THE GEYSER PUMP SOLAR

COLLECTOR SYSTEM

INSTALLATION MANUAL

VERSION 1.1

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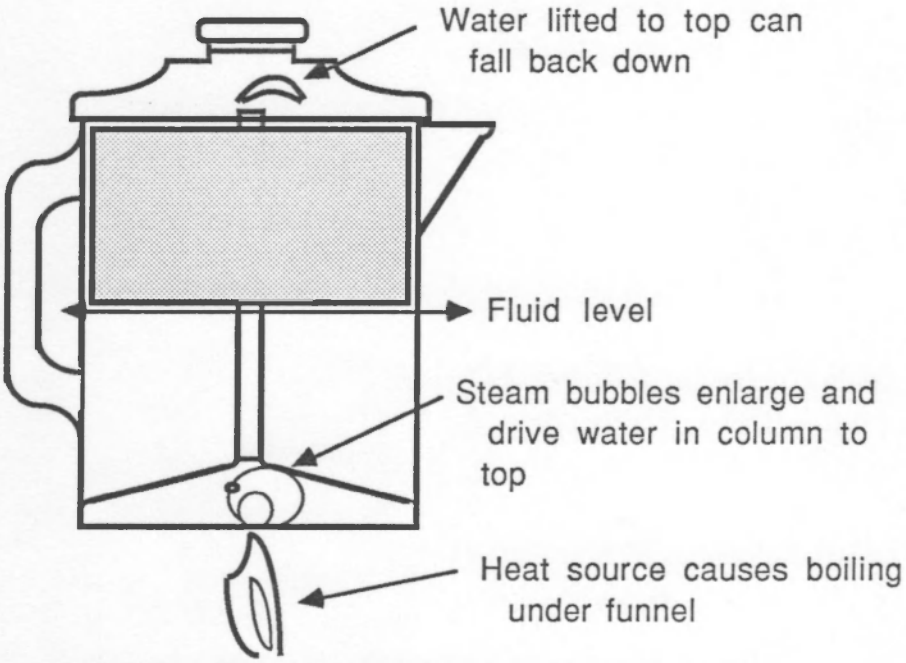
1: SYSTEM OVERVIEW

1:1 How does it work?

The Geyser Pump Solar Collector is a self-pumping, self-regulating, closed-loop, freeze-proof solar collector system that actiuely pumps hot fluid down from the collector panels to a lower storage tank, and does it passiuely with no mouing parts, sensors, electronics or anything but the solar energy shining on the collector plate. To understand how it works let's first consider the simple coffee percolator. Water boils in the very bottom of the pot, under a

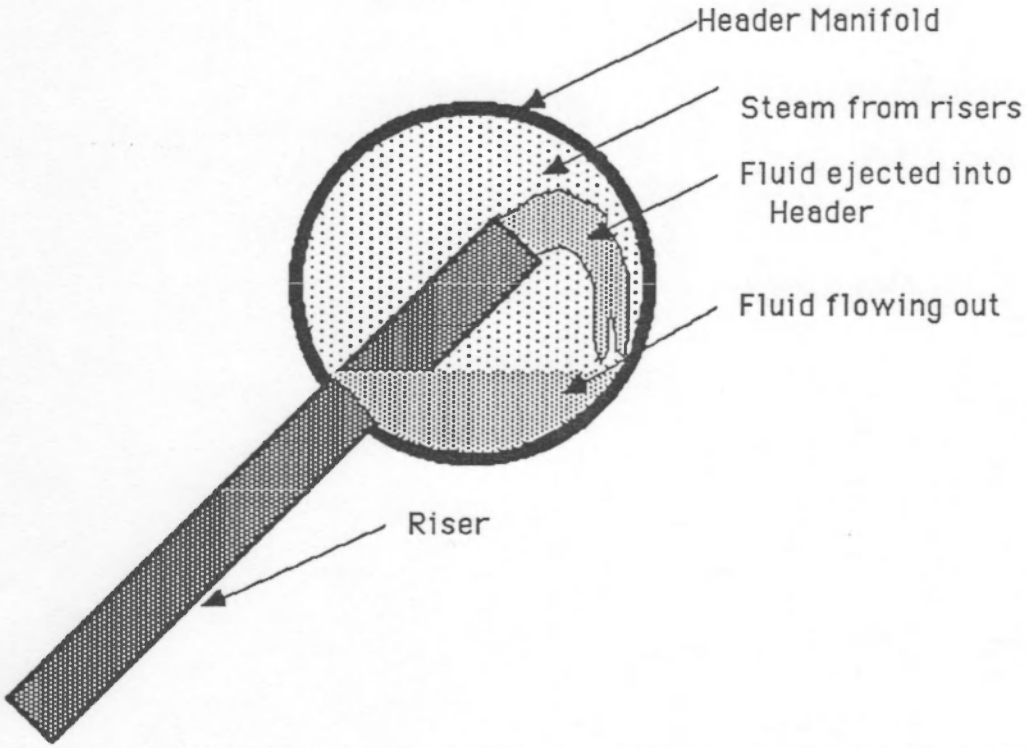


The simple Coffee Percolator is like a Geyser Pump Solar Collector System

funnel, causing steam bubbles to form. These steam bubbles expand and driue the water standing in the column to spurt up against the top of the coffee pot. The steam bubbles escape the column after pushing the water out and then the steam flows out of the pot through the spout. The water that was lifted falls through the coffee grounds then back to the reseruoir in the bottom of the pot.

The Geyser Pump Solar Collector works on the same principle as the coffee percolator. The Geyser Pump plate has a number of uertical riser tubes connected to an absorbtion fin. The risers are almost full of fluid to the top, where they are inserted into a header manifold. When sunlight shines on the absorbtion fin the fluid in the risers heats and begins to boil. Steam bubbles form in the risers at the point of boiling a few feet below the fluid level. These steam bubbles expand and driue the fluid in the column aboue them up into the header

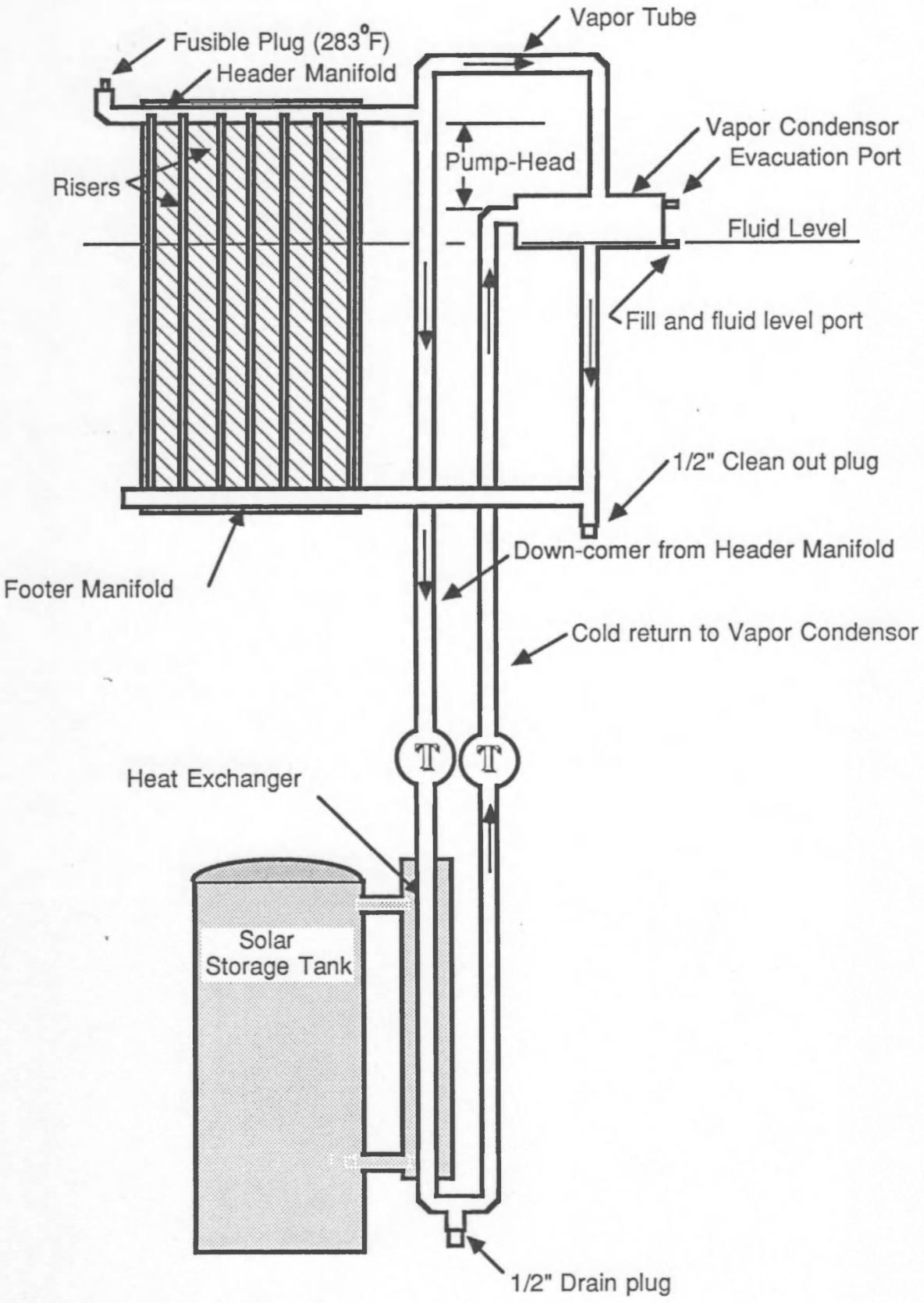
manifold. The risers, being inserted half-way through the manifold, keep the fluid from returning back down. The hot fluid runs out the end of the manifold and down to the heat-exchanger where it loses its heat to the storage tank. It returns to the vapor condensor and then back to the bottom of the risers through a footer manifold that connects all of them. The fluid refills the empty risers, heats, boils and cycles again. Note: it is the lifting of the fluid to the manifold and subsequent stacking of the fluid in the down-comer that drives the



Header/Riser Detail

fluid through the heat exchanger; the steam bubbles in the risers only serve in lifting the column of fluid in the risers to the manifold.

A few key additions have made the Geyser Pump work more efficiently: first, the loop described above is hermetically sealed and evacuated so all that remains in the system are the fluid and it's vapor. There is no air or air pressure. This allows the fluid to boil at a very low temperature. In fact, the fluid boils at a temperature, slightly higher than the heat-exchanger temperature whatever it may be. The fluid in the collector can boil as low as 20^{0} C. [This lowering



Geyser Pump Schematic

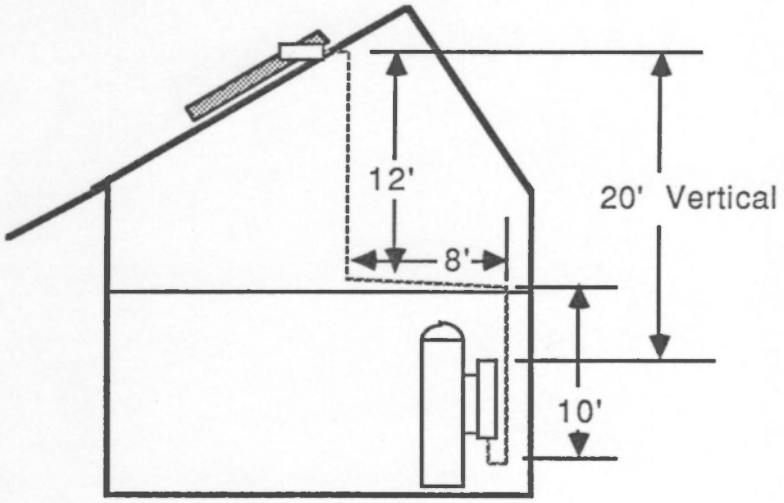
of the boiling point is simila. to the lowering of the boiling point of water at high altitudes: while backpacking at high elevations where the air is thin (lower pressure) it is very difficult to cook rice or potatoes because the water boils at a much lower temperature.] Solar collectors operate more efficiently at low temperatures because they lose less energy to their surroundings. The evacuating of the Geyser Pump Solar Collector insures pumping at low temperatures and greater thermal efficiency.

Second, the steam that is produced during the boiling is condensed in the vapor condensor. The vapor condensor allows the steam to mix with the cool fluid returning from the heat-exchanger. Condensing the steam reduces the pressure in the system so that boiling can continue at low temperatures. Without some type of vapor condensor the system would heat, attain a high pressure and pumping would be uery inefficient.

1:2 Pump Head

When the fluid leaves the upper manifold it falls to the fluid level in the down-comer, which is at about the same level as the top of return pipe to the vapor condensor. The vertical distance between the top of the return pipe to the vapor condensor and the bottom of the header manifold is the effective pump head of the Geyser Pump system.

The pump head is the amount of pressure available to push the hot fluid down to the heat-exchanger and the cool fluid back up to the vapor condensor. Typically, only a few inches are required to effectively move the fluid. When calculating the pump head required for a system allow 3 inches for each 15 vertical feet between the vapor condensor and the top of the heat-exchanger plus 1 inch for every 30 feet of pipe between the vapor condensor and heat-exchanger. Every system should have at least 3 inches of pump head regardless of vertical distance and pipe runs.



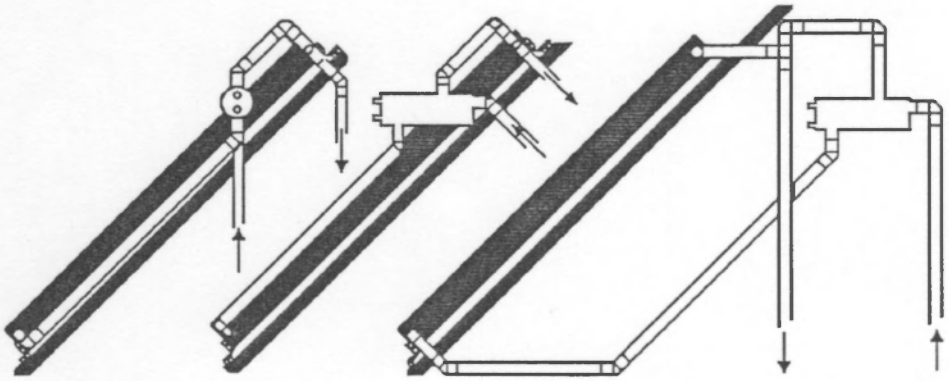
EXAMPLE: This installation has a 20' vertical drop and 35' of pipe between the condensor and the heat-exchanger.
For the vertical drop allow:
3" x 20/15 = 4"
and for the plumbing run allow:
1" x 35/30 = 1-1/8"
for a total of 5-1/8" of vertical distance between the header manifold and the return tube to the vapor condensor.

2: INSTALLATION PROCEDURES

2:1 Solar Collectors

The installation of Geyser Pump collectors is similar to other actiue flat plate collectors, but they should not be mounted at pitches below 4:12. (18.5^{0} above leuel). They should be canted at least 3/8" with the exhaust end down to allow the fluid to effectiuely drain from the header manifold. The collectors can be mounted on racks or flush with the roof, but a separation of a few inches between the roof and the back of the solar collectors eases the installation of the uapor condensor when installing the condensor outside.

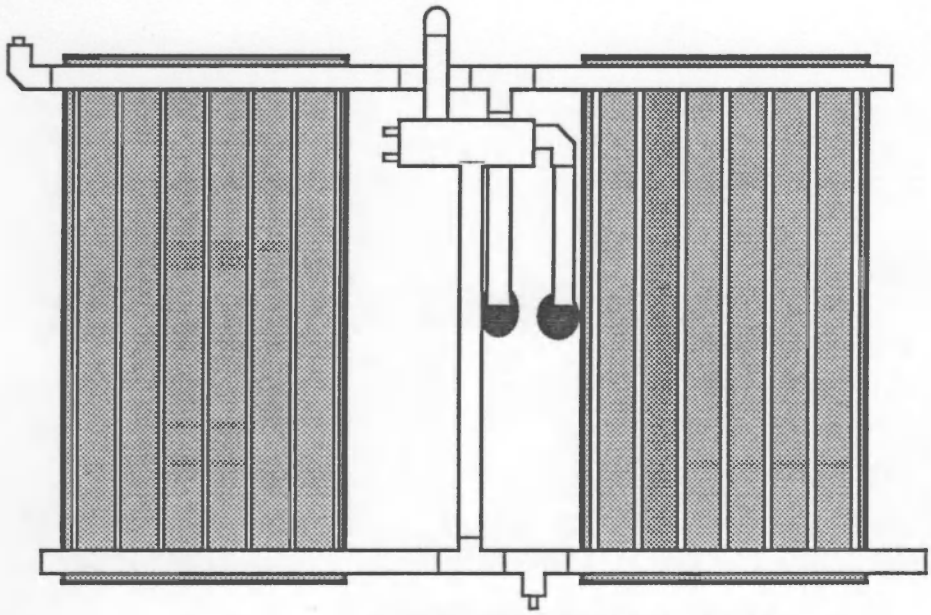
When two collectors are ganged the uapor condensor should be between them, but if necessary the uapor condensor can be at the end of the array. Systems with more than two collectors should try to balance the collectors on either side of the uapor condensors. One uapor condensor is required for euery two collectors. Systems with many collectors may require special uapor condensors. The uapor condensor can be mounted flush with the roof line or protruding out from the roof. If conuenient it can also be mounted in the attic as long as the pump head is allowed for. It is only necessary that the



aboue roof in attic

Condensor Installations

fluid lines to and from the collector are all ascending and that the 3/4" i.d. steam tube from the uapor condensor to the header be no more than two feet in length. If a longer steam tube is required it should be enlarged to 1" diameter tube and be no longer than 3'. If the condensor is mounted under the roof the steam tube leading from the upper manifold should be 1" i.d. and either level or slightly descending toward the uapor condensor. A 1" tee should be affixed to the end of this tube in such a way as to allow the steam to separate from the hot fluid. The uapor must be forced upward so that it is impossible for hot fluid from the collector manifold to flow into the vapor condesor.

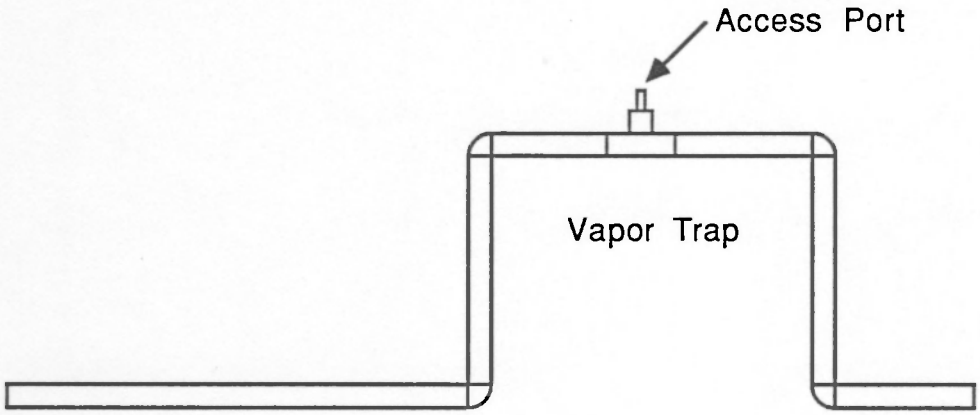


A Two Collector System

2:2 Plumbing Runs

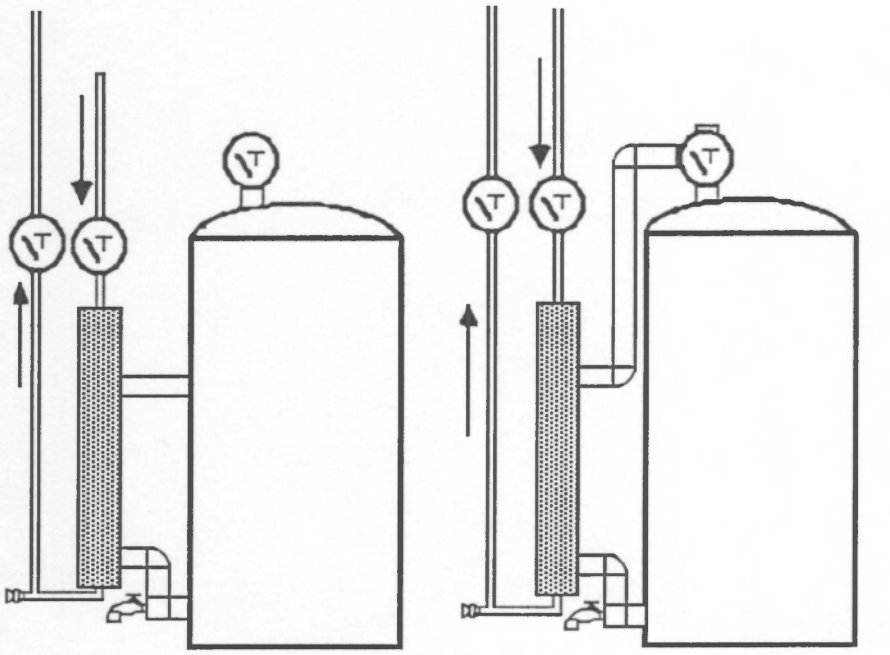
For single collector systems where the storage tank and the

collector are within 10 feet of each other 1/2" copper tubing can be used, otherwise 3/4" copper tubing should be used. The system must be absolutely leak tight. Pressure testing with water or air to 100 psi. is usually sufficient to expose any hidden leaks. Plumbing runs should be ascending throughout to auoid uapor traps. If necessary an euacuation access port can be added where uapor traps must be installed.



Either siluer-brazing with 3-5% silver alloy or 95/5 solder can be used in the connection of fittings. Threaded fittings larger than 3/8" pipe thread should be doped with high-temperature, low uolitility, silicone gasket sealer like that used in automobile emission systems. It can be purchased at most auto part stores. For smaller threaded fittings teflon tape is satisfactory.

2:3 Heat-Exchanger

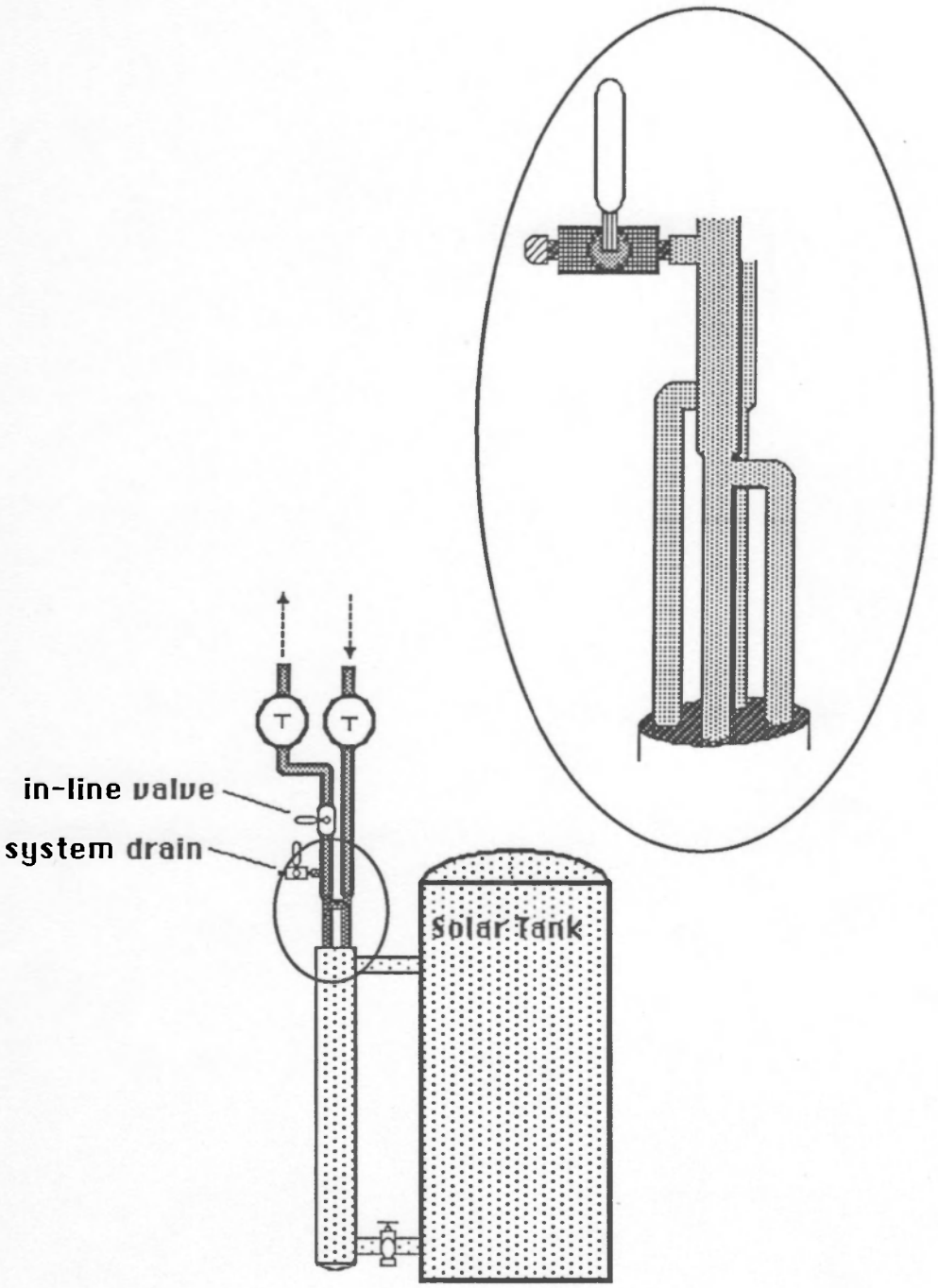


Preferred Satisfactory

Turbotec Installation

One 36" Turbotec heat-exchanger is required for each collector plate in the system. It should be attached to the upper element port and the drain port of the solar storage tank. If necessary the upper arm of the heat-exchanger can be attached to the hot-water discharge of the tank. Installation in the upper element port is preferred because the potential for air locks in the thermosiphon loop are reduced.

Thermometers should be installed in the inlet and outlet of the heat-exchanger on the solar loop and on the hot water exhaust from the tank to the house.



Noranda SETS Installation

A Noranda Sets ™ Heat Exchanger can be installed in a Geyser Pump system but must be installed up-side-down from the Noranda installation directions. The preferred tank attachment and thermometer locations are the same as those for the Turbotec. One Noranda Sets Heat Exchanger is sufficient for up to three Geyser Pump solar collector plates.

3: Filling the system

3:1 Jet Pump Method

After the solar loop has been flushed and leak tested it can be evacuated and filled. It is important to remove all fluid from the system before evacuating and filling with antifreeze solution. A ball valve should be inserted into the vapor condensor fill and fluid level port. The outlet of the ball valve should be attached to the anti-freeze fluid fill hose. Evacuate the system to approximately 30 inches of Hg (-14.7 psi) through the evacuation port using the jet pump apparatus. Stop the evacuation by closing the access valve (counter-clockwise) on the evacuation port. Insert the antifreeze fluid fill hose into the antifreeze and open the valve on the fill and fluid level port allowing the vacuum in the system to draw fluid until it is full. Take care not to let air into the system while filling. The vacuum gauge will read about 0 when the system is full. Open the access valve on the evacuation port and loosen the hose fitting at that point to allow air into the system, and open the fill and level port valve to allow fluid above the drain plug to flow back out of the system. After the excess fluid is drained, remove the ball valve and replace it with a plug. Evacuate the system again (note that full vacuum in a warm, full system may be between 5 and 25 inches of Hg because of the higher vapor pressure of the warm fluid) and allow the system to run at least 30 minutes under full sunlight. This will drive off any dissolved gases in the fluid which can cause a higher boiling point and decrease system efficiency. After 30 minutes evacuate once more. It may be necessary to return to evacuate again after a few weeks of operation to remove any more foreign gas in the system.

3:2 Sun-Starting

The Geyser Pump System can also be started with the heat from the sun but only with intense and continuous sunlight: without water in the storage tank, fill the system with fluid by holding the antifreeze bottle above the collector and allowing the fluid to flow, by gravity, into the fill and fluid level port on the vapor condensor. The evacuation port must be open for this to occur (an access valve can be used to open the evacuation port). When the fluid flows out of the evacuation port the system is full. Lower the antifreeze bottle under the fill and fluid level port and let the excess fluid drain into the bottle. This will bring the fluid in the system to the level of the fill and fluid level port: the correct operating level. Put the access value and hose apparatus with the vacuum gauge on the evacuation port. Close the ball value just past the tee holding the vacuum gauge. Open the access valve so that the pressure in the collector will register on

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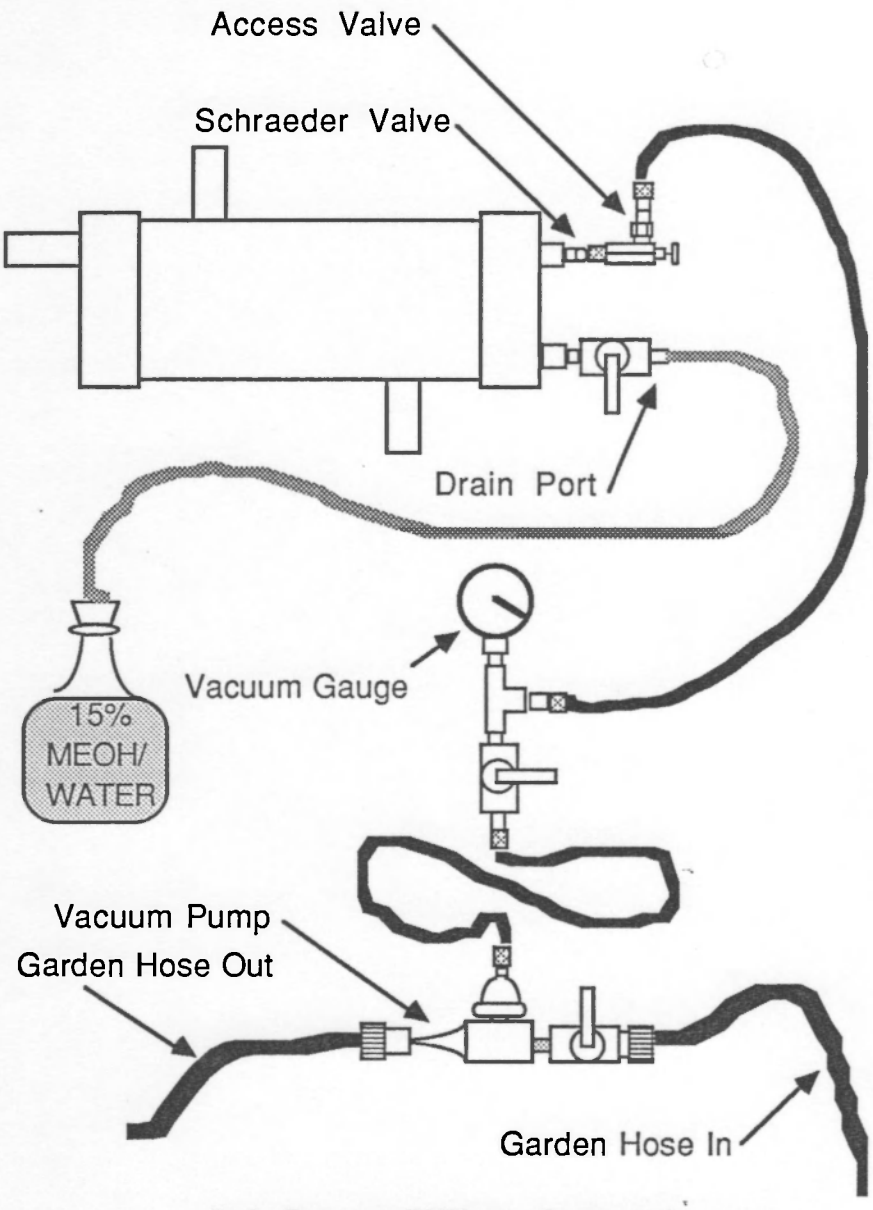
the gauge. Let the system heat under the sunlight and when a positive pressure of approximately 10 psi is registering on the gauge open the ball-valve and let the pressure off slowly, being careful not to let any fluid escape. The pressure is caused by the production off steam in the closed system. When the steam is released it takes with it any air that may be in the header. Don't let all of the pressure off because air will flow back into the system. Allow the system to operate until the pressure builds up again; when it does open the valve again. After the system has run for a while the volume of the fluid in the system will decrease because the foreign gas will have escaped into the open area above the fluid level. The system should also be operating at a slight vacuum by this time. Use the vacuum in the system to draw about a quart of fluid into the fluid fill and level port. Open the access value to let air into the system and allow the excess fluid to drain as described above. Letting air into the system in this way will not allow much foreign gas to re-dissolve into the fluid. Allow the system to pressurize and let off the steam as described aboue. Repeat this until the difference in temperature between the inlet to the vapor condensor and the exhaust from the collector is about $10^{o}C$. The system is then free of foreign gases. Remove the access valve apparatus leaving the Schraeder valve and cap it. The tank can now be filled with water. If the system does not equilibrate at a low difference in temperature it may be necessary to adjust the liquid level again. Also if a good vacuum is not achievable it may be necessary to stagnate the collector by heating the return pipe to the vapor-condensor with a torch while the sun heats the collector plate. This will allow a positive pressure to be reached in collector. The pressure can then be bled off through the access valve taking the foreign gases with it.



Jet Pump Filling Apparatus

4: Freeze and Overheat Protection

4:1 Freeze Protection

The antifreeze fluid used in the Geyser Pump Solar Collector is 15% by weight Methol Alcohol. This mixture has been tested to $-40^{0}C$ without any damage to the system. The expansion upon freezing of this solution is nominal and it dosen't freeze into a hard mass, rather, it freezes into a slush.

4:2 Overheat Protection

A standard pressure/temperature relief ualue is required, by

code, on every storage tank in the system. In addition an H&H temperature control valve is suggested for the solar storage tank. This valve will exhaust water from the solar storage tank when it reaches 185°F. By exhausting hot water at this temperature cool water enters and cools the tank, keeping it below 185°F. An additional safety precaution required on the Geyser Pump System is a 283°F fusible-plug mounted on the header manifold of one of the collectors. If for some reason the system should stagnate at high temperatures the fusible-plug will open and empty the steam from the collectors. The fusible-plug should be mounted in a safe direction, away from the roof and people traffic. The fusible plug must be installed as close as possible to the header manifold and be well insulated. If the fusible-plug blows a service call will be required. The only way the plug will blow is if some other part of the system is malfunctioning and in need of service.

4:3 Safety Precautions

Every installation should be labeled with a permanent label showing the following information: a) name, trademark or logo of the manufacturer; b) appropriate model number; c) heat transfer fluid recommendation (15 w/o MEOH); d) heat transfer fluid inlet and outlet; e) potable water inlet and outlet.

The user of the installation should be informed as to the toxicity of the anyifreeze solution and the precautions to be taken if contacted.