Thermo Siphon Solar Systems

Thermo Siphon Solar Systems are a very cost effective way of producing hot water due to their simplicity in design and installation requirements. Usually more common in hotter climate countries a typical system will involve a standard solar panel, hot water cylinder also known as a geyser and connection pipes.

This system takes full advantage of heat energy and convection movement
(hot water rises and cold sinks)

The technology is called passive solar design unlike active solar heating systems; it doesn't involve the use of mechanical and electrical devices such as pumps or controllers to operate the system.

Convective movement of the liquid starts when liquid in the solar panel is heated, causing the liquid to expand and become less dense, and thus more buoyant than the cooler liquid in the bottom of the solar panel. Convection moves heated liquid upwards in the system as it is simultaneously replaced by cooler liquid returning by gravity. Ideally, the liquid flows easily because a good thermo siphon system should have very little hydraulic resistance to obstruct or slow natural circulation. The piping from the solar panel must rise from the panel to the cylinder which must all be above the solar panel. Hot liquid from the solar panel rises into the flow connection pipe, gravitates in to the cylinder and flows back through the return at a much lower temperature.This process continues naturally until the temperature of the water reaches an equilibrium with solar radiation input.

Types of Systems

Domestic Thermo Siphon solar systems usually range from 80-litre up to 300-litres of hot water storage depending on the user's hot water requirements. As a rule of thumb!
A typical 2m2 flat plate solar panel will be sufficient to support a 100-litre cylinder,
4m2 of solar panels for a 200-litre cylinder, and 6m2 for a 300-litre cylinder.

Thermo Siphon Solar systems are either Indirect or Direct type.

Indirect Systems

Also known as a split system, within an indirect solar heating system the domestic hot water is not passed through the solar circuit or the solar panels. A heat exchanger separates the domestic consumed hot water from the solar circuit. The solar circuit is filled Glycol,
Glycol acts as an anti-corrosion inhibitor and antifreeze.

Indirect solar systems require a special solar cylinder with an internal heat exchanger. The heat exchanger is a coil located within the water of a storage cylinder. Solar cylinders are

manufactured with this required heat exchanger within the unit. This is why when installing an indirect solar heating system the installation will require a solar indirect geyser to be installed.

Direct Systems

Within a direct solar heating system, the domestic hot water is passed through the solar circuit by circulating it from the domestic storage geyser directly through the solar panels. Direct solar systems have been fitted in various formats, often connecting to the existing hot water geyser.

Advantages and Disadvantages of both Direct and Indirect Systems

Advantages of a Direct System

- Lower installation cost But! Has a lower system life expectancy.

- Slightly better system performance over an indirect system.

Advantages of a Indirect Solar System

- No risks of scale damaging within the solar panels or the solar circuit. The Glycol within the solar circuit will protect the system form corrosion.

- System performance will not be reduced as a direct result of scale.

- No risk of freezing of fluids, even on a very cold day the system can still operate without risk to equipment.

- Bacteria will not build up in the panels and have direct contact with the domestic water.

- Panels carry a better panel warrantee due to the fact that they are not at risk of corrosion of scale.

Disadvantages of a Direct System

- Greater accumulation of lime-scale, silt and other debris in the solar circuit resulting with loss of system circulation, heat transfer, blockage of safety vales of bacteria build-up.

- Loss of performance and quantity of hot water due to the presence of scale reducing the thermal exchange between the solar panel and its water content.

- Potential freezing of fluids in the solar circuit and other parts of the primary circuit with risk of damage to equipment.

- Reduced life expectancy of the solar panels due to the scale blockage within the solar panel pipe system.

- Manufactures of direct panes have a very low or do not provide warrantee agent blockages on solar panels.

- Direct water circulated panels have a higher maintenance requirement to ensure panels are circulation correctly and not blocked.

Disadvantages of Indirect Systems

- Higher installation cost But! Has a greater system life expectance.

What is Hard Water?

• The hardness of water refers to the sum of the concentrations of two harmless minerals: calcium and magnesium. The greater the concentration of these minerals, the harder the water. The hardness of drinking water around South Africa varies depending on the rocks and soils of the area that the water comes from, and the treatment process used by the water provider.

Possible Effects:
• Hard water is healthy to drink because it provides high levels of minerals, but can cause other problems. It can also form scale deposits in pipes and hot water appliances like kettles. Hard water may also change the taste of water; it can also corrode pipes and appliances.

What should I do?
• Contact your local authority or water provider to find out the hardness of your drinking water supply. Most water providers quote water hardness as mg/lCaCO3. Water with a level of calcium carbonate over 80-100mg/l is considered "hard". Water with less than 100 mg/l CaCO3 is generally labeled "soft". Hardness can also be expressed in a number of ways including mg/l CaCO3, ppm CaCO3, mmol/l alkaline earth metals, German Degrees Hardness, or French Degrees Hardness.

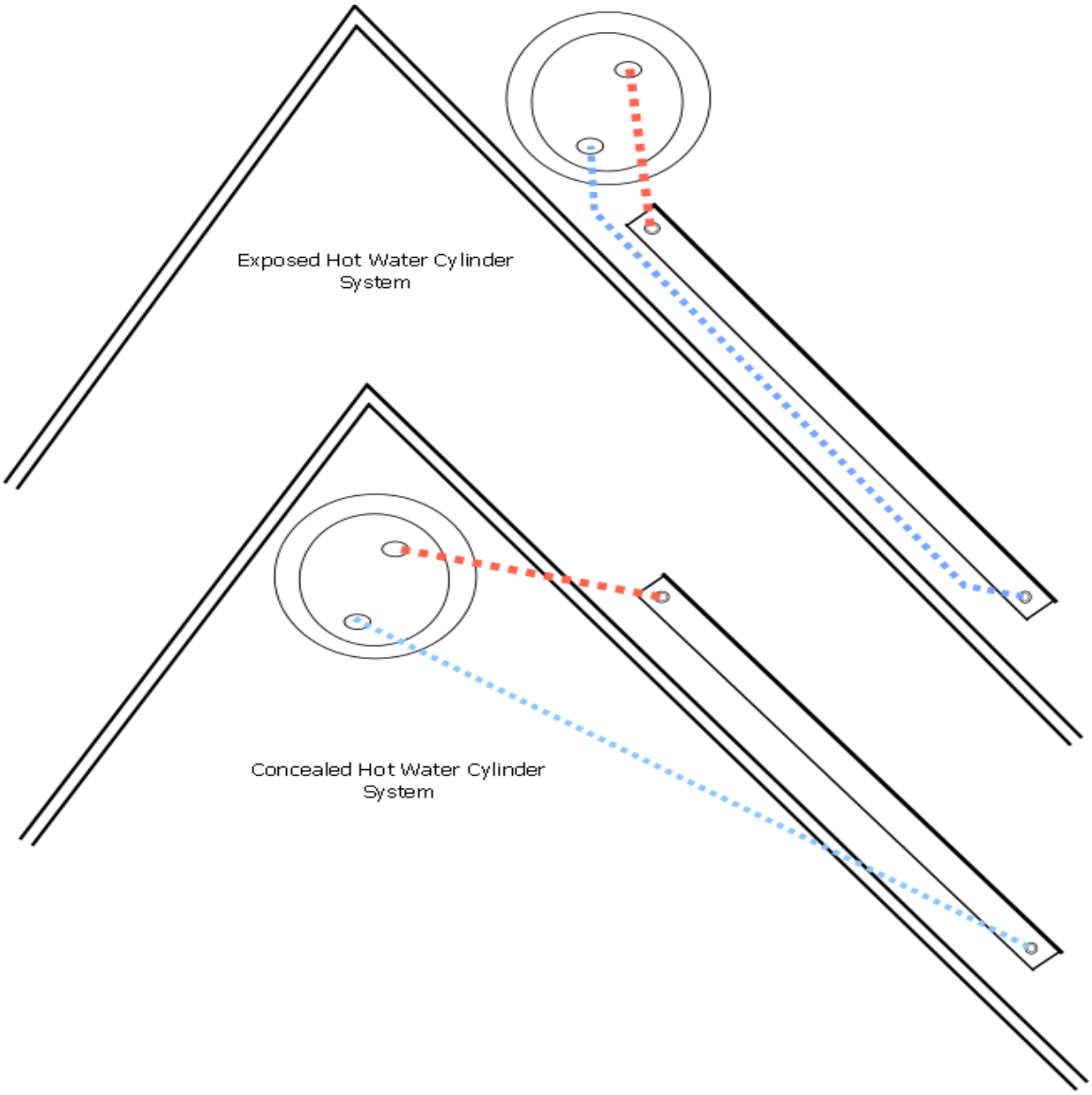
Location of the Hot Water Cylinder / Geyser

When installing a gravity system the location of the hot water cylinder can be located on two different positions as illustrated in Fig1

Option 1 exposed hot water cylinder probably the most practical to install out of the two installations. This type of installation is most favoured in countries with a hotter climate if the outside temperature is very cold the cylinder will be subjected to freeze issues and can rapidly cool over night leaving no hot water the following morning. Cylinders and connecting pipe work need to be well insulated.

Option 2 concealed hot water cylinder is recommended if the hot water cylinder could be subjected to over night freezing conditions, or if the customer is not happy about a hot water cylinder sat on the roof of their property. The installations can be a little more difficult and time consuming. The hot water cylinder must always be above the solar panel at all times, if not the system would fail to operate sufficiently.

Fig-1



Hot Water Caution

Due to the nature of Thermo Siphon and the lack of thermostatic control applied to them caution must be take when installed to safe guide the user of the system for very hot water.

Thermo Siphon solar systems will generate hot water quickly and efficiently. Under normal daily use, it will operate between 60ºC and 70ºC. However, the temperature can exceed this and under certain circumstances may be as high as 95ºC. This can occur during prolonged periods of direct sunlight and particularly in summer or long periods of reduced hot water usage.

Extreme care should be taken in these circumstances. Advise the user to check the water temperature before use, such as when entering a shower or filling a bath or basin, to ensure it is suitable and will not cause scald injury.

We recommend and it may also be required by regulations, that an approved temperature limiting device (Thermostatic Mixing Valve) to be fitted into the hot water pipe work when

the system is installed. This will keep the water temperature below 50°C. The risk of scald injury will be reduced.

Weight Loading

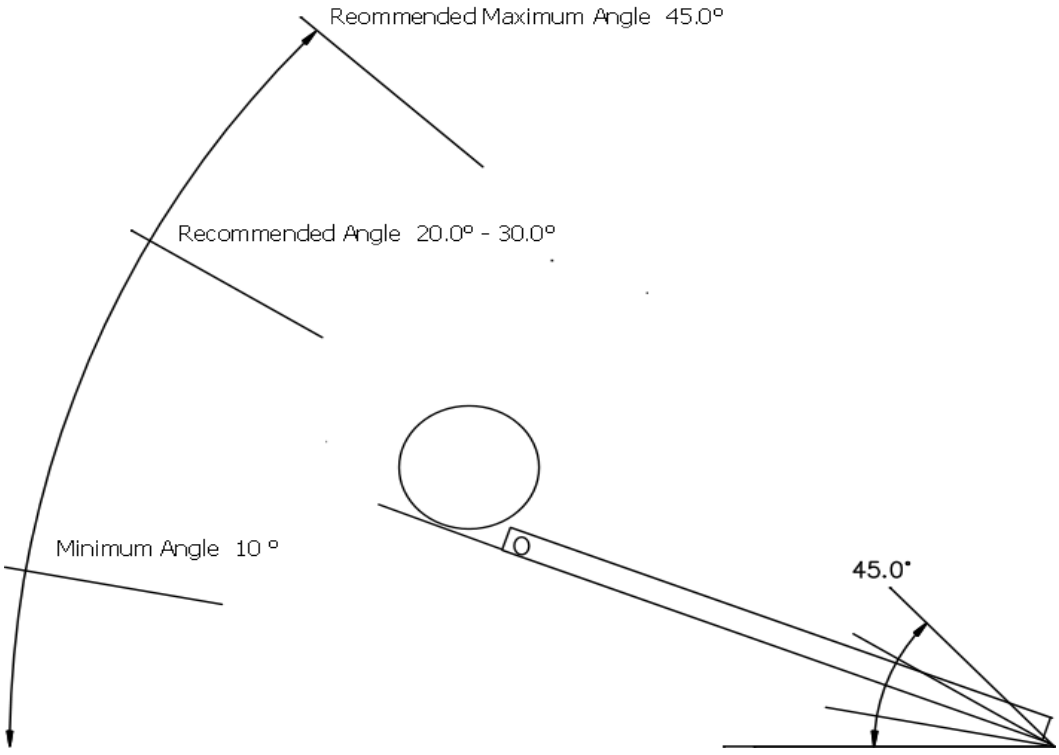
When considering installing a Thermo Siphon system it's important to ensure the roof structure of the building can carry the weight of a hot water cylinder. A structural engineer would need consulting if unsure. Remember 100 liter of water = 100 kg.

Orientation

In the Northern hemisphere solar collectors should ideally face south. In Southern hemispheres the solar collectors should ideally face north. However orientations between, S.W. S.E or N.W N.E are acceptable but should expect a 10-15% loss in efficiency.

Tilt Angle

It is not recommended to install the system less the 10˚incline, the system would fail to gravitate naturally and the solar circuit would require a pump to assist circulation.
Thermo Siphon systems will perform best between 20˚ - 45˚ and systems installed over 45˚ will naturally gravitate but! Installation could be difficult.



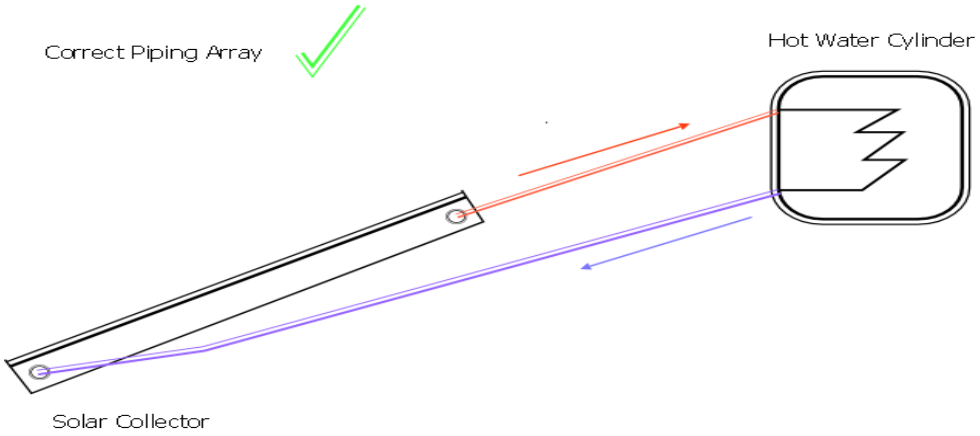
Piping the Panel to the Cylinder

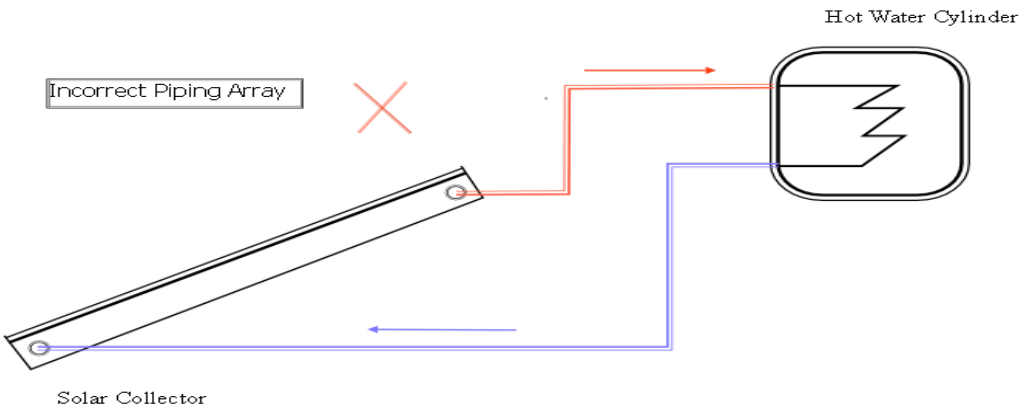
Care must be taken when piping the solar panel to the hot water cylinder to ensure natural circulation can take place. The hot water cylinder must be positions so that the flow and return outlet pipes, from the solar cylinder is above the top of the solar panel.

Piping an exposed system is very much straight forward and requires minimum pipe work. The solar cylinder will be positioned above the solar panels and will have a solar inlet Flow connection and a solar Return outlet connection. The Flow connection connects with the top of the solar panel and the return will connect with the bottom of the solar panel.

We recommend 22mm cooper pipe (NO PLASTIC) and insulated with solar rated pipe insulation. I some cases the manufacture will supply the system with stainless steep connection piping as part of the system.

Piping a concealed system needs a little care as the piping will need to travel through the roof weathering. Pipes must not be less then 22mm and must have a continuous rise from the panels to the cylinder. Any 90° bends will stop natural circulation and the system will fail to heat the hot water cylinder.





Hot Water Cylinders and System Components

Depending on the Pluming practises of your country hot water cylinders are connected to a cold water supply by either Direct or Indirect connection.

Direct connection allows the cold water supply to the cylinder to be connected directly onto the mains cold water supply. This type of system requires a good available mains water pressure for the system to operate sufficiently. Extra components like temperature/ pressure relief valves, expansion vessel and pressure reducing valves will need installing.

(Contact your local water authority for current installation regulations)

Indirect connection cold water to the cylinder is supplied via a cold water storage tank located at least 1m above the cylinder. The pressure of the hot water is governed by the high of the cold water storage tank. This type of system is ideal for places with low mains water pressure.

Indirect Solar Cylinders Components

Cylinder specially manufactured with an internal heat exchanger. The heat exchanger allows the solar heated glycol to transfer its heat energy into the cylinder and heat the stored water. The glycol does not come into contact with the mains water.

Not all solar cylinder are thermo siphon compatible ensure the hot water solar cylinder is compatible with a thermo siphon system before installing.

Cold Water Inlet Cold water inlet connection to direct mains or tank fed cold water supply. If connected to mains water supply a pressure reducing valve is usually installed.

Hot Water Outlet The hot water outlet pipe from the cylinder is connected to the hot supply of the property. It's highly recommended to install a Thermostatic Mixing valve at this point to reduce the risk of excessive hot water.

Electrical Back Up An electrical auxiliary back up heater is usually supplied with the hot water cylinder. Installed within the cylinder the electrical back up is used to ensure the hot water demand can be maintained and also more importantly protects the thermo siphon unit from legionella if used correctly.

Pressure Reducing Valve is installed at the cold water inlet of the cylinder to regulate the mains water pressure entering into the solar cylinder.

Non Return Valve installed on the mains cold water supply inlet entering the hot water cylinder. Required to prevent contaminated water re-entering the mains water supply.

Temperature and Pressure Relive Valve installed to protect the solar cylinder from excessive temperature and pressure, this safety devise is activated when stored water temperature exceeds 90 Deg C and 6 Bar cylinder pressure.

Pressure Relive Valve (closed circuit) usually installed to protect the glycol circuit from over pressurising. Most quality thermo siphon cylinders will be designed to allow natural glycol expansion without the need for an external expansion vessel.

Due to the typical thermo siphon system containing a low volume of glycol the glycol expansion when heated is taken up within the internal heat exchanger of the cylinder. If the cylinder is installed to a large array of panels an external heat exchanger could be required.

legionella in Thermo Siphon Units

Thermo Siphon solar systems are at RISK from legionella if systems are installed incorrectly and the user of the system is not clear on how to operate the system correctly.

Preventing legionella in solar-thermal hot water systems needs a thoughtful approach to avoid wasting the potential of the solar energy.

Legionella bacteria are found in water in the natural environment, but it is only in man-made water systems that the bacteria can exist in numbers high enough to cause disease. As the resulting Legionnaires' Disease can be fatal.

It is now well established that the bacteria is encouraged to colonise where there is stagnation, accumulation of debris, scale and corrosion, or in lukewarm water between 20 and 45°C. Research has shown that at 70°C legionella bacteria is killed in seconds, at 60°C over 90% of the bacteria is killed after two minutes, whilst at 50°C it would take two hours to achieve the same level of elimination. As well as temperature, another consideration is the time taken for normal use to completely replace the volume of water held in the storage vessel.

Ensuring legionella is controlled within the system it's important to ensure the auxiliary heater within the solar hot water cylinder is operated to decontaminate the hot water cylinder. This is archived by activating the axially heater to heat the cylinder to a minimum 65 Dec C at least twice a week to remove bacteria growth.

Its best practice to connect the auxiliary heater to an electrical timer switch which will automatically activate the auxiliary heater for one hour periods through out the week. It's best to activate the auxiliary heater at night when solar gain is low avoiding wasting valuable solar energy.