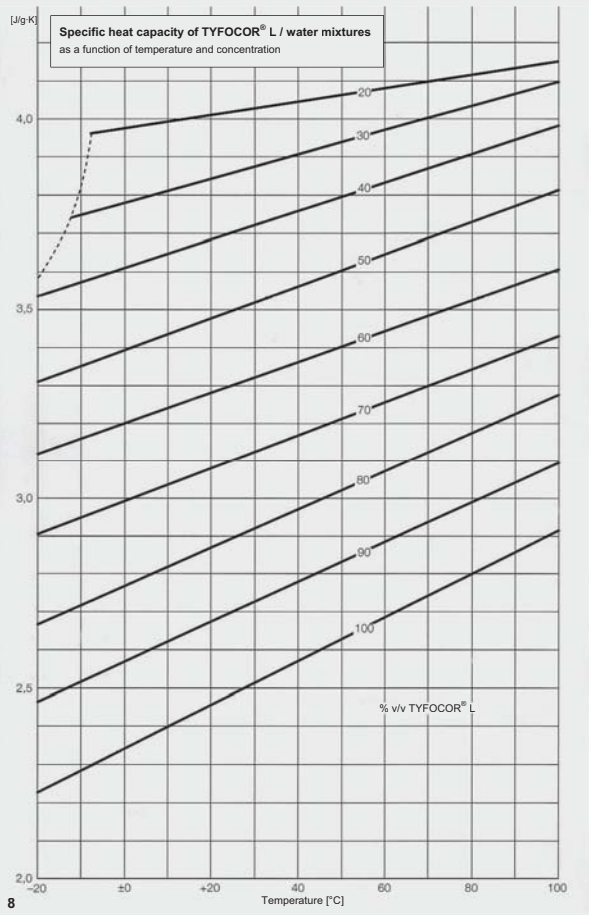
Heat Exchanger Model ZILMET **Table 5**

No. of Collectors	DHW-Tankless Only	Space Heating / DHW-Tank Systems	Pool Heating
1	Zilmet ZB207/Z2	Zilmet ZB207/Z2	Zilmet ZB207/Z2
2	Zilmet ZB207/Z2	Zilmet ZB207/Z2	Zilmet ZB207/Z2
3	Zilmet ZB207/Z2	Zilmet ZB315/Z2	Zilmet ZB315/Z2
4	Zilmet ZB207/Z2	Zilmet ZB315/Z2	Zilmet ZB315/Z2
5	Zilmet ZB207/Z2	Zilmet ZB315/Z2	Zilmet ZB500/Z2
6	Zilmet ZB315/Z2	Zilmet ZB500/Z2	Zilmet ZB500/Z2
7	Zilmet ZB315/Z2	Zilmet ZB500/Z2	Zilmet ZB500/Z2
8	Zilmet ZB315/Z2	Zilmet ZB500/Z2	Zilmet ZB500/Z2
9	Zilmet ZB315/Z2	Zilmet ZB500/Z2	Zilmet ZB500/Z2
10	Zilmet ZB315/Z2	Zilmet ZB500/Z2	Zilmet ZB500/Z2
13	Zilmet ZB315/Z2	Zilmet ZB600/Z3	Zilmet ZB500/Z2
15	Zilmet ZB500/Z2	Zilmet ZB600/Z3	Zilmet ZB600/Z3
17	Zilmet ZB500/Z2	Zilmet ZB600/Z3	Zilmet ZB600/Z3
20	Zilmet ZB500/Z2	Zilmet ZB600/Z3	Zilmet ZB600/Z3
25	Zilmet ZB600/Z3	Zilmet ZB600/Z3	Zilmet ZB600/Z3
30	Zilmet ZB600/Z3	Zilmet ZB600/Z3	Zilmet ZB600/Z3
35	Zilmet ZB600/Z3	Zilmet ZB700/Z3	Zilmet ZB600/Z3
40	Zilmet ZB600/Z3	Zilmet ZB700/Z3	Zilmet ZB600/Z3
45	Zilmet ZB600/Z3	Zilmet ZB700/Z3	Zilmet ZB600/Z3
50	Zilmet ZB700/Z3	Zilmet ZB700/Z4	Zilmet ZB700/Z3
60	Zilmet ZB600/Z3	Zilmet ZB600/Z3	Zilmet ZB600/Z3
70	Zilmet ZB700/Z3	Zilmet ZB700/Z4	Zilmet ZB700/Z3
80	Zilmet ZB700/Z3	Zilmet ZB700/Z4	Zilmet ZB700/Z4
90	–	–	–
100	–	–	–

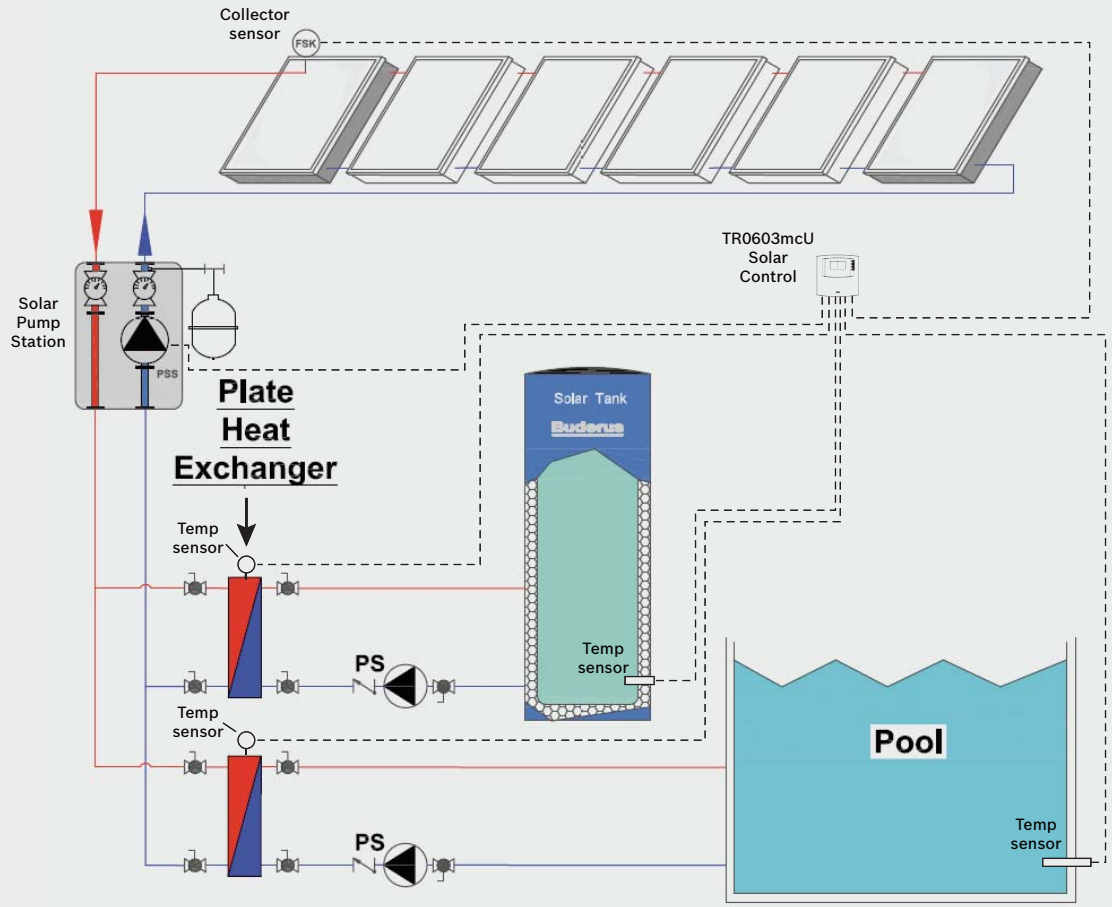
Heat Exchanger Model GEA **Table 6**

No. of Collectors	DHW-Tankless Only	Space Heating / DHW-Tank Systems	Pool Heating
1	FG5X12-4	FG5X12-6	MPN5X12-4
2	FG5X12-4	FG5X12-6	MPN5X12-4
3	FG5X12-4	FG5X12-8	MPN5X12-4
4	FG5X12-4	FG5X12-10	MPN5X12-4
5	FG5X12-6	FG5X12-10	MPN5X12-4
6	FG5X12-6	FG5X12-10	MPN5X12-6
7	FG5X12-6	FG5X12-12	MPN5X12-6
8	FG5X12-6	FG5X12-12	MPN5X12-6
9	FG5X12-6	FG5X12-12	MPN5X12-6
10	FG5X12-6	FG5X12-14	MPN5X12-8
13	FG5X12-8	FG5X12-16	MPN5X12-8
15	FG5X12-10	FG5X12-20	MPN5X12-8
17	FG5X12-10	FG5X12-24	MPN5X12-10
20	FG5X12-10	FG5X12-24	MPN5X12-10
25	FG5X12-12	FG5X12-30	MPN5X12-12
30	FG5X12-14	FG5X12-36	MPN5X12-14
35	FG5X12-16	FG5X12-40	MPN5X12-16
40	FG5X12-20	FG5X12-40	MPN5X12-20
45	FG5X12-20	FG5X12-40	MPN5X12-24
50	FG5X12-24	FG10X20-20	MPN5X12-24
60	FG5X12-30	FG10X20-20	MPN5X12-24
70	FG5X12-36	FG10X20-20	MPN5X12-30
80	FG5X12-36	FG10X20-24	MPN5X12-36
90	FG5X12-40	FG10X20-24	MPN5X12-36
100	FG5X12-40	FG10X20-30	MPN5X12-40

Specific Heat Capacity of Tyfocor L **Figure 2**



Solar Thermal System Example **Figure 3**



BOSCH

Bosch Thermotechnology Corp.
50 Wentworth Avenue
Londonderry, NH 03053

Tel: 1-866-642-3198
Fax: 1-603-584-1687
www.boschsolar.com