Solar Hot Water Test # 1

What are the six major content domains from NABCEP?

* Conducting a site analysis, including load analysis
* 2. Identifying solar hot water heating safety practices, standards, codes, and certification
* 3. Identifying systems for specific climates and applications
* 4. Identifying proper operation and installation methods
* 5. Identifying proper use of balance-of-system components and materials (e.g., controllers, tanks, pumps, valves, piping, etc.)
* 6. Identifying common solar hot water heating maintenance items

For the next six questions have students identify as many as they can having three correct answers is sufficient.

Explain the following term as to how it is used in solar hot water heating.

* Radiation

Radiation is one of the three basic forms of heat transfer.

Other forms of heat transfer are convection and conduction.

Radiation uses electromagnetic radiation from a body.

The sun is a major source for solar hot water heating

It is different from the other two methods in that it does not require a physical medium to transfer the heat.

It is most efficient in a vacuum.

Infrared is an example of this.

The sun emits electromagnetic radiation.

Thermal radiation is in the form of electromagnetic radiation.

Therefore, solar hot water heating has the potential to convert all of the solar radiation into heat.

Explain the following term as to how it is used in solar hot water heating.

* Conduction

Conduction is when heat is transferred from a higher temperature end of an object to the lower temperature end.

The ability of an object to conduct heat depends on a property know as thermal conductivity.

A temperature gradient is required for the heat to move.

Energy must be externally moved to the object.

If the external energy is removed the temperature differences will come to equilibrium and the heat transfer / conduction will stop.

In the case of solar hot water heating the sun is the external source.

Full spectrum solar radiation is feeding the conduction.

Explain the following term as to how it is used in solar hot water heating.

* Convection

Convection is another form of heat transfer.

Moving heat form, one medium to another through the movement of fluid.

Thermosiphoning is an example used in solar hot water heating.

Natural convection uses no external forces to accomplish this convection.

When a liquid is heated, it expands and becomes less dense.

The warmer liquid will float on top of the same cooler liquid.

This warmed liquid stratifies.

A temperature gradient from top to bottom.

Explain the following term as to how it is used in solar hot water heating.

* Absorptance

Absorptance is the ability of a substance to take in or soak up radiated energy. In this case solar radiance.

Also, the ratio of the absorbed radiant energy to the incident energy.

The opposite of reflection.

Explain the following term as to how it is used in solar hot water heating.

* Reflection

Reflection is the reverting back by an object or surface of heat or light without absorbing it.

Rejecting the incoming solar radiation.

The opposite of absorbance.

Explain the following term as to how it is used in solar hot water heating.

* Thermal mass

Thermal mass is the ability of an object to absorb, hold and release heat.

The thermal lag is the rate at which the object releases the absorbed heat.

The higher the thermal mass, the longer the thermal lag.

Name the two basic concepts of solar hot water heating.

* A solar thermal collector mounted on the roof (or ground) collects the sun’s energy and transmits it to a working fluid. (Water or other).
* The working fluid then transports the heated fluid to a storage tank for future use by the homeowner.

A solar thermal collector is defined as:

* A device that collects heat by absorbing solar radiation.
* It converts the energy into heat.

What are the three types of collectors classified as:

* Unglazed
* Glazed
* Evacuated

For the next three questions three correct answers can be marked as 100%.

What are the traits of an unglazed collector?

* Unglazed collectors are usually made of a black polymer.
* They do not have a selective coating and do not include a frame and insulation at the back; they are usually simply laid on a roof or on a wooden support.
* They are good at capturing the solar energy, but thermal losses to the environment increase rapidly with water temperature particularly in windy locations.
* Commonly used for swimming pool water heating.
* Inexpensive (cheapest of the three types).
* Lightest of the three types.

What are the traits of a glazed collector?

* Glazed collectors often have a selective coating and are fixed in a frame between a glass cover at the front and an insulation panel at the back.
* They are good at capturing the solar energy and their thermal losses to the environment are relatively low.
* Glazed collectors are commonly used for applications requiring energy delivery at moderate temperatures (domestic hot water, space heating and process heating applications at 50°C or less) in medium to cold climates.
* In areas where freezing air temperatures are expected they can be operated year-round with freeze protection (e.g. glycol, drain-back design).
* The efficiency of glazed collectors is independent of wind.

What are the traits of a glazed collector?

* Evacuated collectors have a selective coating enclosed in a sealed, evacuated glass tubular envelope.
* They are good at capturing the solar energy; their thermal losses to the environment are extremely low.
* Systems presently on the market use a sealed heat-pipe on each tube to extract heat from the absorber (a liquid is vaporized while in contact with the heated absorber.
* Heat is recovered at the top of the tube while the vapor condenses, and condensate returns by gravity to the absorber).
* Evacuated collectors are good for applications requiring energy delivery at moderate to high temperatures (domestic hot water, space heating and process heating applications typically at 60°C to 80°C depending on outside temperature) in cold climates.
* They can be operated year-round with freeze protection.
* The efficiency of evacuated collectors is independent of wind.

Describe NABCEP:

NABCEP The North American Board of Certified Energy Practitioners® (NABCEP®) is the most respected, well-established and widely recognized certification organization for professionals in the field of renewable energy. NABCEP offers certifications and credentials for skilled professionals, specialists and those new to working in the areas of photovoltaics, solar heating, and small wind technologies.

Describe components specific to active direct solar systems

* Active refers to external energy is put into the system to move the heating fluid (water).
* Direct refers to heating the end use water without a heat exchanger.
* Active direct systems involve a circulating system to move the water through the collector and back to the storage tank.
* An electrical pump is used to move the water.
* Since the system is direct the potable water returning from the collector is sent directly back to a storage tank for use in the house.
* Having a pump to move the heated fluid means that the system does not rely on thermosiphon.
* Direct refers to the solar energy is heating the water to be used directly.
* This means that there is no heat exchanger used in the system.
* The collectors deliver the heated water to the storage tank directly.
* Very efficient.

Describe components specific to active indirect solar systems

* The active component is a pump like the first objective.
* Indirect suggests that the heated fluid does not go directly to the end usage storage tank.
* The heated fluid is placed into a heat exchanger.
* The heat exchanger, exchanges the heat from the working fluid to another fluid.
* This system is not as efficient as a direct system.
* The reason for a heat exchanger is keep the working fluid away from the end fluid.
* Keeps them from mixing.
* An example is having the working fluid as an antifreeze fluid.
* The antifreeze will not freeze in cold weather, but in daytime will heat up and let the heat exchange with the domestic water.

Describe components specific to passive direct solar systems

* Passive means no pump (not active).
* Direct means no heat exchanger.
* This type of system does not require any extra energy to make it work.
* Works without electricity.
* No moving parts.
* Requires the storage tank to be at a higher elevation than the collectors.
* Works on thermosiphon.
* The heated working fluid (water) will rise in the collectors.
* The colder water (unheated) from the storage tank takes the place of the heated water and it gets heated.
* The water continues to heat up.
* The storage tank water and the collector water continue to thermosiphon.
* The water will continue to heat up as long as the solar radiation provides energy into the collector.
* When the solar energy is reduced the thermosiphon action also slows or stops.
* When water is drawn off from the storage tank, fresh cold water enters the tank.
* If the collector water is hotter than the water in the storage tank it will thermosiphon into the storage tank from the collector.

Describe components specific to passive indirect solar systems

* Passive means no pump.
* Indirect is using a heat exchanger.
* These types of systems are sometimes called Closed Loop system.
* The closed loop system can have a heat exchanger jacket wrapped around the inner cylinder as part of the solar storage tank design or it can be a coil in the storage tank.
* The heat exchanger and solar collectors are connected by pipe work and form a closed circuit which is filled with closed circuit fluid (working fluid).
* The closed loop fluid can have a solution for antifreeze and water or a solution that keeps local water from the collectors due to impurities in the local water.
* As the working fluid in the solar collector gains the solar energy from the absorber, the increase in temperature causes the fluid to rise through the fluid ways in the collector into the pipe leading to the storage tank.
* Then the working fluid transfers its heat into the water in the solar storage tank.
* As the heated working fluid enters the heat exchanger, the cooler working fluid from the bottom of the heat exchanger flows down the solar cold pipe into the solar collectors to be heated by the solar energy.
* This process continues while solar energy is available and the water in the solar storage tank requires heating.

Describe components specific to swimming pool heating solar systems.

* Swimming pools like radiant heating systems do not require high temperatures.
* Inexpensive unglazed collectors work well for solar pool heating.
* Swimming pools circulate water through a sand filter to help keep the water clean.
* Therefore, they have a water pump.
* By adding a three-way valve after the sand filter, the cleaned water can be diverted to solar collectors.
* A controller is required.
* Swimming pools circulate water through a sand filter to help keep the water clean.
* A controller is required to add or subtract heat from the swimming pool.
* Some controllers will put the water into the collectors at night to help cool the swimming pool water.
* The controller opens and closes the 3-way valve.
* Air check valve to let air out of the system and to help drain water from collectors.