Measuring Coefficient of Thermal Expansion (CTE) of Parallel Plates on ARES/RDA-3 Rheometers

(1) Make sure that Instrument is "CONFIGURED" to work with OVEN in the hardware. This is done by going into the Instrument Configuration Screen **(UTILITIES > SERVICE > INSTRUMENT CONFIGURATION…. And Selecting Temperature Control Setup at the top Instrument Setup dropdown list).**

(2) The Oven should be selected as the Type of Temperature Control.

(3) The maximum and minimum temperature limits should be properly set. For most instruments, the Max. Limit is 600°C, however some instruments may have a value lower than 600C.

(4) The minimum Limit should be;

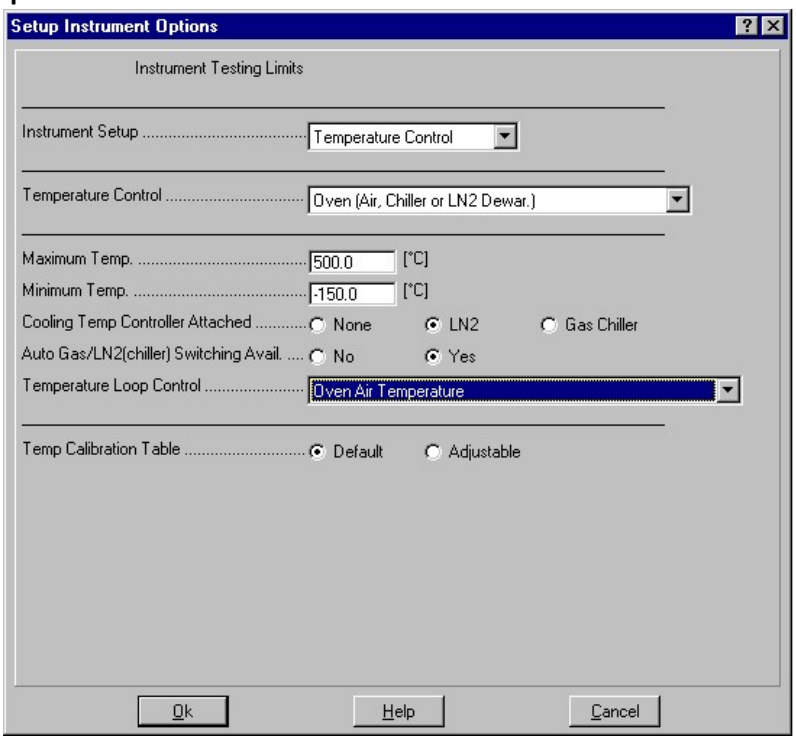
- **a. +20°C for instruments without any cooling or**
- **b. -60°C with Chiller or**
- **c. -150°C with LN2 Controllers.**

(5) If you wish to turn ON the Automatic Switching between LN2/Chiller and Gas/Air, then Auto Gas/LN2 switching Available should be selected as YES. Otherwise, it should be set to NO.

(6) Next step depends on the type of fixture you are going to use;

- **a. For Parallel Plates you can choose Sample/Tool Control.**
- **b. For Torsion Rectangular fixtures, the Temperature Loop Control Should be selected as Mode 3.**

(7) Leave the Temp. Calibration Table to DEFAULT.



ARES V6/V8 and RDA-3 Temperature Control Setup Screen with Oven and LN2

(8) Click OK when done. These settings will be saved into the non-volatile memory (EEPROM) of the CPU Board for that instrument.

Parallel Plate Geometry Preparations: (MAKE SURE THAT THE TEST SURFACES OF YOUR PLATES ARE CLEAN OF ANY RESIDUE POLYMER SAMPLES)

(1) Install the Tool PRT Assembly into the Motor's socket.

(2) Install the Lower 25mm Plate onto the Tool PRT and tighten the thumb screw on the motor's tool mounting hardware mechanism.

(3) Install the Upper 25mm Plate onto the Transducer.

(4) Zero out the Residual Torque and Normal Forces on the instrument as follows;

a. **For all ARES instruments with Firmware V5/15 and below, press the XDCR Zero Button under the Blue Screen of the instrument.** *(On these V5/15 and below instruments, pressing XDCR Zero button makes both Torque and Normal residual forces to zero).*

b. For all ARES and RDA-3 instruments with Firmware V6 or V8, click on the GAP CONTROL Icon on the Orchestrator Software and then click on Offset Torque to Zero and Offset Normal to Zero. *(V6/V8 instruments allow to separately zero out Torque and Normal via the Gap Control screen).*

(5) Using the manual stage control switches, bring the platform/stage down so that both the Upper & Lower plates are approximately 2mm apart.

(6) NOW you MUST zero out the Gap between the two plates as follows;

a. For all ARES instruments with Firmware V5/15 and below;

i. **Click on the Gap Control Icon. These instruments allow you to zero the Gap by typing a desired Gap** *(which the stage will move UP to, AFTER zeroing process is completed)* **and Maximum Normal Force** *(during the gaping).*

ii. **Type a Gap of 0mm and maximum force of 100 gm.**

iii. **Click on ZERO Fixture and allow the plates to zero themselves out.** *(The instrument will bring the stage down, let the plates touch each other but not to exceed a force of 100 gm, then reset the gap to zero and then remain at the gap of 0mm)*

b. For all ARES and RDA-3 instruments with Firmware V6 or V8, click on the Gap CONTROL Icon on the Orchestrator Software.

i. **In the Gap Control Screen, type Gap of 0mm and Maximum Force of 100 gm and then click on Zero Fixture and allow the plates to zero themselves out.** *(The instrument will bring the stage down, let the plates touch each other but not to exceed a force of 100 gm, then reset the gap to zero and then remain at the gap of 0mm)*

(7) Gently Close the Oven and set the Temperature to 25C and select the Source as GAS (Not LN2).

- **a. If your ambient/room temperature is LESS than 25C, the control will stabilize at 25C.**
- **b. If the ambient temperature is MORE than 25C, the instrument can't cool on its own without the use of cooling accessory (using Gas as the source). In that case, set the Temperature to 30C.**
- **c. Allow the temperature to stabilize at either 25C or 30C, depending on the situation mentioned above.**
- **d. Once the Temperature is stable at 25C (or 30C), then again re-zero the plates at the stable temperature.**
- **e. WAIT FOR THE TEMPERATURE TO BE STABLE at 25C (or 30C).**
- **f. Now click on the Control Menu of the Orchestrator Software and select SET TEST CONDITIONS.. Here you can enter an Auto Tension Sensitivity value. Enter a value of 10 gm and click OK.**
- **g. Now click on HOLD Button (ICON) or under Control Menu, click on HOLD.**
- **h. Now go back into the Set Test Conditions Screen and set the Temperature to 100C more than your room/ambient temperature. (i.e either 125C or 130C).**
- **i. Because you have selected HOLD and set the Auto Tension Sensitivity to 10gm, as the plates heat up, their metal expands. If the expansion causes the Normal Force to be more than 10gm, the stage will move up automatically. Once the Temperature of the Plates is stable at 125C (or 130C), then the expansion will stop and the stage will no longer move up.**
- **j. Allow sufficient time to allow the plates to be very stable at 125C (or 130C). Then read the GAP on the Blue Screen (or in the Software).** *The new Gap is the Gap (in mm) which was necessary to raise the stage up by, in order to eliminate/relieve the added normal force due to metal expansion.* **Take this Gap (in mm) and divide it by 1000 to convert it into micro meter. Then further divide that Gap in micro meter by the temperature difference of 100C (125C-25C or 130C- 30C). That will be your plates Coefficient of Thermal Expansion. For Example, if the new gap at 125C (or 130C) was 0.225 mm (or 225 micro meter), then the CTE of the plates will be 225 micro meter / 100C = 2.25 micro meter per degree C.**
- **k. Enter this value into the CTE for those plates.**