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Control of Temperature and Pressure in Solar Heating Systems

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Abstract :- Controls for solar heating systems are usually more complex than those of a conventional heating system, because they have to analyze more signals and control more devices (including the conventional back-up heating system). Solar controls use sensors, switches, and/or motors to operate the system. The most sophisticated systems use microprocessors to control and optimize heat transfer and delivery to storage and zones of the house. It is possible to use a solar panel to power low voltage, direct current (DC) blowers (for air collectors) or pumps (for liquid collectors). The output of the solar panels matches available solar heat gain to the solar collector. Active solar heating systems use solar energy to heat a fluid -- either liquid or air -- and then transfer the solar heat directly to the interior space or to a storage system for later use. If the solar system cannot provide adequate space heating, an auxiliary or back-up system provides the additional heat.

Keywords:

I. INTRODUCTION

SOLAR HEATING

Solar liquid collectors are most appropriate for central heating. They are the same as those used in solar domestic water heating systems. Flat-plate collectors are the most common, but evacuated tube and concentrating collectors are also available. In the collector, a heat transfer or "working" fluid such as water, antifreeze (usually non-toxic propylene glycol), or other type of liquid absorbs the solar heat. At the appropriate time, a controller operates a circulating pump to move the fluid through the collector. The liquid flows rapidly, so its temperature only increases 10° to 20°F (5.6° to 11°C) as it moves through the collector. Heating a smaller volume of liquid to a higher temperature increases heat loss from the collector and decreases the efficiency of the system. The liquid flows to either a storage tank or a heat exchanger for immediate use. Other system components include piping, pumps, valves, an expansion tank, a heat exchanger, a storage tank, and controls. The flow rate depends on the heat transfer fluid.

HEAT STORAGE

Liquid systems store solar heat in tanks of water or in the masonry mass of a radiant slab system. In tank type storage systems, heat from the working fluid transfers to a distribution fluid in a heat exchanger exterior to or within the tank. Tanks are pressurized or unpressurized, depending on overall system design. Before choosing a storage tank, consider cost, size, durability, where to place it (in the basement or outside), and how to install it. You may need to construct a tank on-site if a tank of the necessary size will not fit through existing doorways. Tanks also have limits for temperature and pressure, and must meet local building, plumbing, and mechanical codes. You should also note how much insulation is necessary to prevent excessive heat loss, and what kind of protective coating or sealing is necessary to avoid corrosion or leaks. Specialty or custom tanks may be necessary in systems with very large storage requirements. They are usually stainless steel, fibreglass, or high temperature plastic. Concrete and wood (hot tub) tanks are also options. Each type of tank has its advantages and disadvantages, and all types require careful placement because of their size and weight. It may be more practical to use several smaller tanks rather than one large one. The simplest storage system option is to use standard domestic water heaters. They meet building codes for pressure vessel requirements, are lined to inhibit corrosion, and are easy to install.

HEAT DISTRIBUTION

You can use a radiant floor, hot water baseboards or radiators, or a central forced-air system to distribute the solar heat. In a radiant floor system, solar-heated liquid circulates through pipes embedded in a thin concrete slab floor, which then radiates heat to the room. Radiant floor heating is ideal for liquid solar systems because it performs well at relatively low temperatures. A carefully designed system may not need a separate heat storage tank, although most systems include them for temperature control. A conventional boiler or even a standard domestic water heater can supply back-up heat. The slab is typically finished with tile. Radiant slab systems take longer to heat the home from a "cold start" than other types of heat distribution systems. Once they are operating, however, they provide a consistent level of heat. Carpeting and rugs will reduce the system's effectiveness. Hot-water baseboards and radiators require water between 160° and 180°F (71° and 82°C) to effectively heat a room. Generally, flat-plate liquid collectors heat the transfer and distribution fluids to between 90° and 120°F (32° and 49°C). Therefore, using baseboards or radiators with a solar heating system requires that the surface area of the baseboard or radiators be larger, temperature of the solar-heated liquid be increased by the backup system, or a medium-temperature solar collector (such as an evacuated tube collector) be substituted for a flat-plate collector.There are several options for incorporating a liquid system into a forced-air heating system. The basic design is to place a liquid-to-air heat exchanger, or heating coil, in the main room-air return duct before it reaches the furnace. Air returning from the living space is heated as it passes over the solar heated liquid in the heat exchanger. Additional heat is supplied as necessary by the furnace. The coil must be large enough to transfer sufficient heat to the air at the lowest operating temperature of the collector.

II CONTROLS FOR SOLAR HEATING SYSTEMS

Control of temperature

The boosting element in a solar water heating cylinder needs to be installed and configured to maximise the proportion of water heated by solar energy. Maximising the proportion of water heated by solar energy. It is important that the booster system does not heat water when there is solar energy available. Any solar systems should incorporate a timer to turn the element off in the mornings. In a 2006-08 BRANZ study of solar water heating systems, only seven of 35 systems had a timer. The position of the element within the system is also important. If there is an element at the top of the cylinder, only the water above the element is heated when solar energy is low. In the 2006-08 BRANZ study found there were three cylinders with elements at the top and bottom and two of these systems were found to perform well.

Temperature and pressure relief valves Over-temperature pressure relief valves are essential on solar water heating systems. Water heated by solar radiation can reach very high temperatures, and if there is an event that stops water circulating (such as an electricity failure that stops a pump), the temperature and the pressure can rise quickly within the collector and pipes. While new systems have been tested to confirm they are physically strong enough to contain very high pressures, this system strength may be reduced in older systems, and the very high pressures should be avoided.In the 2006-08 branz study of solar water heating systems, 10 of 31 systems had no apparent over-temperature relief system. Others depended on roof-top air admittance valves, while others relied on the temperature/pressure relief (TPR) valve on the storage system itself. BRANZ recommends the installation of over-temperature pressure relief valves on all solar water heating systems.Water tends to expand in volume when heated up and contract in volume when heat is taken out of it. This invention relates to systems where solar energy causes pressure changes in water occupying fully a rigid closed container. Pressure energy is allowed to escape the container in a controlled way to operate a reaction turbine and shafted D.C. generator to produce electrical energy.

1. A solar energy conversion system comprising: a. a pressure vessel full of water, b, a water turbine, c. an electric generator shafted to said turbine, d. a chamber within which is said water turbine, and e. a first pipe operatively connecting said pressure vessel and said water turbine, and a second pipe connecting said pressure vessel with said chamber, all operatively connected so increasing solar energy will be converted into electrical energy.
2. A method for converting solar energy into electrical energy comprising the steps of: a. opening a first valve to drain water from a chamber into a pressure vessel at dawn, b. closing said valve when said pressure vessel is full of water, c. opening a second valve in a pipe connecting said pressure vessel with a water turbine within said chamber when sufficient pressure has built up in said pressure vessel so pressure energy within said pressure vessel may be made to operate a water turbine within said chamber and a generator shafted to said turbine, and d. closing said second valve after pressure in said pressure vessel has become ambient.
3. The system of claim 1 wherein to said first pipe is fixedly attached a pressure gauge.
4. The system of claim 1 wherein a thermometer is located near said pressure vessel.
5. The system of claims 3, 4 wherein a central processing unit is made to derive information from said pressure gauge and said thermometer and then to operate said first and second valves.

Heat pipe bearing pressure (principle of work):

The vacuum tube attracts the warm heat pipe to pass on the heat conduction - heat preservation water tank pneumatic control system. Heat pipe bearing pressure type solar-powered water heater collection hot way: The use vacuum tube collection heat, the heat pipe bearing pressure type solar-powered water heater built-in wing piece, passes to the heat pipe, the heating coil the high temperature environment's in quantity of heat to seep rapidly the thermal biography the water tank, especially in cloudy, in the radiation intensity low situation, the start transfers heat quickly.

After tests continuously, the heat pipe type solar-powered water heater, the daily average thermal efficiency reaches as high as 56 Pipe bearing pressure (Heat pipe technical parameter specification): φ8×1520 - φ58×1800

1). Heat transfer efficiency high we carry on the examination to the domestic all heat pipes, according to GB/T14812-1993, GB/14813---1993 pair of heat pipe performance and the heat pipe life carry on the experiment to examine, finally designated that the inorganic molecular heat pipe. The heat transfer does not need the working substance changes, depending on the molecular heat movement, transfers heat, the heat transfer efficiency to be high quickly. 2). Bearing pressure ability high the heating coil type solar-powered water heater water tank, uses the 2MM steel plate, the arc shell cover, the CO 2 automatic wildings, bearing pressure ability 0.6MPa, the seal working pressure reaches as high as 1.2Mpa. Selects the international advanced chemistry nickel plating technology, the superficial spray coating achieves the international advanced level. The collector may withstand the running water the pressure, test pressure to be highest may reach 1.2MPa, and the size conforms to the TB311-74 stipulation. 3). Anti-frozen, bearing capacity strong the heat pipe type solar-powered water heater uses the heating coil heat transfer technology, in the collection heat pipe anhydrous, excessively will not be low because of the high and cold local temperature and the frozen broken collection heat pipe, thus influence use. Because moreover in tube anhydrous, if a heat pipe breakage, will not interfere with the complete machine work, such water heater use scope will be broader. The support material uses the import galvanization steel plate or the stainless steel completely; the intensity is high, anti-spoiled ability.

The specifications above are used for producing split pressurized solar water heater or more than 1000liters hot water solar water heater project which supplies hot water for swimming pool, wall heating system, floor heating system, big hotel and so on.

Pressure solar collector: Product specification:

1) We can make the tube quantities for each solar collector according to customers' requests, but maximum tube quantities are 42tube per collector
2) Collector header: Inner material of collector header: Manifold copper pipe outer shell material of collector header: Aluminum alloy, black color or original aluminum color .Insulation layer of collector header: Mineral wool/rock wool, thickness: 50mm.
3) Vaccum tube: 58x1800mm Material: high borosilicate glass, three-layer deposition vacuum tube(ALN-Cu-SS) with copper heat pipe and aluminum fin in it.
4) Bracket material: Alunimum alloy or galvanized steel, original aluminum color or black color.
5) Advantage: there is no water in the tubes, if one or two tubes broken, the whole system can work as usual.
6) Hailstone resistance: 25mm
7) It can endure 0.7MPa high pressure

III. Conclusion

The solution found was to lay down tubes of water side by side in the ground under the collector. The tubes of water are closed that's why there is no evaporation. The water will be heated during the day; it will store the thermal energy. During the night this hot water will permit to the ground to stay hot for a longer time because the heat capacity of the water is about five times higher than that of the soil. Thus the ground will radiate and heat the air under the collector during a longer part of the night and the process will so become more efficient. In fact the ground heated during the day, stores heat and radiates during the day and during the night as much as he loses its heat. This radiation heats the air under the collector during a part of the night. But the natural soil was not so efficient. Something better would have to be found to store more thermal energy.

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