Cooling Capacity

The standard chiller integrated with the Coherent Chameleon laser system is the Thermotek T-255P Air-cooled recirculating chiller. With a set temperature of 20°C, a flow of 0.9lpm and a room temperature of 20°C, the T-255P is capable of maintaining a baseplate temperature <35°C (See *chart 5.11-1*). In some cases, the ambient air temperature, flow rate or the set temperature will inhibit the chiller's ability to maintain a stable baseplate temperature. Baseplate stability should be verified after the system has been allowed to stabilize with the chiller on for a minimum of two hours. Initial rises in baseplate temperature are to be expected as the pump laser ramps up to the set power. This occurs as a result of the Vanidate crystals producing excessive heat when the pump cavity is in a low efficiency condition as seen at lower powers. Once the pump laser has reached it's set power, the baseplate should settle to a temperature close to the estimated temperature (See *chart 5.11-1*).

In order to maintain optimum cooling water quality, the only approved coolant for the Chameleon laser system would be distilled water with a 10% dilution of Optishield-Plus additive. Use of any other coolant must be approved by Coherent in writing, or the system Warranty could be VOIDED! Certain chemicals referenced in this document can be used for cleaning purposes only, and are not intended to be used to cool the system. Systems that have been cleaned must be flushed out entirely with pure distilled water before replacing the coolant with the distilled water/Optishield-Plus mixture.

Water Condition

Changing the coolant from time to time is recommended, at a minimum the coolant should be changed annually. In certain applications the coolant may require more frequent changes. In general, the water color should be clear with a slight yellow color, this is a due to the Optishield additive. The water may feel "slimy" to the touch, but should have a viscosity similar to that of pure water. If the water appears cloudy, black, green or brown, the system should be flushed out with distilled water, and then refilled with the distilled water/Optishield-Plus mixture(Ref. The section titled "Flushing the system"). If the coolant is being routinely changed, and no loss of color or clarity is noticed, the system can be drained, and a new mixture added without the need to flush the system.

Flushing the system

If the Chameleon and chiller have undergone a "cleaning", or the coolant recently drained from the system was contaminated or dirty, the cooling loop must be flushed out with pure distilled water. No additives are required at this time since the intent of this process is to remove deposits, concentrations or remaining solvents, older/weaker additives or contamination in the system. Any hoses that show evidence of contamination or biological growth should be replaced.

1. Remove the return side hose from the Chameleon head.
2. Connect one of the accessory hoses from the Chameleon draining kit p/n 1055004 (this is included in both the accessory kit, p/n 104290 and in the storage accessories p/n 1111832) onto this fitting.
3. Place the open end of this hose over a drain, or into a bucket.
4. Turn the chiller on and let the pump force the fluid through the system, do this until the low flow alarm is triggered on the chiller, at this point the pump will shut down automatically, and no more fluid should come out of the hose.

5. You have the option of opening the top cap and taking a clean screw driver to hold the float at the top of the shaft(this will turn the pump back on), or draining the reservoir by tilting the chiller and pouring the remaining fluid out(disconnect the chiller from the AC power to drain the chiller by tilting it).
6. Disconnect the 'drain' hose from the output side of the Chameleon and re-connect the 'cooling loop' hose from the chiller.
7. Fill the chiller reservoir with pure distilled water.
8. Turn the chiller on and let it run for at least 30 minutes.
9. Disconnect the return side hose again, and repeat steps 2 through 6 to drain the distilled water from the chiller.
10. The system has been flushed of any remaining solvents or other contaminants, the chiller can be filled with the 10%/90% Optishield/Distilled Water mixture.

Baseplate Temperature

The chiller's primary function is to remove heat. Heat is generated primarily from the Verdi Cavity, and the FAPIs. The FAPIs are air cooled so the only significant heat that the chiller has to deal with is about 60W to 90W of heat load from the Verdi cavity in addition to added heat from the environment. The secondary function for the Chiller is to maintain the Ti:Sapphire temperature. The amount of heat generated from the Ti:Sapphire is insignificant, however, maintaining the temperature is extremely important to maintain good performance at all wavelengths. If a Chameleon system sees excessive loss of Modelock at the shorter and longer wavelengths, has an excessive amount of change to the Cavity 'Y' and Pump 'Y' PZT positions, or has a baseplate temperature that typically exceeds 36°C, there might be a concern over the condition of the baseplate's ability to circulate water. Below(See *chart 5.11-1*) is a typical baseplate temperature relative to a corresponding room temperature for a typical flow of ~1.0lpm. Baseplate temperatures more than 5°C above these estimated values could be an indication of low coolant flow, low air flow through the chiller fans, or a failing TEC in the chiller.

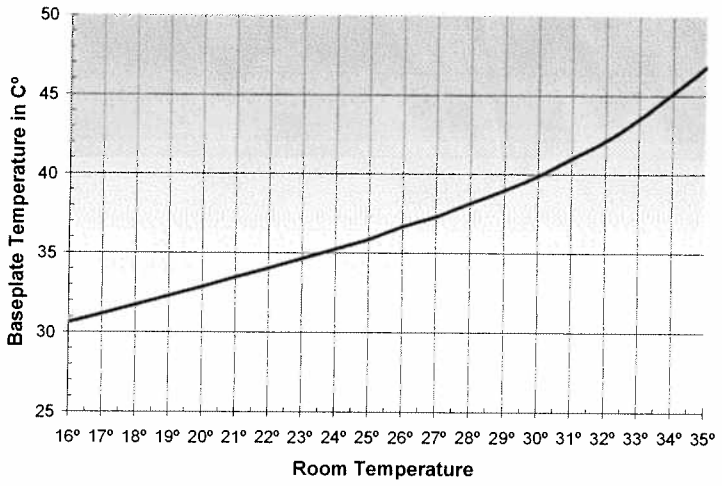

Chart 5.11-1

Typical Baseplate temperature relative to ambient air temperature using a Thermotek T-255P Chiller set to 20°C ~1.0 lpm

Chiller TEC Failure

A failing TEC is one of the more obvious temperature regulation problems to isolate. The Chiller itself will display a measured temperature several degrees higher than the set temperature if the problem stems from the chiller. For example, if you have a set temperature of 20°C, and the baseplate temperature is 39°C with a room temperature of 20°C, you have a baseplate temperature ~6° higher than expected. Since the chiller reads the supply side, or outgoing temperature, you can quickly see if the higher baseplate temperature is coming from the chiller's inability to provide enough cooling. In this case, a possible failing TEC would be indicated by a measured temperature of 26°C on the Thermotek display. In the majority of TEC failures, the measured temperature exceeds the set temperature by more than 10°C making a TEC failure fairly easy to diagnose since the failures are generally total failures of the device.

With room temperatures above 26°C, the cooling capacity of the Thermotek T255P may be pushed to its limits and the measured temperature may be a few degrees higher than the set temperature. This can be compensated for by reducing the set temperature, it is recommended that the set temperature NOT be adjusted lower than 17°C and that local dew point temperatures be considered to avoid condensation. Additionally, if the temperature regulation appears to be compromised, other possible causes should be investigated. In no case should the set temperature and the read temperature delta exceed 5°C!

A failing TEC is not the only problem that can cause the Thermotek to show a measured temperature higher than the set temperature. As described below, insufficient air flow can also cause this, in addition, coolant level and line voltage can also add to the inefficiency of the chiller. The bottom line is that, if there is sufficient air flow, the coolant level and mixture is appropriate, and the room temperature is below 26° the chiller set temperature and measured temperature should be within 2°C of each other. A delta larger than 2°C is an indication of inefficiency in the chiller, and larger deltas are usually indications of a failed TEC. Ideally there should be no difference between the set temperature and the measured temperature.

Air Flow

The placement of the chiller is also important, especially if room temperatures are above 20°C. The Thermotek chillers are designed to be placed on the floor, this is convenient since it allows for more bench space for the laser system, however, dirt and dust can build up in the air filter much quicker when the Thermotek is placed in floor locations. It is recommended that the air filter be inspected monthly, and cleaned as needed to maintain optimum air flow through the TEC heat sink. The air filter can be cleaned using compressed air(do not exceed 600kPa), or a preferred method would be to use warm water with a mild detergent(such as dish soap). After washing the filter, it should be rinsed and dried thoroughly before re-installing it into the chiller. The air filter is located on the right side of the Thermotek when facing the front (See *Fig 5.11-1*). If the floor area in the facility is prone to high levels of dust and dirt, the chiller should be placed off of the floor, enough to prevent rapid build-up of dirt in the filter.

The fans provide the TEC with an air flow of 112 lit/min. Any reduction in this flow due to adjacent equipment or from a confined area will seriously affect cooling efficiency. The Thermoteck T255P requires 0.4m of clear space on either side of the unit to insure proper flow. The ambient air temperature on the right side of the unit must be between 15°-30°C in order to provide sufficient cooling for the Chameleon. Never place the chiller near a heat source or exhaust duct! If the fans are functioning normally, they can easily deflect a standard sheet of paper on the exhaust(left) side of the chiller.

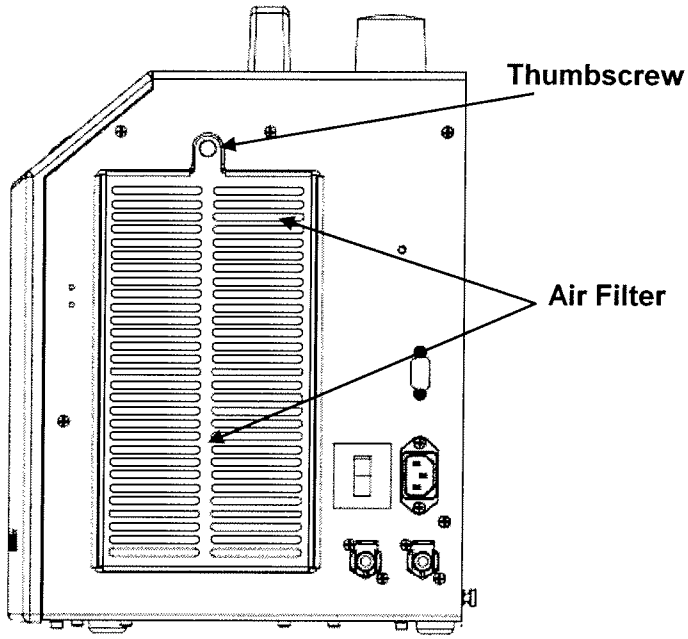

Fig 5.11-1
Right side of Thermotek T-255P

Coolant Flow

Low coolant flow is generally a result of a restriction or some sort of a build-up in the cooling loop or baseplate. The pump in the Thermotek can also be the cause, and should be checked before attempting to isolate the problem to the cooling lines or baseplate.

To check the Thermotek flow:

1. With the Thermotek T255P chiller turned off...
2. Disconnect the supply or outlet side of the Thermotek, be careful with Thermotek chillers manufactured after July of 1006, the connectors do not have the 'self-sealing' valves.
3. Connect the quick disconnect fitting p/n ????? to the outlet side, it works best with a hose attached, this makes it more convenient when checking the flow rate.
4. Make sure the reservoir is full, otherwise the lowflow condition will shut the chiller off before the test is complete.
5. With the quick disconnect(and hose) place a 1/2 liter beaker or other small container with a 0.25 liter level mark at the output where the coolant will exit.
6. Using a stop-watch, watch or other timer, turn the chiller on and start timing once the coolant starts to exit the hose. DO NOT start timing immediately after turning the chiller on, there is a delay of 5-8 seconds that cannot be quantified enough to allow sufficient determination of flow with this test.
7. Stop timing and turn off the chiller once the 0.25 liter mark is reached.
8. The chiller has sufficient flow if this time is less than 8 seconds.

If the Thermotek cannot provide 0.25 liters in less than 8 seconds with minimum restriction, call Product Support to determine the next plan of action. This may include a complete replacement of the Thermotek chiller.

The cooling lines can be tested in the same manner as the pump by connecting them, one at a time, to the outlet side of the Thermotek and performing the procedure below.

To check the cooling line flow:

1. With the Thermotek T255P chiller turned off...
2. Inspect the connectors for signs of buildup.
3. Make sure the reservoir is full, otherwise the lowflow condition will shut the chiller off before the test is complete.
4. Disconnect the "coolant in" line from the left side of the Chameleon when looking at the back of the laser head.
5. Remove the quick disconnect fitting p/n 1052048 (See *Fig 5.11-2*) at the end of this line.
6. With the end of the hose disconnected place a 1/2 liter beaker or other small container with a 0.25 liter level mark at this open end.
7. Using a stop-watch, watch or other timer, turn the chiller on and start timing once the coolant starts to exit the hose. DO NOT start timing immediately after turning the chiller on, there is a delay of 5-8 seconds that cannot be quantified enough to allow sufficient determination of flow with this test.
8. Stop timing and turn off the chiller once the 0.25 liter mark is reached.
9. The cooling line has sufficient flow if this time is less than 12 seconds.
10. Reconnect the fitting to the end of the hose, and swap the entire hose with the 'Coolant out' hose and repeat this process.

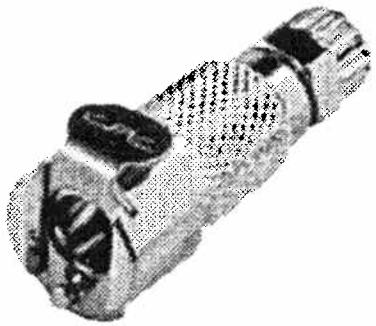

Fig 5.11-2
Quick disconnect fitting p/n 1052048

The hoses can be cleaned by the chemical cleaning process outlined in the 'cleaning' section of this procedure. It is recommended however, that the hoses be replaced since the benefit is rather substantial. The hose replacement kit is p/n 1039965, [1094710 RoHS version].

The primary cause for low coolant flow is the baseplate itself, the baseplate flow with the standard fittings is rather restrictive leaving an overall coolant flow less than 1.0 liters/min in most cases. Because of this the Thermotek chillers should be set to the 'Low Flow' mode. The flow can be checked in the same fashion as used for the pump and coolant lines.

To check the baseplate flow:

1. With the Thermotek T255P chiller turned off...
2. Before proceeding, be sure that the chiller and cooling lines have been tested for flow rate.

3. Disconnect the "return" line from the right side of the Chameleon and the right side of the Thermotek, be careful with Thermotek chillers manufactured after July of 1006, the connectors do not have the 'self-sealing' valves.
4. Place one of the two hoses provided with the Chameleon draining kit(ref: p/n 1055004) to the right side 'coolant out' fitting on the rear of the chameleon. This kit is part of the accessories kit.
5. Make sure the reservoir is full, otherwise the lowflow condition will shut the chiller off before the test is complete.
6. With the disconnected end of the hose place a 1/2 liter beaker or other small container with a 0.25 liter level mark at this open end.
7. Using a stop-watch, watch or other timer, turn the chiller on and start timing once the coolant starts to exit the hose. DO NOT start timing immediately after turning the chiller on, there is a delay of 5-8 seconds that cannot be quantified enough to allow sufficient determination of flow with this test.
8. Stop timing and turn off the chiller once the 0.25 liter mark is reached.
9. The baseplate has sufficient flow if this time is less than 25 seconds.
10. Remove the Chameleon draining hose and replace the original cooling line.

If the baseplate has demonstrated insufficient flow, follow the process outlined in the 'cleaning' section of this procedure.

Cleaning Procedure

Chemical Cleaning:
Before resorting to scouring out the cooling channels in the Chameleon baseplate, it is recommended that an attempt to clean the system chemically is tried first.

Only the chemicals reference and the concentrations prescribed in this procedure will be allowed as a substitution for the coolant during the cleaning process ONLY! The system must be properly 'Flushed' out as described in the section 'Flushing the system' before being returned to normal operation. Under no circumstances should the laser or any of the laser circuits be energized in any way during the cleaning. All power to Chameleon and the pump laser must be disconnected. Only the Chiller should be connected to any line voltage(the MRU is not an issue).

Optishield Plus has cleaning as well as anti-corrosion and algaecide properties. Because of this, the system should be cleaned with Optishield Plus before attempting to use Isopropyl Alcohol.

1. Drain the Thermotek T-255P of any remaining coolant by tipping the unit over a bucket or drain.
2. Fill the reservoir with a 50%/50% mixture of Optishield Plus and Distilled water.
3. Make sure that all coolant connections are secure.
4. Turn the Thermotek on and set the temperature to 25°C.
5. Allow the unit to run for at least two hours.
6. After two hours, the Optishield Plus cleaning mixture can be inspected to see if it has removed any organic debris. The fluid may be slightly more discolored or have a more cloudy appearance, this is a good sign that it has "shocked" the system enough to dislodge or remove any organic or corrosive material.
7. The system can be flushed(see section titled 'Flushing the system') and the flow re-tested at this point. If the flow remains low, continue with this process, otherwise the cleaning is complete.
8. Drain the Thermotek T-255P of any remaining coolant by tipping the unit over a bucket or drain.

9. Fill the reservoir with a 50%/50% mixture of Isopropyl Alcohol and Distilled water.
10. Make sure that all coolant connections are secure.
11. Turn the Thermotek on and set the temperature to 25°C.
12. Allow the unit to run for at least two hours.
13. After two hours, drain some the Isopropyl Alcohol and Distilled water mixture into a clear container and inspect it for cloudiness and for the presents of debris.
14. If there appears to be no debris present, it is recommended to pour the mixture back into the reservoir and run the system overnight(proceed to step #17 if the chiller requires additional cleaning)
15. If there appears to be significant debris and/or dis-colorization to the solution, drain the reservoir over a bucket or approved container so that it can be disposed of properly.
16. The system can be flushed at this point(see section titled 'Flushing the system') and the flow re-tested. If the flow remains low, proceed to the section titled 'cleaning the cooling channels'.
17. If the system is to be run overnight, verify that all power is completely disconnected from the Chameleon head and power supply.
18. Confirm that the chiller is set to 25°C and that the fans are operating.
19. Monitor the measured temperature on the Thermotek for 10 minutes and make sure it stabilizes to within 1°C of the set temperature. Drift more than 1° is NOT acceptable, and the cleaning process should be stopped immediately. Proceed to the section titled 'cleaning the cooling channels' if this is the case.
20. After running the chiller overnight, drain some the Isopropyl Alcohol and Distilled water mixture into a clear container and inspect it for cloudiness and for the presents of debris.
21. If there is no debris, the flow should still be verified, however, the likelihood that the system was cleaned well enough is doubtful.
22. The system can be flushed at this point(see section titled 'Flushing the system') and the flow re-tested. If the flow remains low, proceed to the next section titled 'cleaning the cooling channels'.

Cleaning the cooling channels:
As a last resort after all other cleaning and cooling loop options have been exhausted, the Chameleon Baseplate can be cleaned mechanically with the following process.

Equipment needed-
- Chameleon Draining kit p/n 1055004.
- Cylindrical Brush, p/n 1128458.
- 6mm Flat head screwdriver.
- Cooling Hardware kit p/n 1109798.

1. Verify that the Chameleon head and power supply are disconnected from any power source.
2. Disconnect and drain the Chameleon baseplate of any coolant with the Chameleon draining kit(ref: p/n 1055004)
3. Disconnect the MRU along with any other unneeded connections such as the fast photodiode external BNC cable, USB cable and any of the Chameleon harness connections that are accessible.
4. DO NOT disconnect the fiber optic cables!
5. Remove the Chameleon head cover.
6. Remove the front and rear panels from the Chameleon and make sure you have access to all of the cooling block plugs(see *Fig 5.11-3*).

7. If necessary loosen the Chameleon foot clamps to get access to all the plugs, this may compromise any optical alignment in front of the Chameleon so be sure to investigate all of your options.
8. Remove each plug p/n 1001217 with a 6mm Flat Blade screw driver. There should be eight in all(see *Fig 5.11-3*).

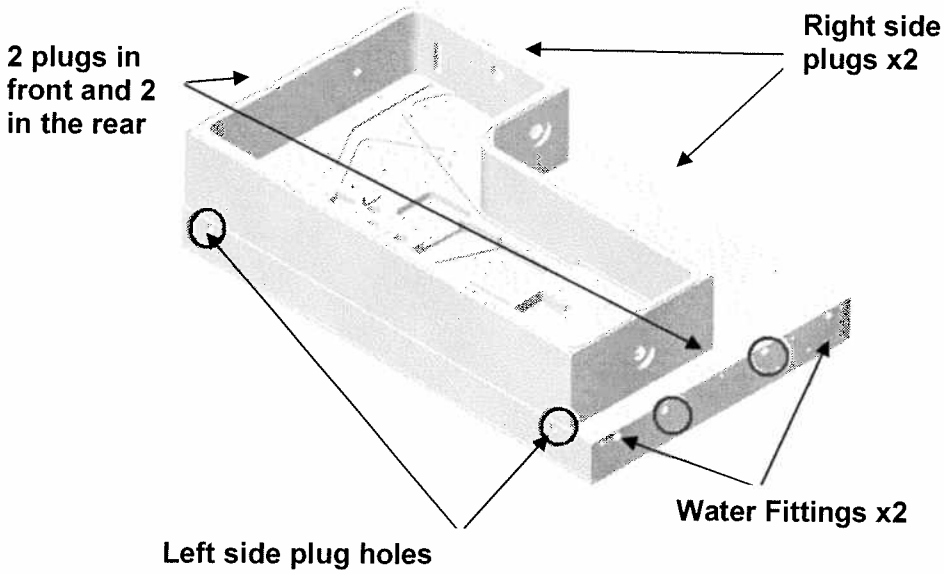

Fig 5.11-3
Chameleon Cooling Block "clean out placements"

9. Remove the two water fittings from the back of the Chameleon Head(see *Fig 5.11-3*)
10. Inspect the conditions of the O-rings and replace as needed. If there is a large amount of buildup or corrosion on the plugs and/or fittings, replace the entire part(Ref: Kit p/n 1109798).
11. Soak the Cylindrical Brush, p/n 1128458 in Isopropyl Alcohol before inserting into the "clean out holes" to the cooling channels(the plug holes where the plugs and water fitting were removed from)
12. Using the Cylindrical Brush, clean out the cooling channels in numerical order(see *Fig 5.11-4*). Rinse and soak the brush in Isopropyl Alcohol between each cleaning.
13. If the brush collects excessive dirt or debris after cleaning out one of the channels, clean the brush off thoroughly and repeat the process for that particular channel.
14. If necessary squirt the Isopropyl Alcohol directly into the cooling channel and let it soak for 20 minutes. This should help loosen some more adherent material.
15. If the end of the brush appears to be collecting the majority of the material, try rotating the brush in the same direction as the bristles are formed similar to turning a screw. This will reduce the chances of packing the material into the cooling block.
16. Pay special attention to cooing channels ?? and ??(see *Fig 5.11-4*) If it appears that you are pushing the build-up further into the channel, you may have to hold back on the distance you are pushing the brush until you have made several passes and removed a substantial amount of material.

17.