heliodyne
SOLAR HOT WATER

FLUSH VS TILT HARDWARE

COST AND PERFORMANCE COMPARISON

EXCELLENCE BY DESIGN

FLUSH VS TILT

To create consistency and ease for all our customers, Heliodyne offers flush roof mounting hardware for any roof pitch, and tilt racking hardware for recommended tilts of 35° for year round water heating, and 45° for space heating combination systems.

In solar water heating design, the rule of thumb for collector tilt is: "For year round hot water heating, use tilt equal to latitude; for winter biased loads, use a tilt equal to latitude plus 15°." These optimal rules are not always easy to follow and often create more work than is necessary for little or no added benefit.

The tilt of Heliodyne collectors can influence much more than solar performance, and all these factors should be taken into account when planning and installing a solar system. The four main factors that tilt affects are:

- System performance
- Structural loading
- Cost
- Visibility

System performance, the most obvious factor, is influenced less than one might think, and extreme tilts –even in the case of space heating combination systems– can negatively affect the performance and therefore lengthen system payoff period.

Structural loading can be increased with steeper collector tilts, because more of the collector is exposed to the horizontal pressure that winds create. Inversely, it can reduce the dead load on the collector from snow.

As previously mentioned increased tilts can lower system annual performance and when coupled with increased hardware and installation costs, these costs and performance drops can draw out payoff periods by many years.

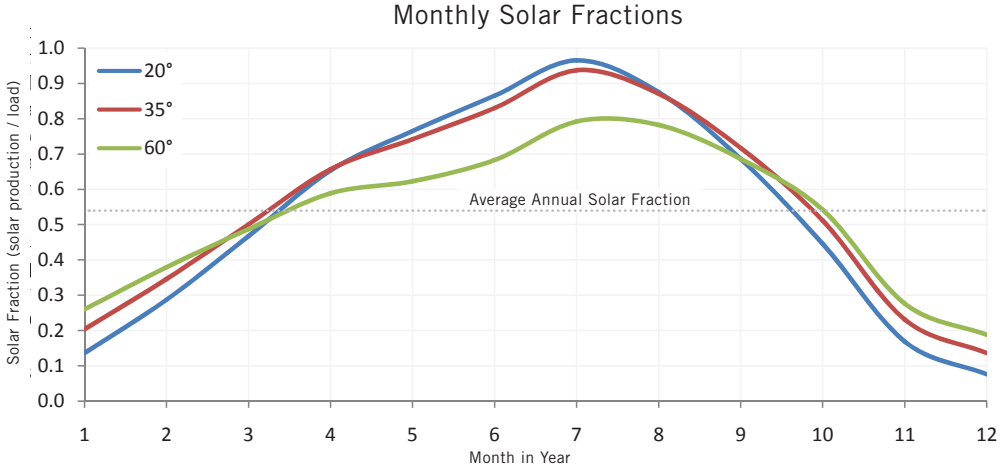
The fourth factor, visibility, is a subjective matter, but no less important as potential architects, businesses and customers think about including thermal solar on projects, decide whether a system is right for them, and whether or not they desire collectors standing out on the installation site.

Below we investigate the effects of tilt on system performance and cost. Structural loading has been previously addressed in Heliodyne Manual 7, Code Compliant Manual.

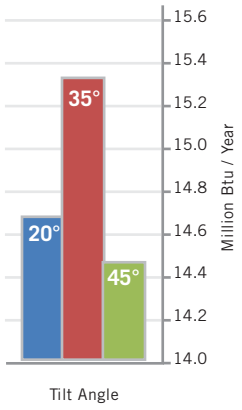
Case 1: Tilt effects on year round domestic hot water production.

System: 2 Gobi 410 001, with HPAK 016 closed loop system
Load: 120 GPD @ 120°F
Location: Missoula, MT (46.92°N, 114.08°W)

Monthly Solar Fractions



Yearly Production

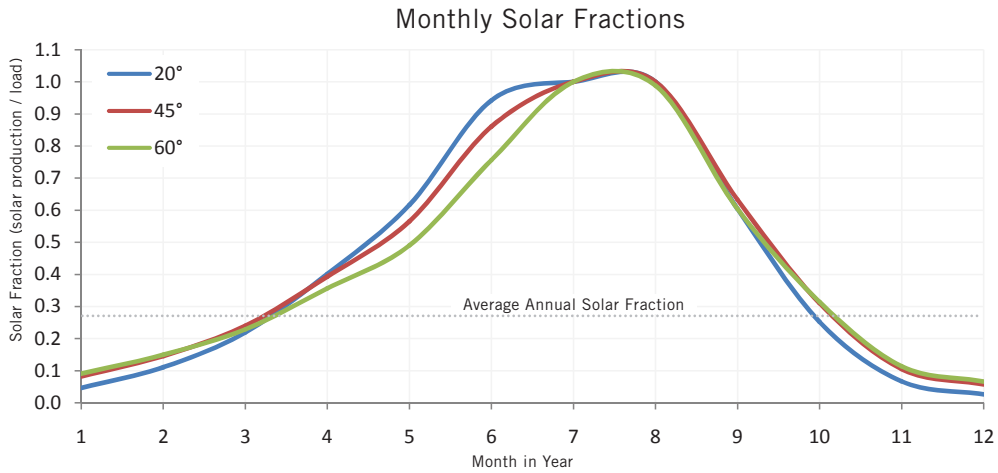


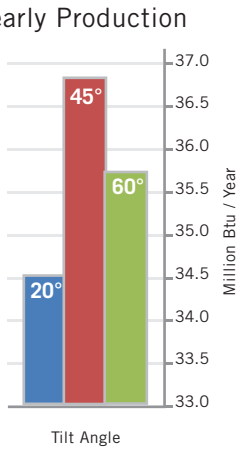
For year round hot water production, it is shown that shallower tilts produce higher annual solar fractions, though not every month in the year is higher producing. In this particular city, any production from September to March stays relatively similar between the three tilts; however, between April and August, the shallower tilts, when the most sun is available throughout the year, make the large part of yearly production.

The system tilted at 35° produces the most (55.6% of load), about 5% more than 20°, and 6% more than 45°; each percentage point accounts for about 1°F rise in the storage tank, so the average yearly temperature in the solar storage tank would be 87°F @ 35° tilt; 82°F @ 20° and 81.5° @ 45°.

Case 2: Tilt effects on space heating combination systems.

System: 5 Gobi 410 001, with HPAK 032 closed loop system and 360 gallons of solar storage
Load: 120 GPD @ 120°F DHW and 1800ft² residence (UA = 540 BTU / hr·°F) with space heat (radiant floor heating)
Location: Missoula, MT (46.92°N, 114.08°W)





The plot above shows that a Heliodyne recommended tilt of 45° produces a higher annual solar fraction, than any other tilt. This occurs because during the time of year when space heating is necessary – February to April and August to mid October – the collectors are better positioned for solar collection when the sun is at a higher intensity.

While the system at 45° will collect slightly more summertime waste heat than the steeper tilted system, a smart and correctly sized design kept it to only two months of the year (July and Aug.), and the steeper system still overproduced in July, and had 98.8% in August, only a 1.2% reduction in waste heat for 15° as compared to the 45° tilt system. In addition, the Heliodyne closed loop Helio-Pak system design prevents boilout protection for any stagnating system.

The system tilted at 45° produces the most (28.0% of the annual combined load), about 4% more than 60°, and 8% more than at 20°.

Cost Effects on System Payback Period due to Performance and Hardware

The table below illustrates the increases or decreases of performance due to collector tilts, and what effect the performance and hardware costs has on extending the system payoff term, which can vary depending on what backup energy the system is replacing. For simplicity, we did not take into account the increased cost of installing a rack system versus a flush system, and we limited our financial calculations to a simple estimation of energy rates for natural gas and electricity backups. The prices for energy are estimates for this study only. In short, the Heliodyne recommended tilts are viable and preferred.

Table Notes

1. See Case 1 for system description
2. See Case 2 for system description
3. Collector tilt from horizontal
4. Flush mount tilt was simulated at 20°.
5. Based on retail price sheet (rev Aug. 2008) for Heliodyne standard flush or rack systems for appropriate collector array.
6. With 70% backup efficiency and cost of gas at $1.50 / Therm
7. Additional years solar system must operate to offset additional hardware cost (does not include installation or maintenance).
8. With 90% backup efficiency and $0.15 / kWh.

System Type	Domestic Hot Water[1]			Space Heat Combi[2]		
Collector Tilt[3]	Flush[4]	35°	60°	Flush[4]	45°	60°
Mounting Package Retail[5]	$270.00	$441.00	$441.00	$655.00	$997.00	$997.00
Price Difference	-	$171.00	$171.00	-	$342.00	$342.00
Annual Solar Fraction	0.531	0.556	0.523	0.259	0.280	0.270
Production (10^6 BTU / yr)	14.728	15.422	14.506	33.856	36.601	35.294
Production Difference	0.0	0.7	-0.2	0.0	2.7	1.4
Natural Gas Replacement						
Equivalent Therms[6]	210.4	220.3	207.2	483.7	522.9	504.2
Therm Difference	0.0	9.9	-3.2	0.0	39.2	20.5
Added Life Cycle (years)[7]	0.0	11.5	Infinite	0.0	5.8	11.1
Electricity Replacement						
Equivalent kWh[8]	4,692.0	4912.9	4,621.3	10,785.4	11,659.9	11,243.4
kWh Difference	0.0	220.9	-70.7	0.0	874.5	458.1
Added Life Cycle (years)[7]	0.0	5.2	Infinite	0.0	2.6	5.0

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