

Installing Solar Thermal Collector for Hot Water Production

SLIDE 1

Introduction

The Sun as an Energy Source

- The Sun is an inexhaustible source of energy (by human standards).
- It can be likened to an integral radiator (black body) of 5777 K which sends us 1367 W/sq.m. of energy from outer space.
- In reality, the Sun is a nuclear fusion reactor located at a distance of 150 million kilometres from the Earth.

System Type

The system considered in this training material is a forced circulation solar heating installation, providing hot water in a house, a typical installation for the following reasons:

- It is an indirect, closed loop, pumped system.
- The fluid that flows through the collectors is isolated from the potable water, which permits use of antifreeze and anti-corrosive agents, reducing freezing and corrosion problems and therefore increase the durability and reliability of the system.
- As the system has pumped circulation, a large part of the system, including the tank, can be installed inside of the house, with the additional advantage of lower thermal loss and increased durability.
- The auxiliary system is installed in series with the potable water, and as it is an instantaneous water heater, it achieves higher final output with lower consumption. The auxiliary energy source is only consumed when needed.

This training content has been produced in fulfilment of requirements of the PROGREEN project, financed by ERASMUS⁺, covers custom-build solar thermal installations for hot water.

SLIDE 2

Custom-built installations

Custom-built solar heating systems (customized installations) are systems constructed in single block form or assembled from a list of components. Systems in this category are considered to be a set of components. The components are tested separately and the results of the tests are included in a complete system review.

- The requirements for solar heating systems made to measure are listed in ENV 12977-1:2000, the test methods are specified in prENV 12977-2:2000 and peENV 12977-3:2000. Custom-built solar heating systems break down into two categories:
- Small custom-built systems are offered by one company and described in a so-called component summary which lists all components and possible configurations of the systems manufactured by that company. Each possible combination of a system configured with components on the list is considered a single customized system.
- Large custom-built systems are designed for specific applications. In general, they are designed by engineers, manufacturers or other experts.

Installer of SOLAR Collector

SLIDE 3

At the end of this course, the candidate should be able to install, pressurise and commission a small size, force circulation solar thermal system. This module is constituted by 4 lessons.

- LO1: Installing solar thermal collectors
- LO2: Installing press-fitting Solar Loop Piping
- LO3: Installing solar pump station
- LO4: Pressurising solar thermal system loop

SLIDE 4

Prior to accessing the contents of this training material, the candidate should master skills in the following specific areas:

- Reading and interpretation of projects
 - Flow
 - Head losses
- Site survey prior to system installation
 - Take measure of area where solar collectors are to be installed
 - Collector tilt, orientation and shading
 - Determine the length between collector field and heat exchanger
 - Evaluate the available space for other equipment
- Preparing a competent offer
 - Know the main equipment distributors in the region
 - Check the unit price for the items that will integrate the offer

SLIDE 5

Prior to accessing the contents of this training material, the candidate should master skills in the following specific areas:

- Reading and interpreting collector characteristics
 - Collector dimension
 - Collector stagnation behaviour
 - Collector maximum pressure
- Collector shading
- Pipe joining methods and technics
- Pipe insulation
- Pump selection for primary circuit
- Installing solar hot water tank
- Control and command of solar thermal systems

LO1: Installing Solar Thermal Collectors

SLIDE 1

This learning outcome considers solar collectors mounted on-flat roof. The information provided does not replace the installation requirements and instructions of the manufacturer. Additional care must be taken to prevent skin roof damage.

Safety concerns

Read all the safety regulations, including the regulations about working at heights. Since all roof work is considered hazardous, prior to undertaking any kind of work, make sure you are acquainted with country's safety regulations and carry out risk assessments. A safety fence should be mounted and secured firmly to guarantee protection.

Main tools

- Ladders
- Set of wrenches
- Drill machine
- Tube cutter
- Reamer

SLIDE 2

Collector tilt and orientation

How do you define the angle for solar collectors?

If there is no project or any document defining the project angle, the solar tilt angle from the horizontal should be decided according to the latitude of your location.

Which direction should solar panel face?

For countries in Northern hemisphere, solar panels should be in South facing direction. Dish anthem can be taken as reference point.

SLIDE 3

Work steps

- Define the transport path for the collectors from the ground to the location.
- Measure and mark all details of collector field on the roof, considering the height, width, and orientation.
- Look for surrounding objects that can cause shading
- Lay out the building protection mats
- Position and screw collector stand (support structure) on the flat roof
- Transport collectors to the roof
- Place collector on the stand, using all supplied components
- Proceed to make the connections between collector and copper pipe coming from the pump station. This should be done for feed (cold) and return (hot) pipes
- Place the control system hot sensor
- Close any holes in the roof
- Thermal insulate the pipes, leaving no gaps in the insulation



LO2: Solar Loop and Piping Using Press-connect Joints

SLIDE 1

Prior to selecting the joining system, it is necessary to check on the piping material to assembly the solar loop. Among the materials available in the market, copper tube offers a greater versatility, considering that the number of different tools that can be used to assembly the solar loop.

This lesson provides information in one of the joining techniques, press-connect. People who are not familiar with the other joining techniques should look for additional information.

Main tools

- Tube cutter
- Reamer
- Press machine and adequate jaws

SLIDE 2

Work steps

Measuring and cutting

- Correctly measure the length of the tube.
- Avoid excessive length, which introduces unnecessary stress to the joining, with the probability of affecting the durability of the joining.
- If the tube is short, the joining might fail due to short contact area between the tube and the fitting and excess filling material might accumulate in the fitting.
- When cutting the tube, disc-type tube cutter should be applied to secure square end. During the cutting process, it is important to avoid deforming the tube to secure proper sitting in the fitting cup.



SLIDE 3

Reaming

Clear all excess material that will result from the cutting.

In order to secure that the tube sits properly inside the fitting cup, ream the cut tube and make sure it does not present deformations. Reaming reduces turbulence and potential erosion-corrosion in the join. Properly reamed tube provides a smooth surface for better flow. Burrs removed on the outside of the tube ends ensures proper entrance of the tube into the fitting.



SLIDE 4

Marking

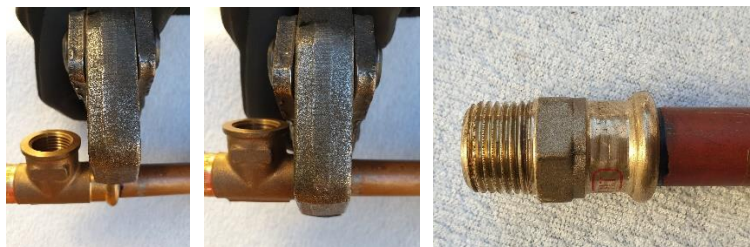
This module considers only press-connect joints. After correct measurement, cutting and removal of any excess material, the fitting must be examined to ensure that the sealing gasket is adequate to high temperature, properly positioned and not damaged. The tube is then introduced into the fitting and marked.



SLIDE 5

Pressing

Place the tube inside the fitting and mark its depth of insertion. Remove the tube and measure the marked on the tube to secure the correct length. Insert the tube back into the fitting, select appropriate size of pressing jaw, insert it into the pressing tool. It is extremely important that the tube is completely inserted to the fitting stop (check the previous mark), prior to applying the pressing jaws onto the fitting. Place the selected jaw over the bead of the fitting, ensuring 90° angle to the centerline of the tube. Press the trigger and do not stop until pressing cycle is completed. Release the pressing jaw and visually inspect the joint to ensure the mark on the tube is square with the fitting. To remove the pressing jaw, press the trigger again and allow the jaw to depress the tube and fitting. Do not change the position of the pressing tool during the pressing.



LO3: Installing solar pump station

SLIDE 1

Main Tools

- ✓ Drill
- ✓ Set of wrenches
- ✓ Pipe cutter
- ✓ Pipe reamer

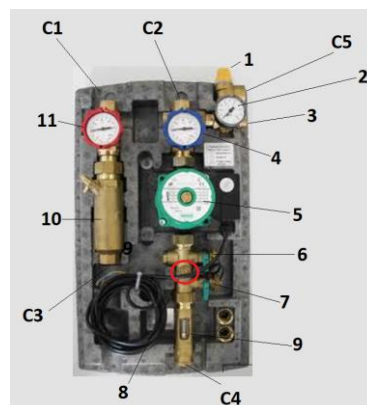
Preparations

Evaluate pipe diameter and the circuit pressure drop presented in the project or any support documents that provide details of the installation.

- ✓ Check whether the proposed pipe diameter needs any specific adaptation so that it can be directly connected to the solar pump station
- ✓ Check whether you will need threaded components for the connections to be made
- ✓ Select the joining system
- ✓ Read the pressure drop presented in the project and compare it to the pump performance curve. It should be clear whether the equipment you intend to install meets the requirements of the flow and pressure drops presented in the project.
- ✓ Double check all other technical specifications related to height, width and depth of the pump station.
- ✓ In case the selected pump meets the requirements of the project, you can move to the next phase of work preparation.

SLIDE 2 & 3

Identify all the components of the pump station. Know all the functions and parameters of different components of the pump station.



- 1 - Safety valve** also known as **pressure relief valve**, limits the maximum circuit pressure and prevents circuit overpressure. They are adjusted to operate at pressures which are lower than the maximum working pressures of the components in the circuit.
- 2 - Pressure gauge** provides circuit pressure reading
- 3 - Expansion vessel connection** provides the connection to the expansion vessel. Expansion vessel is a fundamental component since it absorbs all pressure changes and the fluid expelled from the collector field when vaporization occurs.
- 4 - Thermometer gauge** on return valve (COLD) provides the cold circuit temperature
- 5 - Pump** circulates the fluid between heat exchanger and solar collector
- 6 - Filling flow valve** connection to inject water / fluid
- 8 - Filling return valve** connection to reject cleaning water

- 9 - Filling **shut-off valve** to flushout the rejected water out of the loop
- 10 - **Flow meter** helps read and set the circuit flow
- 10 - **Air separator device** accumulates the air present in the fluid
- 11 - **Thermometer gauge** on return valve (HOT) provides the hot circuit temperature

12 - The **check valve** is not represented on the pump station. It is located on the pipe beneath component 4. This component prevents convective liquid circulation from taking place in the solar circuit when the circulating pump is switched off, which would withdraw heat from the store and transfer it to the surroundings via the collector field.

The pump station presents **four connections to the solar system**, two connections to the solar collector and two to heat exchanger.

- C1 - Solar loop connection to hot circuit of solar panel
- C2 - Solar loop connection to cold circuit of solar panel
- C3 - Solar loop connection to hot circuit of heat exchanger
- C4 - Solar loop connection to cold circuit of heat exchanger
- C5 - Connection to the expansion vessel

SLIDE 4 & 5

Work Steps

Positioning and connection of the pump station

- ✓ Determine whether the pump station will be wall fixed or placed in the solar tank
- ✓ Using adequate accessories, connect C1 to the copper tube from solar collector field (hot side). You might use soldering, press fit or any other suitable joining system

List possible joining systems for copper tube

- Soldered Joints
- Brazed Joints
- Flared Joints
- **Press-Connect Joints**

- ✓ Using adequate accessories, connect C1 to the copper tube from solar collector field (hot side). You might use soldering, brazing or any other suitable joining system. However, in this lesson, press-connection has been selected as the joining option.
- ✓ Using adequate accessories, connect C2 to the copper tube from solar collector field (cold side). You might use soldering, brazing or any other suitable joining system. However, in this lesson, press-connection has been selected as the joining option.
- ✓ Using adequate accessories, connect C3 to the tube from heat exchanger (hot side). You might use soldering, press fit or any other suitable joining system
- ✓ Using adequate accessories, connect C4 to the tube from heat exchanger (cold side). You might use soldering, brazing, press-connection or any other suitable joining system
- ✓ Using adequate accessories, connect C5 to the expansion tank. You might use soldering, brazing, press-connection or any other suitable joining system

LO4: Pressurising solar thermal system loop

SLIDE 1

Tools required

- ✓ Set of wrenches
- ✓ Flushing and filling power pump station

Work steps

- Connect the filling pump station to the solar thermal system, using connections 6 and 7 of the pump station.
- Proceed to clean
 - Pump fresh water around the solar loop
 - Drain all water to remove residue
- Fill and pressurize the system using fresh solar fluid



SLIDE 2

Connections to the equipment

The filling flow and return valves, and the filling/shut off valve (components 6, 7 & 8), are used for flushing and filling the solar thermal installation.

- ✓ Use filling flow valve connection to inject water / fluid
- ✓ Use filling return valve connection to reject cleaning water
- ✓ Use filling shut-off valve to flushout the rejected water out of the loop

SLIDE 3

Proceed to clean

With all the connections in place, start by injecting fresh water to the loop, using filling flow valve connection. At the same time, the filling return valve connection will be open to make sure that the rejected water will be flushed out of the loop, after passing through different components. During this procedure, the filling shut-off valve will be off. Pump fresh water around for minimum 15 minutes and ensure water is entering all sections. Drain all water to remove residue. The collectors should be shaded during the entire process to avoid overheating.

Once the rejected water presents no residuos, the solar loop might be considered clean and might be ready for filling.

SLIDE 4

Fill the system

For this phase a mixture of water and glicol should be used on a proportion that will prevent freezing.

- ✓ Determine the total volume of the circuit
- ✓ Prepare the fluid for solar circuit, using the correct mixture and the filling station reservoir
- ✓ Connect the hoses to the filling station, using the same connections as the previous to clean the circuit
- ✓ Connect the supply hose to the upper connection on the pump station (connection 6).
- ✓ Connect the return hose to the lower hose connections on the pump station (connection 7), ensuring that it is firmly attached.
- ✓ Open both green valves on the pump station.
- ✓ On the pump station ensure that valve 7 is off.

- ✓ Operate the pump.
- ✓ As the fluid level in the reservoir goes down, add solar fluid, previously prepared.
- ✓ Continue adding fluid until fluid starts coming back and the level no longer goes down.
- ✓ All passage ways must be open, pump stations, or diverter valves, fill all sections.
- ✓ In case you have different groups of collectors, you should ball valves to isolate them so that you can fill one each time. Add more solution to the bucket if necessary always making sure to add equal parts of propylene glycol and water.
- ✓ You should see air bubbles coming back into the bucket through the hose connected to valve 7. As the time goes by, the tank will present lesser and lesser fine bubbles and the fluid will become clear and less milky.
- ✓ Pump fluid around for a minimum of 45 minutes depending on system size.

The solar primary circuit is a fully filled loop with no empty zones. No air should accumulate in the loop. When pumping the solar fluid in the system, a large part of the air is removed by submerging the end hose connected to valve 7 completely in the container liquid. When the movement of fluid on the container becomes smooth and no more air bubbles come out, valve 7 must be closed in order to start the next phase.

SLIDE 5

Pressurize the system

- ✓ Continue running the filling pump.
- ✓ Once ready to pressurize the system close the valve 7.
- ✓ Watch the pressure rise and set it to system target pressure.
- ✓ Shut off the valve 6 on the supply hose and immediately shut off the pump.
- ✓ Open valve 8 and check whether the pressure drops.
- ✓ If the pressure drops, check for a leak and, if present, fix it before refilling the system.
- ✓ If the pressure holds steady, the system is ready to be operated.
- ✓ Turn on the solar pump and observe the flow meter on the pump station. If the indicator pulses noticeably, there is still a significant amount of air in the system that needs to be removed.
- ✓ Dial in the system flow rate to match the number of collectors.
- ✓ See the control unit installation instructions for details.

In setting the system target pressure, please consider:

- ✓ The height of the collector field in relation to pressure relief valve and expansion tank
- ✓ The total circuit pressure drop
- ✓ Collector stagnation temperature

The system is ready to be operated.