Oventrop Solar Applications Guide

Solar hot water systems are simple in principal but complicated in practice. This guide is designed to describe and explain the process for designing a solar hot water system. There are many ways to design a solar hot water system to achieve the same end result. The two system types that Oventrop uses are external heat exchanger systems (i.e. the Regusol X) and Immersed coil heat exchangers (i.e. internal coil tanks). All of Oventrop's systems are based on one of these two variants.

Solar Design Basics

Incoming solar radiation at the earth's surface on a perfectly clear day is approximately 300 BTU/H per square foot. With that said, solar collector performance depends on several factors. These factors include, but are not limited to: ambient temperature at the location of the solar collector, required operating temperature of the working fluid in the collector, incoming solar radiation (energy), geographical location of the collector, shading of the collector, and inclination angle of the collector.

The difference in temperature between the working fluid and the ambient temperature drives the heat loss of the solar collector. This temperature difference has the greatest influence on the solar collector's thermal efficiency. This efficiency measures the solar collector's ability to convert incoming solar radiation to usable heat in the form of a hot working fluid. This hot working fluid can be used for any application.

The availability of solar radiation (energy) is dependent on weather, time of year, site shading, and collector inclination angle. Throughout the year, the distance of the sun from the horizon will change from the longest on the first day of summer to the shortest on the first day of winter. This translates to a 47-degree change in the sun's angle with respect to the collector throughout the year. The optimal inclination angle to minimize this change and maximize year-round performance is equivalent to the latitude at which the collector is located. Shading at the collector site determines the amount of available solar radiation to which the collector is exposed.

Understanding that all of the above factors affect the performance of the solar thermal collector, one cannot make a location independent generalization of collector performance.

Design conditions are calculated as the maximum instantaneous solar radiation, in other words, the most energy the system can handle at any given time. For design conditions we assume the collector is at an operating efficiency of 75% on a clear day, facing south and with no shade. Due to this efficiency the maximum output of the solar collector at design is rated at 225 BTU/H per square foot. **This value is in no way a guarantee or estimate of any Oventrop collector's performance.** The table below shows the design BTU/H rating of each Oventrop solar collector.

Collector Type	Design Conditions BTU/H rating
OV 5-16 Evacuated tube collector	6,277 BTU/H
OVF-21 Flat plate collector	4,230 BTU/H
OVF-32 Flat plate collector	6,615 BTU/H
OVF-40 Flat plate collector	8,280 BTU/H

Table 2, below, shows the design flow rates for each Oventrop collector type.

Collector Type	Design Flow Rate per collector
OV 5-16 Evacuated tube collector	0.75 GPM
OVF-21 Flat plate collector	0.525 GPM
OVF-32 Flat plate collector	0.80 GPM
OVF-40 Flat plate collector	1.0 GPM

These flow rates were chosen based on the collection area of each solar collector and the incoming solar radiation at design conditions. The flow rates allow the collectors to achieve an 18 degree Fahrenheit temperature rise across the solar loop.

'The sun is the source, the system is the battery.'

Solar energy is only available for a limited time during each day. It is because of this that the energy must be captured and stored for later use. The amount of energy stored is related to the system operating temperature (i.e. radiant floor heat at 100F or fan coil units at 180F), the storage volume, and to the maximum temperature in the storage vessel. Maximum energy storage [BTU's] is calculated using equation 1, below.

Maximum Stored Energy = 8.33 x Storage volume [Gal] x (Max. tank temp. – System operating temp.)

Where, Storage volume is in gallons and all temperatures are in Fahrenheit.

Optimization of this equation has determined the design number of gallons per collector. The table below shows the number of gallons of storage recommended per collector.

Collector Type	Gallons of Storage per Collector
OV 5-16 Evacuated tube collector	66 Gallons
OVF-21 Flat plate collector	27 Gallons
OVF-32 Flat plate collector	41 Gallons
OVF-40 Flat plate collector	53 Gallons

These storage values are calculated for a national average. Since daily solar radiation varies significantly from the south latitudes to the north latitudes, these storage values are not required, only recommended. Less storage can be used in the northern latitudes and more storage can be used in the southern latitudes. The storage values should only vary plus or minus 5% from the recommended values listed above.

Another way to think of solar storage is as the fuel tank of the system. It is used to store energy that can be used over the entire day. In this way the daily load is matched to the daily collector output.

Oventrop solar hot water systems are designed to optimize the transfer of energy from the collectors to the solar storage vessel.