ADVANCED INDUSTRIAL SYSTEMS, INC.

Applications Note 604
Trouble Shooting PID Temperature Control Loops

Q: What are some techniques I can use to trouble shoot temperature control loops?

Answer: This is the first of two Applications Notes on this subject. This month we will assume that everything worked properly once. Next month we will talk about start-up problems.

Assumption 1: Everything worked properly once
Assumption 2: We are using a contactor or solid state relay to control a heater.

Although many of the techniques are applicable to 4 – 20 loops, control valves, etc, the largest majority of problem calls I get are specifically about heaters. We will therefore assume that we are talking about time proportioned control systems for out check list.

We need to locate the area of the error first. Is it an input error (maybe a defective or open TC) or an output error (defective SSR or Relay, defective controller, fuse blown, defective heater, etc.)?

Input Errors

Scenario 1: Is the temperature approximately correct?

<table>
<tr><td rowspan="7">NO</td><td>Short the TC at the controller input terminals</td><td>It should read room temperature.</td></tr>
<tr><td colspan="2">• If this test fails, remove the TC connections and short the input again. If it still fails, the controller is probably bad. If it passes, you probably have a bad TC or a shorted lead wire (probably shorted to the conduit) or poor connection.
• Inspect the strip points.
• Clean and reconnect the TC connection. (If everything works when you reconnect the TC, you may have had oxidized or loose leads. This is common. Don't forget Red is (-) in TC land.</td></tr>
<tr><td>Short the TC at the TC at the Process end</td><td>It should read room temperature.</td></tr>
<tr><td colspan="2">• If this test fails, disconnect the TC at the process end.
• If it now passes, connect one leg at a time of the extension wire to ground. If you fail one of the two tests, your extension lead wire is probably shorted to the conduit and must be repaired or replaced. This happens a lot. Inspect and reconnect everything. The wiring could be shorted near at the TC connection. Check carefully.</td></tr>
<tr><td>Remove the TC and squeeze it between your hands</td><td>It should approach body temperature (98°F)</td></tr>
<tr><td colspan="2">• You can also use a small lighter. All we are looking for is does the TC responds. If it does, it is probably OK. If it reads open, or does not respond, it is probably bad. As a rule, you cannot fix TC's.</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>YES</td><td colspan="2">Proceed to the tests below</td></tr>
</table>

If you corrected any problem above, you should retest the system to see if it is now working properly.
For most failed TC wire we recommend using PVC shielded TC extension wire. If the failure is a short at a strip point or a point of entry, heat shrink tubing or electrical tape may normally be used to correct the problem. Note that you must always replace TC wire with TC wire. If the wire is too short, you should not use copper wire even for short distances. In high temperature systems, TC failure is often the problem.

PO Box 470 Harrods Creek, KY 40027
(502) 292-0213 1-800-532-2477 FAX - (502) 228-0127
E-Mail: Sales@AdvIndSys.com Website: www.AdvIndSys.com

Output Errors

Scenario 2: The temperature is not correct.

Are the Controller Settings Correct?		
No	Check the set point and process temperature.	The setpoint must be higher than the process temperature for heat.
	• Reset the set point to the proper temperature. This happens often.	
	Check to see that the controller is in a "control mode".	It should not be in "Manual", "Park" or "Autotune".
	• Place the controller in the correct mode.	

Scenario 3: The temperature is too low.

Is the process heating at all?		
NO	Check to see that it the contactor or SSR is energized.	Use a voltmeter to measure the "coil" input. For a DC triggered SSR the "coil" input should measure about 5 – 25 VDC. For an AC triggered SSR (or contactor) it should measure line voltage.
	• Since there is no heat the controller output should be on all of the time and everything should be energized. If they are not, the output from the controller is probably bad, and the controller should be replaced. If they are, the controller is probably OK.	
	Turn on the heater power. Have someone watch so the heater doesn't overheat.	Check the heater voltage at the fuses.
	• If there is no power to the fuses, the contactor or SSR is most likely bad. Replace it. • If there is no power after the fuses (they must all work), replace the fuses. If they blow again, the heater is probably bad. • If there is power after the fuses, heater or its connection is probably bad.	
YES	The temperature is just too low	Sometimes OK, but often low
	• A bad heater will often this problem. Improper (or zero) heater current will tell the tale. • In three phase heaters this can be caused by a blown fuse, or bad output device in one leg.	

Scenario 4: The temperature is too high.

Lower the set-point temperature to way below setpoint (like zero). Does the heater still heat?		
Yes	Check to see that it the contactor or SSR is energized.	Use a voltmeter to measure the "coil" input. For a DC triggered SSR the "coil" input should measure about 5 – 25 VDC. For an AC triggered SSR (or contactor) the "coil input" should measure line voltage (120 – 240 VAC).
	Since the setpoint is way below the process temperature, the controller output should be off all of the time and everything should be de-energized. • If the output of the Contactor or SSR is still on, check its coil. If the coil is de-energized, replace the contactor or SSR. (This is usually the problem) • If the coil is energized, double check the controller settings. If the controller settings are OK, replace the controller.	

Scenario 5: The temperature is erratic.

Does it work OK sometimes and then become erratic for a while (too hot or too cold)?		
Yes	Erratic Operation	Works OK sometimes
	• This is usually caused by failed contacts on the contactor or relay. Replace the device. If the device is inside the temperature controller, replace the controller. • A heater that is about to fail can sometimes cause the same problem.	

There can certainly be other causes, but these cover 99% of the ones that we deal with every day. Please feel free to call for additional assistance. We stock controllers, SSR's, TC's etc, or will gladly help you find them.

For a complete list of Applications Notes and other Data see: www.AdvIndSys.com/ApplicationsNotes.htm .

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