Technical Note

SOLAR HEAT TRANSFER FLUID

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1.0 General Information

The heat transfer fluid employed in the Thermo Dynamics **Solar Boiler**™ is an aqueous solution of propylene glycol. Propylene glycol is a heat transfer medium that has been used successfully for twenty years in solar water heaters requiring freeze protection. The glycol is mixed with distilled or deionised water to form a 40 - 50% (by volume) solution of glycol. Two types of propylene glycol are available: food-grade propylene glycol (propylene glycol, USP) and inhibited propylene glycol, e.g., DOWFROST, DOWFROST HD and Dowcal*20-G [1].

2.0 DOWFROST and DOWFROST HD

DOWFROST may degrade when subjected to temperatures in excess of 250°F (121°C); somewhat higher for DOWFROST HD, 325°F (163°C). There is also evidence that propylene glycol may degrade if boiled at lower temperatures. The degradation of glycol can result in discoloration (dark brown/black colour) and low pH indicating the formation of glycolic acid. Another problem observed only with inhibited propylene glycol is the presence of particulate in the glycol, e.g., green in colour with Dowfrost HD, which is due to elements in the inhibitor/buffer package coming out of solution. This does not mean that the glycol has failed, but the particles may clog a strainer/filter if one is in the glycol-charged collector loop. These particles may also impair the operation of the pump. It is not clear why the particulates form in the glycol, however, it is suspected that it has something to do with the passivation of the copper by the inhibitor package in the glycol, the exposure of the glycol to oxygen and high temperatures (approaching 200°F) and/or boiling, even if at temperatures less than the recommended maxima.

[1] Only available in Europe

3.0 Propylene Glycol, USP

Propylene glycol, USP has been relatively trouble-free in solar water heaters with pressurised glycol loops, where pressures are in the range 15 - 30 psi (100 - 200 kPa). In the event of a pump failing to circulate the glycol on a hot sunny day, the glycol expands in the solar collector, increasing the pressure in the solar loop, and thereby increasing the boiling point of the glycol to prevent boiling. Generally TDL collector stagnation temperatures do not exceed the maximum temperature to which propylene glycol may be subjected. The TDL absorbers with selective surfaces (anodised) may reach stagnation temperatures approaching 400°F (204°C), however, the collector is vented to prevent the occurrence of temperatures in excess of 325°F (163°C).

4.0 Glycol in the Solar Boiler™ System

Since 1989 TDL has manufactured solar water heaters under the trade name **Solar Boiler**™. These Micro-Flo® solar water heaters have non-pressurised, glycol-charged solar loops. The solar loop is closed, but a vent tube is provided with a blow-off cap to prevent pressure in the solar loop rising above 15 psi (100 kPa).

From 1989 throughout most of 1996, the **Solar Boiler**™ module was produced with a built-in, 4-liter reservoir of propylene glycol (50% glycol by volume). Upon installation of the solar water heater and activation of the glycol pump, glycol is drawn from the reservoir, pumped through the line to the solar collector(s), through the solar collector(s) and down the glycol return line. Air is purged from the solar loop and driven into the reservoir, where it remains, trapped. When the pump is deactivated glycol can drainback from the solar collectors into the reservoir. This drainback feature is a consequence of the design of the solar loop with reservoir, and is not a feature essential to the proper operation of the **Solar Boiler**™. As the glycol drains from the solar collectors a partial vacuum is created in the solar collector(s). If the pump ceases to operate on a hot-sunny day the glycol that remains in the solar collector is subjected to high temperatures (120-170°C) and at the same time low pressure (0 -10 psi vacuum). This results in boiling of the glycol and the possibility of degradation of the glycol.

5.0 Solar Boiler Modifications

In order to prevent boiling of the glycol in the solar loop a pressure relief valve (PRV) has been added to the solar loop of all **Solar Boilers**™ shipped from TDL as of December, 1996. For those **Solar Boilers** (serial number: SB9xxxx) equipped with a 4-liter reservoir the PRV has a 75 psi (515 kPa) setpoint. It is located at the top of the 1/2" fill tube (formerly fitted with a brass hose cap). The 1/4" vent tube is capped with a removable brass fitting to allow for venting of air from the module when it is being filled with glycol. The **Solar Boiler** (SB9xxxx) is shipped with the 4-liter reservoir filled with glycol. At the time of installation, remove the PRV and the cap from the vent tube, set the pump in operation at full speed (connect a 12 VDC regulated power supply directly to the motor, bypassing the LCB) and wait for the solar loop to be completely charged with glycol. Fill the reservoir with 2-4 liters of glycol (50/50), supplied with the

system, until glycol starts to drip from the vent tube. Replace the PRV and the cap on the vent tube. Place a 1-liter container below the outlet of the PRV blow-off tube. In this configuration the glycol will not drainback from the solar collectors when the pump is not in operation. If circulation is lost on a sunny day, the glycol will increase in temperature and expand within the solar collectors, increasing the pressure in the solar loop, and increasing the boiling point. At 75 psi the glycol will only boil if the temperature reaches 300°F (149°C).

Prior to charging the solar loop with the glycol, the solar loop must be flushed with a 2%, by weight, solution of trisodium phosphate (TSP) in hot water. Use a pressure pump to circulate the solution through the solar loop for 10 minutes. When replacing the glycol in a solar loop, in which it is suspected that there has been some degradation of the glycol again flush the solar loop and the **Solar Boiler** module with the TSP solution.

6.0 Solar Boiler Mark II mini

The latest version of the **Solar Boiler™**, Model SB10, with serial numbers SB10xxxx, is not equipped with a 4-liter reservoir. The reservoir/fill tube is 0.20 liter in volume. The fill tube is capped by the PRV, which is on a swivel connector. After the **Solar Boiler™** is installed, activate the pump (connect a 12 VDC regulated power supply directly to the motor, bypassing the LCB). The PRV, complete with drain tube, is removed to expose the top of the fill tube. Add about 4 liters of propylene glycol (40/60 to 50/50 solution) through the fill tube at the top of the **Solar Boiler™** module. A special tube fitted with a swivel connector to connect to the fill tube connector is available from TDL to assist in the filling process. Add glycol until the fill tube is filled with glycol to a level 1 - 2 inches (25 - 50 mm) from the top. Allow the **Solar Boiler™** pump to continue running to purge all the air from the solar loop. Add additional glycol as required to keep the glycol at the aforementioned level.

The PRV on the SB10 has a setpoint of 125 psi (860 kPa). Whenever the PRV is to be removed, lift the vent lever on the PRV to vent any pressure before removing the PRV. Normally we do not expect the solar loop to be above or below atmospheric pressure when the pump is not in operation and the glycol in the solar loop has cooled to ambient temperatures. Lifting the vent lever on the PRV will bring the **Solar Boiler™** module to atmospheric pressure, however, this should only be performed when the pump is not in operation and the glycol has cooled to ambient temperatures.

7.0 Solar collector liquid

The liquid circulated through the solar collector(s) must be a solution of propylene glycol (USP) and distilled water. We advise against the use of inhibited propylene glycols, e.g., DOWFROST and DOWCAL. The glycol concentration must be 40% to 50%, by volume. The quality of the glycol must be checked at least once a year. The pH, which indicates the level of acidity of the glycol, should be 8 or more. The concentration of glycol should be at least 40% by volume with distilled water. If you are not able to check the quality of the glycol send a 50 mL specimen to TDL in a clean glass bottle with a tight cover and we will perform the analysis at no charge to you. Replace the glycol if the quality is suspect.

8.0 Foreign particles in solar loop

This causes high solar collector temperatures on hot, sunny days and this, over a period of time, causes a breakdown in the glycol. It may become black (carbon particles) and/or very acidic. The black particles can accumulate at a bend or crevice in the collector loop and cause blockage of flow. A blocked collector loop can cause the pump to overheat, which may destroy the seals, and glycol then leaks from the pump. Acidic glycol can erode the brass and copper components in the solar water heater.