Module 27: Hot water heaters

Module Objectives

By the end of this session, participants will understand:

1. How electric hot water geysers work and should be installed
2. How heat pumps work and should be installed
3. How solar powered geysers work and should be installed
4. Types of foundations.

Module at a glance:

<table>
<thead>
<tr>
<th>Topic</th>
<th>You will learn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric geysers</td>
<td>- Components of a geyser and how to inspect the geyser installation</td>
</tr>
<tr>
<td></td>
<td>- How geysers must be supported</td>
</tr>
<tr>
<td></td>
<td>- Trouble shooting a geyser</td>
</tr>
<tr>
<td>Instant hot water systems</td>
<td>- How these small devices provide easy solutions when only a small quantity of hot water is required.</td>
</tr>
<tr>
<td>Heat pumps</td>
<td>- Why heat pumps are so energy efficient</td>
</tr>
<tr>
<td>Solar powered geysers</td>
<td>- The different types of solar geysers and how they work.</td>
</tr>
</tbody>
</table>

Hot Water Heaters

There are various ways of heating water for a house in South Africa. By far the most common is the electric geyser. Solar geysers and heat pumps are two other solutions which are increasingly becoming more popular as the cost of electricity soars.

Although an electric geyser installation usually costs less than 0.5% of the price of a South African house, geyser problems result in a disproportionate high share of insurance claims.
and maintenance costs. This is because home inspectors find that a very high percentage of geysers in South African houses are incorrectly installed. Incorrectly installed geysers can be very dangerous and can also result in insurance claims being repudiated.

Plumbers are usually responsible for geyser installations – installing the geyser and hooking it up to the water supply – and electricians should then take over and safely connect the electric geyser to the electricity supply.

In practice...
Many geysers in South African homes have been installed by unqualified and unlicensed labour.

For all of the above reasons the ability for a home inspector to accurately check and report on the geyser installation is an important part of the service which the home inspector performs for his/her clients.

Electric geysers

Most new geyser installations are typically high pressure (400-600kpa) system - by far the most common type in South Africa. Vertical geysers are different although much of the description still applies. Low pressure systems (100kpa) are significantly different but are fairly uncommon now.

These are the components of a standard geyser system:

Drip Tray

The geyser sits in a tray made of plastic or steel. Since June 2001, the drip tray is not optional. The tray must be fitted with a 50mm PVC waste pipe that drains the tray by piping the water out the house.

It is important that the correct size tray must be installed for the corresponding geyser capacity. The geyser is to be placed horizontally inside of the tray. The wooden supports
beneath the geyser must be directly under the feet of the geyser when the geyser placed in the drip tray.

The tray must be sloped to the outlet end and rigidly maintained in that position. A 50mm PVC adaptor must be fitted to the waist outlet on the tray. A 50mm PVC pipe is to be attached and piped at a slope away from the drip tray and discharged to the outside of the building in a visible position.

The Vacuum Breakers, Drain Cock and Safety Valve must all be within the overall confines of the geyser drip tray dimensions; so that any water leakage is captured by the drip tray. Should the pressure control valve be installed in the roof, the same applies.

**Vacuum breakers**

These are small brass components mounted at the 30cm length of pipe. They two vacuum breakers stand vertically about 30cm above the geyser. These are important. They prevent the water siphoning out the geyser when the cold supply is stopped.

**Shut off valve on the cold water side**

The cold water side is the side that directly connects to the drain cock.

**Temperature and pressure safety valve (T&P Valve)**

Mounted on the geyser towards often on the opposite side to the drain cock. This is a vital component that should never be messed with or "repaired". This valve should have a 20 mm metal (copper or steel) pipe connected to it and the pipe must lead directly out the building. This vent an important safety feature of the whole system. It must be made of copper or steel - not plastic. The pressure rating valve must match the pressure rating on the geyser. The T&P valve is the least optional component - it has to be there!
Some examples of geyser components which the home inspector must learn to recognise: From left: Two examples of pressure control valves (the first with a shut-off valve); then the crusual T&P valve (temperature and pressure control valve) – only the top section protrudes from the geyser; then the thermostat (used to regulate the water pressure); finally two examples of vacuum breakers. The vacuum breakers, which can drip, must also be located over the drip tray.

**Multi-valve (pressure control valve)**

This is a water pressure control valve fitted to the cold water supply to the geyser. The purpose of the pressure control valve is to "balance" the water pressure of the hot and cold water supply to baths, showers and basins. For a balanced system the cold water supply to baths, basins, showers etc must be taken off the supply between the pressure control valve and the geyser. The pressure control valve reduces the cold water pressure to the same pressure of the hot water coming from the geyser. Sometimes plumbers will locate the pressure control valve outside of the house – where the cold water supply enters the house. This is fine. Mostly however the multi-valve will be found in close proximity to the geyser. The pressure control of the multi-valve is designed to release excess pressure and may therefore drip when water is drawn through the valve. Each geyser must also be fitted with a pressure control valve. As most geysers have a maximum working pressure it is vital that the pressure is controlled in order for the geyser to have a longer life span. If no pressure control valve has been fitted then the geyser guarantee will likely not be honoured.

**Note...**

*If the multi-valve is located inside the roof cavity, then a 13mm overflow pipe extending to the outside of the house, must be fitted to the multi-valve.*
Older low pressure (100 kPa) geysers are still in use in some South African homes. These geysers have old Lacto-type pressure and relief valves.

Geyser casings
The South African home inspector will come across a variety of different geyser types – the most common being those manufactured by Kwikot. The significance of the geyser manufacturer is that the name of the maker indicates to the home inspector the type of geyser casing encounters – geyser casings can be either mild steel, polymer coated mild steel, or copper.

The type of geyser casing is significant for the home inspection report - because mild steel geyser casings will obviously not last as long as a coated mild steel or copper casing. Here are the geyser types likely to be found by the South African home inspector:

- Enamel-coated mild steel casing geysers (manufactured by Kwikot, Franke and Builders Pride). These geysers have self-sacrificing anodes, which should normally be replaced every 3 years, but in areas with poor water quality (high heavy metal content) anode should be replaced every 18 months. Kwikot geysers carry a 5-year guarantee.
- Polymer-coated mild steel geyser (such as Duratherm) - no sacrificial anode. Normally maintenance free with 10-year guarantee.
- Copper geyser casing (such as Tecron and City Heat) - copper geysers have the longest lifespan. Copper is naturally corrosion resistant.
Self-sacrificing anode
Anode rods that come installed with geysers (mild steel casings) are generally made of magnesium or aluminum that is wrapped around a steel core wire. Water heater anode rods are screwed into the tank. Because the rod is made with a higher current potential than other metals in the water heater, it will ensure that the galvanic current flows from the rod to other exposed metals, preventing their corrosion. In other words, the anode rod corrodes and not the tank or the element. The anode rod is "self-sacrificing." When there's no sacrificial metal left on the anode, the tank can rust out. Anode rods generally last about five years but this depends on the quality of the water and how much water travels through the geyser. Not replacing a depleted anode rod will shorten the life span of the geyser.

Electrical isolator switch
Should be within 1m of the geyser. This was not a requirement on old geysers. The geyser also has to be earthed. There should be a cover over the thermostat and element. These are often just left lying next to the geyser.

Thermostat
Regulates the water temperature inside the geyser. A good temperature for household use is 60°C.

Plumbing piping
The geyser may be fed with polycop (plastic) pipe - up to the shut off valve, but the pipe into and out of the geyser must be copper or galvanised steel. The PCV and T&P vent pipes also have to be steel or copper, especially the T&P vent. The hot water should be copper, steel or suitably rated (70 degrees) plastic or composite pipe.

Age of Kwikot geysers
Kwikot geysers are the most common geyser installed in South African homes. If correctly installed the Kwikot product carries a 5 year warranty on the geyser tank.

The age of a Kwikot geyser can be determined from the serial number code of the geyser. The code may read 12-K-5 which means: 12 = month of manufacture (December); K = year
of manufacture starting with “A” in 1998 – therefore K = 2008; 5 = the guarantee period (on the tank only).
This illustration shows the correct way to install a horizontal geyser into a roof cavity. The home inspector must ensure that he/she is thoroughly familiar with this set-up.
**Horizontal geyser installation**

Mostly geysers are fitted within the roof cavities of South African homes, but it is also permissible for the geyser to be wall-mounted in the garage, on the roof or to be mounted onto an exterior wall of the house.

**Vertical geyser installation**

With a vertical geyser installation the drip tray is positioned directly underneath the vertical geyser installation. It must be sloped to the outlet end and rigidly maintained in that position. The 50mm PVC adaptor must be fitted to the waste outlet on the tray and discharged to the outside of the building in a visible position.

The Vacuum Breakers, Drain Cock and Safety Valve must be within the overall confines of the geyser dimensions, so that any water leakage is captured by the drip tray. Should the pressure control valve be installed in a cupboard, the same applies.

Very often vertical geysers are fitted inside built-in cupboards – particularly in apartment blocks where space is at a premium. Very often such installations incorrectly omit drip trays and drain and overflow pipe systems. The home inspector should note and report on this.
Geyser support

It is important for the home inspector to properly check the support of the geyser. Geysers are commonly located within a roof cavity and are extremely heavy. Therefore the building regulations are specific and detailed as regards the strength and suitability of geyser support.

Only geysers up to 150 liters are permitted to be wall mounted with suitable bolts. Filled geysers are extremely heavy. Geysers installed in the roof cavity must be adequately and safely supported on the roof trusses.

NHBRC 3:4.10: The geyser must be placed on the tie beams over an internal wall and supported by timber bearers (at least grade 5 SANS 1783-2) and of a size at least 120mm x 30mm, spaced not more than 500mm apart.

Where there are insufficient internal walls to support these bearers the geyser may be supported on a timber platform built over trusses the bottom chords of which have been reinforced by nailing an additional chord over three trusses (geyser installed at right angles to the trusses), or two additional chords on both sides of each of the trusses on either side of the geyser (where geyser is installed parallel to the trusses). Where the geyser is installed parallel to the trusses then cross members (38X152mm) are fixed over the reinforced truss bottom chords.

Note...
A competent person is required to design the geyser support where the geyser capacity exceeds 150 litres and/or where the truss span exceeds 8m.
## Timber Bearers Sizes

<table>
<thead>
<tr>
<th>Geyser Capacity (Litres)</th>
<th>Total load INCL. Water (Newtons)</th>
<th>750 Trusses c/c (mm)</th>
<th>1000 Trusses c/c (mm)</th>
<th>1500 Trusses c/c (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>1442</td>
<td>38 x 114 (4)</td>
<td>38 x 114 (4)</td>
<td>38 x 152 (4)</td>
</tr>
<tr>
<td>150</td>
<td>2200</td>
<td>38 x 114 (4)</td>
<td>38 x 114 (4)</td>
<td>38 x 152 (4)</td>
</tr>
<tr>
<td>200</td>
<td>2680</td>
<td>38 x 114 (4)</td>
<td>38 x 114 (4)</td>
<td>38 x 152 (4)</td>
</tr>
<tr>
<td>250</td>
<td>3340</td>
<td>38 x 152 (4)</td>
<td>38 x 152 (4)</td>
<td>38 x 152 (4)</td>
</tr>
</tbody>
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**Diagram Notes:**
- 38 x 152 (6) additional bottom chord bolted to truss as shown (for 3m maximum panel length) additional member Must not be nailed along the truss tie beam.
- 2 Hurricane clips at each connection.
- 38 x 114 Timber Bearer

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Geyser over truss X section

Geyser support over strengthened trusses
Parallel geyser support

Perpendicular geyser support
Electric geyser troubleshooting

The home inspector can often provide useful information in his/her report by knowing what can go wrong with a geyser and relating his/her observations to the following:

- Geysers do leak a bit through the pressure control valve overflow pipe. This is normal as the water in the geyser heats and cools. Anything more than a couple of litres per day (up to 8 litres geyser) often points to a faulty pressure control valve. This should be replaced if there is a constant steady drip or flow from the overflow pipe rather than just occasional dripping.

- Poor hot water pressure could be caused by a number of things: Very often blocked pipes, a blocked or dirty valve or simply an old low pressure geyser (100Kpa Latco type).

- Hot water and steam coming out of an overflow pipe. This may indicate a release of the because of excessive temperature (or pressure). The most common cause is thermostat. This is a serious situation that must be attended to immediately. Switch off the geyser until it’s fixed.

- Faulty thermostat. Switch off until it's fixed. A faulty thermostat is designed to fault in the open or "off" position. In this case there is no hot water. However, sometimes the thermostat faults in the "on" position, in which case the water will eventually boil. This is a dangerous situation that must be attended to immediately. Switch the geyser off until the thermostat is replaced.

- Water leaking through the ceiling - if a geyser bursts or springs a major leak, immediately switch off the water supply and open a hot tap to relieve pressure. Remember to also switch off the power supply to the geyser at the distribution (DB) board.

- Hot water coming out the cold tap during a water supply failure. This is because the geyser has not been installed correctly. Don’t allow the geyser to drain dry without
switching it off. This is dangerous for smaller children (and plumbers!) and should be rectified.

- No hot water. Check the geyser circuit breaker. If the circuit breaker has tripped you should only reset it once, if it trips again call an electrician or plumber to investigate the cause. If there is a power supply, but no hot water, then it is either the element or the thermostat that has failed. The element and thermostat should always be replaced at the same time.

- Not enough hot water or water not hot enough. Setting on the thermostat too low or geyser Move the setting to 65 degrees. Geysers calcify over time and it may need to be replaced. Modern geysers work better than the old ones. It is not recommended that a geyser thermostat is set at its highest setting.

**Instant hot water systems**

There are a variety of (mostly imported) under-the-counter instant hot water systems installed in some South African houses. These devices are mostly suitable when only a small quantity of hot water is required – for instance at a kitchen sink or a basin. The device is attached to the cold water supply and plugged into the electrical installation.

Bigger instant hot water systems which can supply sufficient water for a shower are also available, but these normally require a more robust three-phase electrical supply.

Gas instant hot water systems may also be encountered in South African homes. The normal safety rules for a gas installation apply here.

The home inspector should simply report on the presence of any of these instant hot water devices and, if practical, check that the device does produce hot water. This can be done by running the tap. It is beyond the home inspector’s scope to evaluate the condition or effectiveness of such systems.
Heat pumps

A heat pump is a relatively simple device which uses an economical combination of electricity (25%) and solar energy (75%) to supply hot water to a standard electric geyser or to a solar geyser.

Because water heating counts for up to 40% of a South African household electricity bill, Eskom offers generous subsidies for the installation of heat pumps.

Unlike solar geysers heat pumps work in all weather conditions – even at night. Heat pumps are environmentally friendly and provide hot water at a greatly reduced cost – hence the Eskom subsidy. Heat pumps are controlled by a thermostat and timer and start and stop automatically according to the temperature settings. These pumps also are installed to heat swimming pool water.

Did you know...

A heat pump works on the same basic principles as an air conditioner – but in reverse.

The heat pump uses a fan to draw in air over an evaporator coil filled with liquid refrigerant. The ambient heat in the air is absorbed by the refrigerant. The refrigerant is then pumped into a compressor, which intensifies the heat. The extremely hot refrigerant is then pumped into a heat exchange condenser where the heat is transferred to the geyser water supply. The refrigerant returns to a liquid state and is pumped through an expansion valve to cool and then back into the evaporator coil – which starts the process again.
Solar water heaters

There are a large number of quality solar geyser products available in South Africa. Solar geysers, which meet the prescribed standards of quality and safety, should carry the SABS mark and should be Eskom accredited.

A solar water heating system consists of three main components:

- Solar Collector: designed to "trap" and transfer the sun’s radiation.
- Heat Transfer Liquid: transfer the "trapped" heat from the collector to heat the water.
- Hot Water Cylinder: for storage of the heated water.
Solar water heating works by the collector on the roof “trapping” the sun’s radiation and transferring the heat via the transfer liquid to heat the water.

The transference of the solar-heated water from the collectors to the geyser (storage tank) is via convection (thermo-syphon) or a pump-driven system. The geyser can either be close-coupled to the collector (i.e. on the roof), or remote (inside the roof cavity or elsewhere in the house). Remote geysers are called a split-system.

Two close-couple roof mounted systems:
Left: Flat flat collectors.
Right: Evacuated tube collectors. The home inspector should note that the geyser must always be higher than the collectors for the convection system to work.

There are two main types of solar collectors: Flat plate and evacuated tube (ET) collectors:

**Flat plate collector**

A flat-plate collector has the following features:

- A cover (glazing), this is usually made of toughened glass – to withstand hail.
- An absorber plate, coated with a high absorption and low emissive layer of black high-temperature paint or special selective coating.
• A tube system made of the same or a similar material as the absorber plate itself that removes the absorbed heat to the storage tank (geyser).

• A casing for the geyser, both non-corrosive and waterproof. Insulation is needed on the back and sides to assist in maintaining the absorbed heat.

Left: Flat plate collectors. Right: Evacuated tubes – vacuum tube collectors. Both of these collectors are components of split thermo-syphon systems - the geyser is located elsewhere; in this case inside the roof cavity.

**Evacuated tubes**

Vacuum tube collectors have the following characteristics:

The collector in this type of system is located in individual glass tubes. These tubes are rigged in parallel with one another to make up the collector. When the tubes are exposed to high temperatures, the air inside them is forced out or ‘evacuated’. This evacuation of the air creates a vacuum effect and it is this vacuum effect that makes the tubes good insulators. This vacuum effect keeps the heat (hot water) inside the tube, while leaving the outside cool. Heat pipes have a single layer of glass whereas evacuated tubes have a double layer of glass. Heat pipes and evacuated tube collectors both contain a special fluid which begins to vaporize at low temperatures – around 30°C. The steam rises in the individual tubes and warms up the water in the main pipe by means of a heat exchanger. The condensed liquid then flows back into the base of the heat pipe.
The heat transfer between the collector and water can take place in the following ways:

**Direct system:** With a direct system there is no heat transfer liquid. The water circulates through the collector coming in direct contact with the components. The water is heated by the sun and stored in the geyser. Although these systems are reasonably effective, they tend to have a shorter life span. Chemicals in water erode the collectors. The water can also freeze in colder weather, resulting in damages to the system.

This system is not advisable in the frost areas of South Africa where temperatures drop below 3° C. (see frost map below).

**Indirect system:** Instead of circulating the water directly through the collectors, as one would with a direct system, a heat transfer liquid (glycol mixture) circulates through the collectors. The heat transfer liquid transfers the heat to the water via a heat exchange. Are situated in / around or outside the geyser.
Advantages and disadvantages of direct and indirect systems:

While direct systems are very effective if properly installed, the different geyser components are susceptible to corrosion (from chemicals in the water) and need regular maintenance and replacement. Unlike indirect systems, they don't use any anti-freezing solutions and can freeze in very cold weather, rendering them ineffective and causing damage to the pipes.

Indirect solar geysers are not as efficient as direct geyser systems, as the pipes are only able to heat a small volume of water at a time; pipes are also relatively narrow, so tanks take longer to fill. However, they retain heat longer than direct systems. These solar geysers also last longer than direct geysers because they don't freeze; the anti-freezing solution is also non-corrosive, which extends the life of all geyser components.
Configurations for solar water heaters:

A solar system can be installed in any of the following configurations:

**Thermo-siphon systems:** Thermo siphon systems work with the natural laws of circulation - hot water rises and cold water sinks. As the water in the collector is heated, it rises naturally into the geyser, while the cooler, heavier water in the geyser flows down to the bottom of the collector, causing circulation through the system. These systems are possible when the geyser is installed higher than the solar collector, the distance from collector to geyser is not too far and the pipe route does not break the gentle convection flow.

Thermo siphon systems can be either close-couple or split systems.

- **Close Couple Thermo-siphon system:** The solar geyser and collector are mounted externally on the roof and close together. A close-couple thermo-siphon circulation very reliable if installed properly, but should only be used in the frost-free areas of South Africa.

- **Split Thermo-siphon system:** Here the solar geyser and collector are separated with the geyser usually installed inside the roof cavity. The geyser must be above the collector with connecting pipes rising smoothly. The pipes should not level out or dip at any point, as this could cause poor circulation. Geysers used in split systems often incorporate an electric element controlled by a thermostat. Electric heating of the water is then used to supplement the solar heating during times when the solar heating is not efficient.

**Forced circulation/pumped systems:** Here the collectors are mounted outside on the roof, with the geyser installed in a different location, either inside the roof cavity or at ground level. The heat transfer liquid is circulated by a small circulation pump. Either a 12V DC pump with a photovoltaic panel or a 230V AC pump with a differential controller is used. The DC pump will only function if there is enough sun light to power the photovoltaic panel, which will ensure that there is no heat loss through the collector. The AC pump is controlled with a differential controller which will monitor the temperature on the collector and the geyser. This differential controller switches on the pump when the correct temperature is detected at the collector (the controller will only allow water to be released once the water in the collector is higher than that stored in the storage vessel/water tank at any given time). The differential controller therefore also switches the pump off when the heat transfer liquid’s temperature is lower that the temperature of the water in the geyser.
Retro-fit solar geyser systems

This is the conversion of an existing electric geyser within the roof cavity to accept hot water from roof-mounted solar collectors.

On a standard electric geyser there is only allowance made for the hot and cold water connection points. To convert to a solar geyser, two extra connection points to connect the “to and from” points for the solar collector must be provided.

There are various products available to retro fit an existing geyser with collectors. Most of these products convert the geyser to a direct system. Solar conversion systems can be used in conjunction with existing 100 to 250 liter geysers installed in the roof. The Cobra Thermo Arm, for instance, is a “non-invasive” conversion system that is installed next to the geyser and converts any existing geyser into an indirect solar system.

This system works on all types of geysers no matter how old and there is no need to “open” the geyser, avoiding unforeseen complications and headaches. The Thermo Arm can be custom made to fit any size geyser as well as industrial type boilers.

Effective use of solar geysers

An incorrect installation can render the best solar product ineffective.

The orientation of the collector is important: the collector should face true north, a deviation of 25° east or west is acceptable. The pitch of the collectors should be at latitude +10°. This orientation will provide maximum value for sun throughout the year. Evacuated tube collectors depend less on orientation than flat-plate collectors. Shade must not cover more than 10 percent of the surface area of the collectors between 09h00 and 15h00.

Before you take the online test, please......

Make sure that you are thoroughly familiar with the material in this module before completing the online test. The more familiar you make yourself with the information presented in this Module the better you will be as a professional home inspector. Review thoroughly all areas of this module before and during the open book online test.