INTRODUCTION

This brochure provides the general information for the dimensioning and design considerations of solar thermal systems. The information provided can be used for the sizing of small residential systems as well as for larger systems for the accommodation and healthcare sectors and includes both thermosiphon and pumped systems.

The following topics are covered:

- Types of collectors
- Types of systems
- Tilt and orientation of collectors
- Understanding hot water demand
- Sizing of hot water storage tanks
- Sizing of collector area
- Other design considerations

TYPES OF SYSTEMS

Two types of solar thermal systems, also referred to as solar water heaters, are typically used depending on the application, namely thermosiphon and pumped systems.

THERMOSIPHON SYSTEMS

Thermosiphon systems, also referred to as passive heating systems, rely on the thermosiphon principle for circulating and heating water in the tank. These types of systems are most commonly used for residential applications. The location of the tank above the solar collector is important to ensure effective passive circulation in the system.

PUMPED SYSTEMS

Pumped systems, also referred to as active heating systems, makes use of a pump to circulate the water in the system for heating. In these systems, the location of the tank is not important, but the distance of the collector(s) from the storage tank should be minimised to reduce heat losses. These types of systems are most commonly used for large-scale installations in residential, commercial and industrial applications.

Both thermosiphon and pumped systems can be direct or indirect systems. In direct systems, the water inside the tank flows within the collectors whereas in indirect systems, the water flowing through the collector does not come in contact with the water inside the collector - instead the heat is transferred by an internal or external heat exchanger. It is recommended to use indirect systems.

TILT & ORIENTATION OF COLLECTORS

Solar collectors should always be installed facing the equator. This means that collectors installed in the southern hemisphere should be north facing. A deviation of 30° from North is permissible in most Southern African regions, without significant reduction in the annual solar yield of the system (<5%).

The optimal tilt angle of the collector varies with season but a general rule is that the tilt angle is equivalent to the degree of latitude of the site, to ensure maximum yield throughout the year.

TYPES OF COLLECTORS

The most common solar thermal technologies used for generating hot water for residential, commercial and industrial applications are; flat plate collectors and evacuated tube collectors. These collectors are ideal for the production of heat in low temperature applications (below 100 °C) for both domestic and process heat applications.

There are advanced flat plate and evacuated tube collectors that can produce heat at temperatures above 100 °C.
**SIZING OF COLLECTOR AREA**

The sizing of the collector area required to satisfy the daily hot water demand is essential for the **effective operation** of the solar water heating system. For small scale-residential systems, the table below provides the suitable range for the collector area required for a specific storage volume in Southern African weather conditions:

<table>
<thead>
<tr>
<th>Storage volume</th>
<th>BP collector area</th>
<th>SC collector area</th>
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</thead>
<tbody>
<tr>
<td>50 - 75 liters</td>
<td>1.0 – 1.5 m²</td>
<td>0.9 – 1.3 m²</td>
</tr>
<tr>
<td>100 -150 liters</td>
<td>2.0 – 3.0 m²</td>
<td>1.5 – 2.5 m²</td>
</tr>
<tr>
<td>200 -300 liters</td>
<td>3.5 – 4.5 m²</td>
<td>3.0 – 4.0 m²</td>
</tr>
<tr>
<td>300 -450 liters</td>
<td>4.5 – 6.0 m²</td>
<td>4.0 – 5.0 m²</td>
</tr>
<tr>
<td>500 -750 liters</td>
<td>7.5 – 10.0 m²</td>
<td>6.0 – 8.5 m²</td>
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</tbody>
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*BP - black painted absorber; SC - selective coating

A general rule of thumb is to install 1 m² of collector area with selective coating per 100 litre of storage volume for large-scale installations. For the case of the hotel, the collector area (A<sub>c</sub>) required is calculated as follows:

\[ A_c = 1 \text{ m}^2 \times (5760 \text{ litres} \div 100 \text{ litres}) = 57.6 \text{ m}^2 \]

This means a collector area of 57.6 m² with selective coating would be suitable for the installation. This dimensioning guideline could vary depending on the application and the heat demand, especially in the case of process heat applications.

**OTHER DESIGN CONSIDERATIONS**

The **installation quality** of a solar thermal system is a significant contributing factor to the effective operation, maintenance requirements and lifespan of the system. It is critical that the system be installed to the highest quality possible with adequate insulation of all hot water pipes to and from the collectors and tanks as well as all safety components and valves to ensure the installation complies with local standards. Expansion vessels have to be sized and installed correctly to ensure effective operation.