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Operators Manual

Circulating Bath / Immersion Circulator
With
Standard Controller - LED Display

110-052

12/99

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Section 1 - General Information

1.1 Warranty

Thank you for purchasing this circulator. We are confident it will serve you for a long time. Our warranty to you is as follows:

The manufacturer agrees to correct for the original user of this product, either by repair, or at the manufacturer's election, by replacement, any defect which develops after delivery of this product within the period as stated on the warranty card. In the event of replacement, the replacement unit will be warranted for 90 days or warranted for the remainder of the original unit's parts or labor warranty period, whichever is longer.

If this product requires service, contact the manufacturer/supplier's office for instructions. When return of the product is necessary, a return authorization number will be assigned and the product should be shipped, (transportation charges pre-paid), to the indicated service center. To insure prompt handling, the return authorization number should be placed on the outside of the package and a detailed explanation of the defect enclosed with the item.

This warranty shall not apply if the defect or malfunction was caused by accident, neglect, unreasonable use, improper service, or other causes not arising out of defects in material or workmanship. There are no warranties, expressed or implied, including, but not limited to, those of merchantability or fitness for a particular purpose which extends beyond the description and period set forth herein.

The manufacturer's sole obligation under this warranty is limited to the repair or replacement of a defective product and shall not, in any event, be liable for any incidental or consequential damages of any kind resulting from use or possession of this product. Some states do not allow: (A) limitations on how long an implied warranty lasts; or (B) the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights. You may have other rights which vary from state to state.

1.2 Unpacking

Your circulator is shipped in a special carton. Retain the carton and all packing materials until the unit is completely assembled and working properly. Set up and run the unit immediately to confirm proper operation. Beyond one week, your unit may be warranty repaired, but not replaced. If the unit is damaged or does not operate properly, contact the transportation company, file a damage claim and contact the company where your unit was purchased immediately.

Remove any loose packing material which may have fallen into the reservoir during shipping. Also check that nothing remains around the heater or circulator pump. Before proceeding, be sure the power ON/OFF switch is in the OFF position. Refrigerated models should have the Cooling ON/OFF switch in the OFF position.

The instructions in this manual pertain to circulators with reservoirs as well as the immersion circulator. Read the section pertaining to the special instructions for your model, then review the instructions for all models of circulators.

1.3 Specifications For All Models

Accessory cooling coil must be used for temperatures closer to ambient. Auxiliary refrigeration can be used for temperatures at or below ambient.

Temperature Stability . . . . . ±0.05°C

Readout Accuracy . . . . . ±0.5°C

Over-Temperature Protection. . . . . Yes

Low-Liquid Protection. . . . . Yes

Heater . . . . . 1000 W

Pump Speeds. . . . . 2-speed, 7 liters per minute or 15 liters per minute

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1.4 Circulating Bath

Model	Type	Temperature Range	Reservoir Capacity	Amps @ 120v 60Hz	Amps @ 240v 50Hz
9005	Refrig/Heat	-20° to 150°C	6L	12	6
9105	Refrig/Heat	-20° to 150°C	6L	12	6
9505	Refrig/Heat	-30° to 150°C	13L	14	7
9605	Refrig/Heat	-25° to 100°C	28L	14	7
9705	Refrig/Heat	-45° to 150°C	13L	14	7
8005	Heat	Ambient +5° to 150°C*	6L	9	4.5
8105	Heat	Ambient +5° to 150°C*	13L	9	4.5
8205	Heat	Ambient +5° to 150°C*	28L	9	4.5
7305	Immersion/Heat	Ambient +5° to 150°C*	Not Built In	9	4.5

1.4.1 Package Contents of Circulating Bath

- Circulating Bath
- Operators Manual
- Warranty Card
- Hose, bypass, Buna N (-40 to 120°C) pt.# 590-068
- A package of nylon adapters containing:

Description	Quantity	Part Number
3/16 inch barbed tube fittings	2	300-049
1/4 inch barbed tube fittings	2	300-048
3/8 inch barbed tube fittings	2	300-047

1.4.2 Description of Circulating Bath

Standard controller refrigerated and heating circulating baths are designed to provide precise temperature control of fluids for closed loop (pressure only) circulation to external equipment or to be used as a stand alone bath. The reservoir may be used for immersing samples while the unit is connected to an external device. All wetted parts are corrosion resistant 300 series stainless steel. Models are equipped with various size reservoirs and refrigeration capacities.

1.4.3 Circulating Bath Fluid Connections To External Apparatus

On circulating baths, the pump inlet and outlet are internally threaded with female 1/4 inch NPT to allow use of barbed tubing adapters or hard plumbing. Or, you can slide 1/2 inch (13mm) I.D. tubing over each pipe and hold it in place with a hose clamp.

Select tubing and fittings that are compatible with bath fluid and temperature range. If the pump inlet and outlet are not used for external circulation, for best results connect the inlet and outlet pipes with a short length of insulated tubing. Or, plug the pipes with male nylon plugs (supplied) or with metal plugs (not supplied) for high temperature use.

The nylon barbed tubing adapter fittings supplied are for applications from -40°C to 93°C. Brass, stainless steel or Teflon® fittings are recommended for applications above 93°C.

Quick connectors are not recommended as they typically restrict flow rate.

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1.5 Immersion Circulator

1.5.1 Package Contents of Immersion Circulator

— Immersion Circulator
— Operators Manual
— Warranty Card

1.5.2 Description of Immersion Circulator

The immersion circulator is not supplied with integral reservoir and is primarily for heating and circulating fluid in a reservoir supplied by the user. Although not designed for closed loop circula-tion, it can be used for this purpose.

1.5.3 Set Up of Immersion Circulator

Clamp the immersion circulator to the side of a tank (user supplied) or to a support rod adjacent to a tank. Be especially careful to maintain an adequate liquid depth to fully immerse the heater and pump outlet nozzle. When using a plastic tank, position the circulator so the heater does not contact the side of the tank. The rotatable pump outlet nozzle should be pointed along one side of a reservoir wall to produce the best fluid agitation.

1.5.4 Attainable Temperatures for Immersion Circulator

An immersion circulator can be used with reservoirs of varying size and shape, as well as with different types of fluids. These variables may cause a loss of temperature accuracy and stability. The following chart indicates the approximate maximum temperature that can be achieved depending on the reservoir's size and fluid surface area.

Approximate Attainable Temperatures vs. Liters In Uncovered Reservoir

Temperature	30°C	40°C	50°C	60°C	70°C	80°C	90°C	100°C	110°C	120°C	130°C	140°C	150°C
Water	192L	96L	48L	24L	12L	6L	3L	–	–	–	–	–	–
Oil	283L	202L	145L	103L	74L	53L	38L	27L	19L	14L	10L	7L	5L

Results may vary.

1.5.5 Immersion Circulator Fluid Connection to External Apparatus

The immersion circulator does not have inlet and outlet fittings, but it can be used for closed loop applications. ½ inch I.D. tubing may be fastened with a hose clamp to the rotatable pump outlet nozzle and connected to the inlet of external apparatus. Tubing from the external apparatus outlet must return the fluid back into the reservoir.

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Section 2 - Operation - All Models

2.1 Set Up

2.1.1 Location

Locate your circulator on a level surface free from drafts and direct sunlight. Do not place it where there are corrosive fumes, excessive moisture, high room temperatures, or excessively dusty areas. Refrigerated circulators must be four inches minimum away from walls or vertical surfaces so air flow is not restricted. Avoid voltage drops by using properly grounded power outlets wired with 14 gauge or larger diameter wire and if possible, be close to the power distribution panel. The use of extension cords is not recommended. This will avoid low line voltage problems.

2.1.2 Filling the Reservoir

The MAXIMUM FILL LEVEL is one inch below the top of the reservoir. When in operation, add additional fluid to compensate for any additional volume needed for external circulation.

MINIMUM LIQUID DEPTH is enough to fully cover the heater, pump, and one inch of the temperature sensor. If the proper fluid level is not maintained the heater coil may become exposed and possible damage to the heater may result.

An adjustable Low-Liquid Level / Over-Temperature Safety Cutoff is an integral part of all units. Follow the procedure in Section 2.5, Setting The Safety Thermostat for setting this safety.



Warning: These units are equipped with Over-Temperature Protection (OTP). Failure due to low-liquid level or failure to set OTP and properly immerse the heater may result in heater burnout and triac failure. While operating, do not allow the heater to contact any potentially flammable materials such as plastic racks or sides of plastic tanks as a fire hazard may result.

2.1.3 Reservoir Fluids

Use distilled water for temperatures from +10° to 90°C or a mixture of laboratory grade ethylene glycol and water for temperatures from +10° to -20°C. Below -20°C, use a fluid of low viscosity such as DC 200 2cs or Dynalene-HC50™.

A variety of fluids can be used with the circulator depending upon your needs. The fluid must be chemically compatible the reservoir and with 300 series stainless steel in the pump and heater. The fluid must also be able to produce the temperature range desired.

For best temperature stability, the viscosity should be 50 centistokes or less at the lowest operating temperature. This allows good fluid circulation and to minimizes heating from the pump. Most single type of fluids will be able to stabilize to ±0.01°C over a 100°C range. Use fluids that will satisfy safety, health and equipment compatibility requirements.



You are responsible for proper selection and use of the fluids. Extreme range operation should be avoided.

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The chart below will help in selecting a fluid for your application. Stay within the fluid's normal range for best temperature stability and low vaporization.

FLUID DESCRIPTION	SPECIFIC HEAT @25°C	NORMAL RANGE	EXTREME RANGE
Distilled Water	1.00	10° — 90°C	2° — 100°C
Ethylene Glycol 30% / Water 70%	.90	0° — 95°C	-15° — 107°C
Ethylene Glycol 50% / Water 50%	.82	-20° — 100°C	-30° — 100°C
Ethylene Glycol 100%	.62	50° — 125°C	0° — 125°C*
Dynalene-HC 50™	.76	-50° — 60°C	-62° — 60°C
DC200, 5 cs Silicone Oil	.32	-35° — 65°C	-50° — 125°C*
DC200, 10 cs Silicone Oil	.34	-20° — 80°C	-35° — 165°C*
DC200, 20 cs Silicone Oil	.36	0° — 100°C	-10° — 230°C*
DC200, 50 cs Silicone Oil	.39	50° — 150°C	5° — 270°C*
DC510, 50 cs Silicone Oil	.39	50° — 150°C	5° — 270°C*
DC550, 125 cs Silicone Oil	.42	100° — 200°C	80° — 232°C*
DC710, 500 cs Silicone Oil	.45	150° — 250°C	125° — 260°C*

***WARNING - Fluid's flashpoint temperature**

"Sylltherm" is a registered trademark of Dow Corning. DC fluids are manufactured by Dow Corning.

Do NOT use the following fluids:

1. Automotive antifreeze with additives**
2. Hard tap water**
3. Deionized water with a specific resistance > 1 meg ohm
4. Any flammable fluids
5. Concentrations of acid or bases
6. Solutions with halides: chlorides, fluorides, bromides, iodides or sulfur
7. Bleach (Sodium Hypochlorite)
8. Solutions with chromium salts

** At temperatures above 40°C, additives or mineral deposits can adhere to the heater. If the deposits are allowed to build up, the heater may overheat and fail. Higher temperatures and higher concentrations of additives will cause a faster deposit build up. If buildup occurs see Section 3.1, Maintenance - Heater.



WARNING: Do not use a flammable liquid as a fire hazard may result.

APPLICATION NOTES

At fluid's low temperature extreme:

1. Presence of ice or slush adversely affects temperature stability.
2. Viscosity above 10 centistokes adversely affects temperature uniformity.
3. High fluid viscosity and high speed pumping generates heat in the fluid. By using a low viscosity fluid at low temperatures pump motor overload will also be avoided.

At fluid temperature above ambient without using refrigeration:

1. Without refrigeration and within 15°C of room temperature the viscosity should be 10 centistokes or less to avoid friction heating of the fluid. Heat loss should be encouraged by uncovering the fluid and the pump speed minimized.

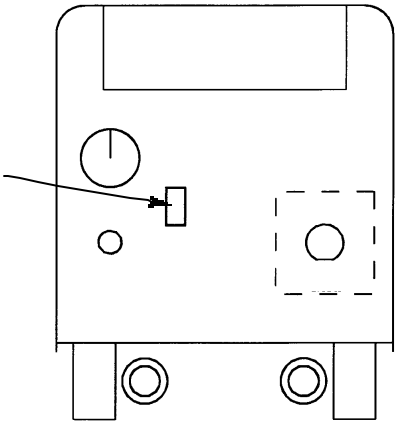
At fluid's high temperature extreme:

1. Heat loss from vapor causes poor temperature stability.
2. A fume hood may be required to prevent the buildup of vapors inside the room.
3. Use a cover and/or floating hollow balls to help prevent heat and vapor loss.
4. Fluid lost from vapor will have to be frequently replenished.

2.1.4 Circulator Pump, Selecting Pump Speed

The 2-speed simplex (pressure) pump may be used for tempering of samples in the reservoir or for circulation in closed loops. It is not designed for pumping from the circulator's reservoir into and out of a second open reservoir.

The HIGH or LOW speed selection switch on the rear panel of the controller allows a choice of pump speeds.



SPEED SELECTION	Maximum Pump Outlet Ratings Line Frequency=60Hz	Maximum Pump Outlet Ratings Line Frequency=50Hz
HIGH	15 LPM / 2.6 PSI	10.4 LPM / 1.8 PSI
LOW	7 LPM / 1.3 PSI	4.8 LPM / 0.9 PSI

The table above uses the following criteria:

1. Maximum pump outlet flow rate is measured in liters per minute (LPM) with no restriction on the pump outlet.
2. Maximum pump outlet pressure is measured in pounds per square inch (PSI) at no flow.
3. Water was used as the circulation fluid. Water has a viscosity of one centistoke. High viscosity or low density fluids will change these figures.
4. When inlet and outlet are plugged on reservoir models, flow rate refers to internal bath circulation.

Select the HIGH pump speed where changes in temperature vary and there is a need for fast recovery, or when pumping to multiple external units. **The LOW speed** is adequate for most applications and provides quieter pumping.

When operating Models 9505 and 9705 near their low end temperatures, use the low pump speed in order to minimize friction heating from the pump.

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2.1.5 Closed Loop Circulation

Connect the pump inlet and outlet to your application. Use care to avoid restrictions in the tubing in order to maintain adequate flow. When connecting to more than five closed loops we recommend use of a manifold made of "Y" adapters to divide the fluid into two or more banks. A booster pump may be added without damage to the circulation bath pump. After setting up multiple closed loops, check that there is adequate flow at the return manifold for each loop. Also recheck bath fluid level.

The control stability of a closed loop system will generally be better at the external apparatus than in the immediate vicinity of the heater, provided the apparatus control point represents a constant load and is well insulated For example, if you circulate at 50°C through a viscometer, the temperature variation observed in the reservoir may be +0.05°C, whereas in the viscometer it may be only +0.02°C. Although stability is better at the external apparatus control point, depending on the insulation and length of tubing used, the accuracy of temperature may be slightly different than the temperature indicated in the reservoir.

2.1.6 Power Requirements

Plug the unit into a properly wired, grounded outlet with the same voltage and frequency indicated on the identification label on the back of the unit. With the power switch OFF, the display should respond by showing standby (...). If there is no response, check if the circuit breaker is in the ON position. Use of an extension cord is not recommended, but if necessary, use one that is properly grounded and will handle the total wattage of the unit. The extension cord must not cause more than a 10% voltage drop to the circulator.

Indicated Voltage Volts/Phase/Frequency	**Operational Voltage Range**	**Phase**	**Frequency**
100/ 1 / 60	90 to 110 Volts	single	60 Hz
100/ 1 / 50	90 to 110 Volts	single	50 Hz
120/ 1 / 60	110 to 130 Volts	single	60 Hz
230/ 1 / 60	208 to 230 Volts	single	60 Hz
240/ 1 / 50	220 to 240 Volts	single	50 Hz

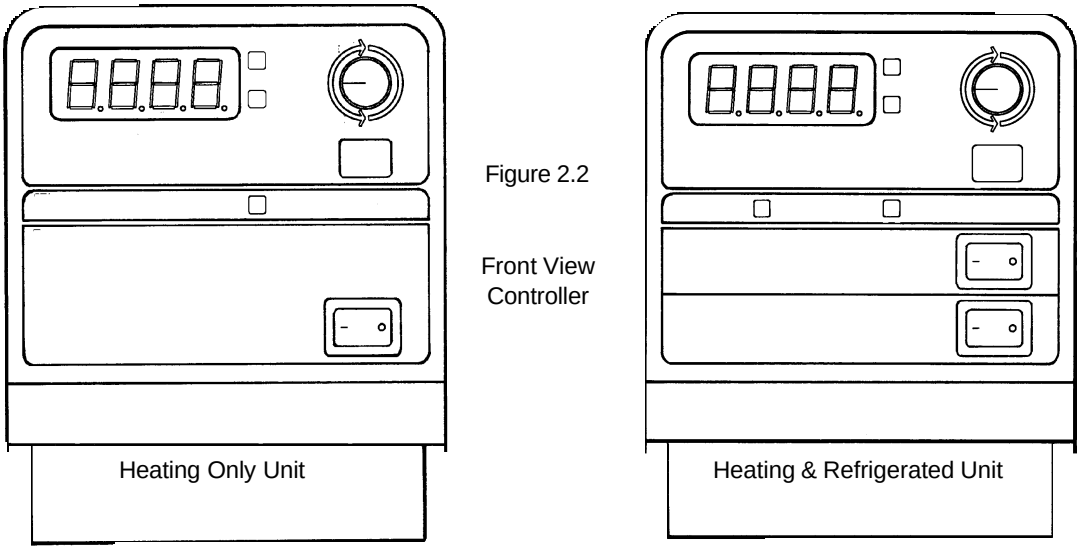


Figure 2.2

Front View
Controller

2.2 Standard Controller Temperature Setting, Powering Up

After filling the reservoir with fluid, the circulator must be set for the desired temperature level:

See figure 2.2 on previous page

1. Before pressing the power switch ON, set the Safety Thermostat (OTP) knob on the rear panel to full clockwise position*. The pump starts to operate. The display indicates (8888), the power self test and the °C light flashes. You are now ready to set the front panel controls to the desired temperature setting.

   *This does not set the Safety Thermostat temperature, this only allows for powering up and setting desired temperature. See Section 2.5, Setting the Safety Thermostat.
2. Press the SET/ENTER button. The degree light flashes to indicate that the temperature can now be changed. Turn the INCREASE/DECREASE knob to the desired setting. This setting is accepted after pressing the SET/ENTER button or automatically accepted after a few seconds.
3. The degree light stops flashing and the display indicates the actual bath temperature. The set temperature may be checked by pressing the SET/ENTER button at any time. Allow sufficient time for the bath to stabilize at the desired temperature.

If you are unable to raise the set temperature, it is possible that the high limit is set lower than the new temperature you have selected. If this happens, set the high limit to be 1°C or more higher than your new temperature. See 2.3, Setting the High Limit, then follow the procedure for setting the new control temperature.

2.3. Operation of Refrigerated Models

For operation at temperatures below 40°C, refrigeration is normally required. To start the refrigeration system, press the cooling switch to the ON position. The refrigeration on Models 9005 and 9105 will automatically shut down if the bath fluid is above 55°C, even if the refrigeration switch is on.

Refrigeration on Models 9505, 9605, and 9705 can be operated up to 200°C. These high capacity and large volume models are equipped with a modulating system to provide maximum cooling capacity, quick cooldown and greater energy efficiency.

When refrigeration is switched off, it should not be restarted for approximately 10 minutes in order to allow the internal pressures to equalize. System damage could result if you do not observe this waiting period.

2.4 Setting the High Limit

This feature provides additional set point security by allowing a selectable upper limit set point. If the fluid reaches the high limit, the unit will shut down and display “HI-L” until the fluid temperature is reduced or the”HI-L” value is raised. The “HI-L” should be at least 1°C higher than the selected control temperature to avoid unwanted shut down during regular operation. Set the high limit temperature as follows:

1. Press and hold the SET/ENTER button until the display reads “UNIT”.
2. Turn the INCREASE/DECREASE knob until the display reads “HI-L”.
3. Press the SET/ENTER button and enter the desired value using the INCREASE/DECREASE knob.
4. Press SET/ENTER or the setting will be accepted after a few seconds.

The factory default setting for the high limit is 152°C.

2.5 Setting the Safety Thermostat

The Over Temperature Protection (OTP) thermostat safety feature, <u>located at the rear of the controller</u>, prevents your unit from burnout in case of primary controller failure or a low liquid condition by switching off power to the heater. This feature is independent of the high limit setting and has a range of 60°C to 220°C. The high limit as indicated in Section 2.3 must still be set.

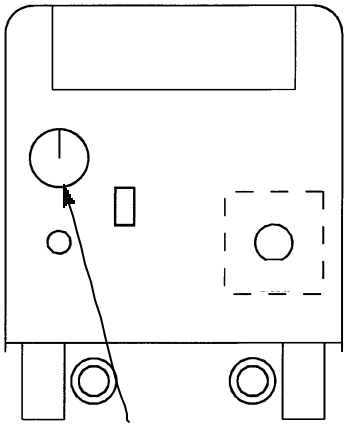
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For temperatures less than 60°C:

1. Turn the OTP knob located at the rear of the controller fully counterclockwise (minimum setting).

For temperatures over 60°C:

1. Turn the adjustable thermostat (OTP knob) located at the rear of the controller fully clockwise (Maximum+) until it stops.
2. Stabilize the bath at the maximum desired control temperature.
3. Turn the OTP knob slowly counter-clockwise until you hear a click. The unit will halt and the display will read “E-oP” (Over temperature).
4. Turn the OTP knob clockwise slightly above the position where the unit tripped then reset the OTP thermostat breaker by pressing the red OTP reset button located below the knob. OTP is now set to trip a few degrees over the stabilized fluid temperature.



Over Temperature Protection (OTP) thermostat

2.6 Selection of Celsius or Fahrenheit Readout

To change the readout to display in °F or °C:

1. Press and hold the SET/ENTER button until the display reads “UNITS”.
2. Press SET/ENTER again then turn the INCREASE/DECREASE knob and select °C or °F.
3. Press SET/ENTER or the setting will be accepted after a few seconds.

2.7 Controller Optimization

There is provision to optimize the the controller for special applications. **If the temperature stability using factory settings is satisfactory, there is no need to change the controller tuning**. Control performance equal to or greater than ± 5°C from the setpoint temperature is not affected by tuning. To achieve close control, tuning may be necessary to: use a closed loop system of large volume; use a fluid other than water; or use a viscous fluid.

Tuning of Proportional Integral Derivative (PID) controllers requires extensive knowledge of PID technology or time lost in pure guesswork. The tuning parameters below are simplified and are figures that can be easily measured and entered. Settings are not critical, estimates are acceptable. Each of the three values used for tuning can be changed without having to change any other value. Each value is independent. ***See next page for procedure to change tuning***.

TO CHANGE THE TUNING:

For each of the following steps, first press and hold the SET/ENTER button until the display reads “UNIT”

“CAP” (Capacity)

1. Turn the INCREASE/DECREASE knob until the display reads **“CAP” (Capacity)**. Press SET/ENTER.
2. Enter the estimated total system volume in liters using the INCREASE/DECREASE knob. Press SET/ENTER or the setting will be accepted after a few seconds.

   The factory default setting for "CAP" (Capacity or system volume) is 10 liters.

“FLO” (Flow Rate)

1. Turn the INCREASE/DECREASE knob until the display reads **“FLO”(Flow Rate)**. Press SET/ENTER.
2. Enter the estimated actual flow rate in liters per minute using the INCREASE/ DECREASE knob. Press SET/ENTER or the setting will be accepted after a few seconds.

   The factory default setting for "FLO" (Flow Rate) is 10 liters per minute.

“SHC” (Specific Heat Capacity)

1. Turn the INCREASE/DECREASE knob until the display reads **“SHC” (Specific Heat Capacity)**. Press SET/ENTER.
2. Enter the specific heat capacity of the fluid being used by turning the INCREASE/DECREASE knob. Press SET/ENTER or the setting will be accepted after a few seconds.

   Refer to Section 2.1.3 for specific heat values of various liquids and Section 4.8 for returning to factory default controller settings.

   The factory default setting for "SHC" (Specific Heat Capacity) is 1.0.

Refer to Section 2.1.3 for specific heat values of various liquids and Section 4.8 for returning to factory default controller settings.

2.8 Controller Display Messages

	Display	Message
Normal Screens:	...	Standby mode. Unit plugged in. Power switch off.
	8888	Power up self test. Power switch on.
Menu Screens:	Unit	Change to °F or °C
	FLO	Flow rate selection for controller tuning
	CAP	Capacity (volume) for controller tuning
	SHC	Specific heat value for controller tuning
Error Screens:	AL-M	High-temperature alarm
	E-oP	Over-temperature fault
	E-5F	Sensor failure
	E-tF	Triac (alternistor) failure

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