The following are short excerpts from an out of print book, *Solar Domestic Hot Water*, by Russell Plante, 1983

Heat Transfer Fluids

Heat transfer fluids must be checked every fall for safe pH levels (i.e., measurement of solution acidity; $-\log_{10}[H_3O^+]$) and for safe freeze protection levels. Commercial test kits are available as illustrated in Figure 9-24 to make fluid condition analysis easy. Such kits can include controller testers, Hydrion® papers for pH level checks, VOM's for troubleshooting electrical problems, and refractometers for freeze resistance checks.

Freeze resistance can be checked by either a refractometer, which requires only a few drops of fluid and uses the index of refraction for comparison, or by the determination of the specific gravity of the fluid. ***Specific gravity*** of material is the ratio of its density to that of water and can be determined with an instrument called a hydrometer. By determining the relative density to that of water, the freezing point of the fluid can be determined. This method requires the use of more transfer fluid than does the refractometer method. If too large a sample is taken, the system may have to be refilled. Using the index of refraction method avoids the large sampling. Figure 9-25 represents a typical index of refraction chart used to determine freeze potential of ethylene and propylene glycol. The antifreeze protection point is observed through the refractometer where the dividing line between light and dark (edge of shadow) crosses the scale.

The pH test can be performed using the same fluid withdrawn for the freeze concentration test. A piece of wide-range Hydrion paper can be dipped into the solution. The color of the paper is then matched to the color chart on the dispenser roll. A more accurate pH reading can be then obtained using a shorter range pH paper. The pH condition should be compared with the minimum standards specified by the collector manufacturer. If the pH or freeze requirements are not met, the fluid should be changed or buffers should be added, depending on the type of fluid used. Normally, glycol solutions should be changed every 2 years, hydrocarbons every 5 to

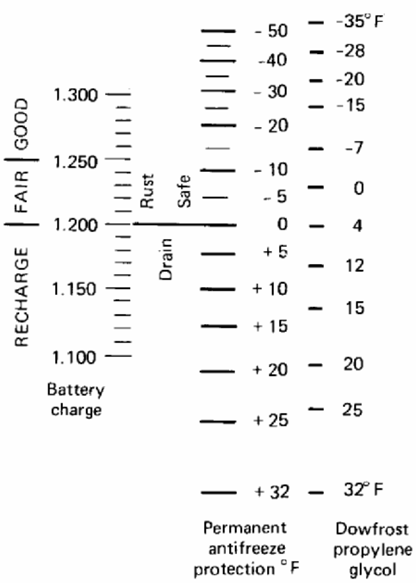

Figure 9-25. Index of refraction chart to determine freeze potentials. (Reprinted with permission from Solar Design Associates, Inc., Champaign, Ill.)

10 years, and silicones every 15 to 20 years as recommended by their manufacturers.

Miscellaneous Plumbing Parts

Automatic Air Vents

Check air vent caps to ensure they are at least two counterclockwise turns loose to allow air to escape from the system. An air vent will sputter audibly if dirt or debris is caught in the float mechanism.

Gauges, Pressure, and Temperature

System pressure of a closed loop should be checked daily. (Initial system pressure should be recorded on a tag on the system fill line for comparison.) Temperatures should be checked daily for proper system operation. A differential temperature of 30° F between storage inlet and outlet is typical.

Pipe Insulation

Inspect exterior pipe insulation once a year. Note any areas exposing insulation to weather. Seal those areas with silicone sealant. Ensure all jacket material is sealed. Look for ultraviolet damage.

Strainer

Clean the strainer in an open loop system once a year as follows:

1. Drain the solar collector array.
2. Isolate the strainer from the tank (i.e., by closing a gate valve, Figure 3-6).
3. Open the strainer cap with an adjustable wrench.
4. Remove the stainless steel screen and clean it out with water.
5. Reinstall the screen, and tighten the strainer cap.
6. Open the tank to collector loop filling the system.

Valves

Inspect all fittings and seals once a year from visible leaks. Check gaskets and valve seats. These seals are usually designed for resistance to water and not to all transfer fluids. Solenoid and automatic valves should be jumpered to simulate valve operation. Ensure that such valves are not getting wet, thus having the potential to short out.

Pumps and Blowers

Some types of pumps and blowers are sealed and permanently lubricated, some are lubricated by the transfer fluid, and some require periodic lubrication. The manufacturer's literature should be checked for possible lubrication schedules. Some pumps and blowers have variable speed ranges that can be set by the homeowner. Flow may be varied depending on the season and latitude of the system. High temperatures must be maintained for practical household use while maximizing the total BTU collection. The pump speed should be varied accordingly. Using Equation 5-2 we can demonstrate this optimization of heat collection.

We shall assume two sets of conditions and note the results.

Condition I

Assume:

Inlet temperature to storage = 180° F
Outlet temperature from storage = 83° F } Flow rate at 2 gal/min
Specific Heat C_p = .56 BTU/lb-°F
Weight per unit m = 7 lb/gal

Because $Q = mC_p \Delta T \times \text{(Flow Rate)}$

$$Q = (7 \text{ lb/gal})\left(\frac{0.56 \text{ BTU}}{\text{lb-°F}}\right) \quad (180° \text{ F} - 83° \text{ F}) \times [(2 \text{ gal/min})(60 \text{ min/hr})]$$

And

$Q = 45{,}630$ BTU/hr

Condition II

Assume:

Inlet temperature to storage = 158° F
Outlet temperature to storage = 133° F } Flow rate at 9.5 gal/min
Specific Heat C_p = 0.56 BTU/lb-°F
Weight per unit m = 7 lb/gal

Because $Q = C_p \Delta T \times \text{(Flow Rate)}$

$$Q = (7 \text{ lb/gal})\left(\frac{0.56 \text{ BTU}}{\text{lbs-°F}}\right) \quad (158° \text{ F} - 133° \text{ F}) \times [(9.5 \text{ gal/min})(60 \text{ min/hr})]$$

And

$Q = 55{,}860$ BTU/hr

Because the outlet temperature from storage is sufficient for practical household functions, the working temperature difference is approximately 26° F across the collector, and there is more heat accumulated, Condition II would be the preferred operating condition. Typical pump operation will demonstrate increased pump speeds during summer use and slightly lower pump speeds during nonsummer use. Conditions will vary from one locale to another, and the installer/owner can vary the pump speeds while observing the corresponding change in system operation.

Storage Tanks

To prolong the life of the water heater/storage tank it can be drained once each year to remove scale and sediment from the bottom. It is important to drain the tank completely because the last few gallons of water will draw the sediment out with it. If the tank is directly in the solar collector loop, then it should be drained at night or on a cloudy or rainy day. The following steps can be followed to drain the storage tank:

1. Shut off all power such as electric elements, oil, and gas burners prior to draining.
2. Shut off the cold water supply to the bottom of the tank. If the collector loop is open to the tank, it also must be drained in order to isolate and drain the tank.
3. If necessary, attach a hose to the tank outlet drain and run the hose to a suitable drain. Open the tank drain valve.
4. Lift the lever on the automatic pressure and temperature relief valve to allow air into the tank to assist in draining.
5. To reverse the process, close the drain valve and open the valve between the cold water inlet and the water heater. Open the nearest hot water faucet to facilitate filling, and close it once filling is complete.
6. Refill the solar collector loop if it was previously emptied, and turn on the backup power.