Temperature Control of an Ace Glass 2 Liter Double-Jacketed Reactor with a Presto LH 85

The Objective:
Ace Glass Inc. has developed a new style of jacketed glass reactor with a total of two jackets. In addition to the standard heat transfer fluid jacket, the reactor is equipped with an additional outer vacuum jacket. This vacuum jacket provides superior insulation against temperature losses. An added benefit is that the reactor does not become covered in frost at low temperatures, allowing the user to clearly see the contents of the reactor throughout the entire operating range of the reactor. The picture below was taken with the jacket fluid at -55°C! Notice there is no frost build up on the vacuum-jacketed surface.

Julabo USA was curious as to the performance of the reactor with our Presto LH 85 Heating and Refrigerated circulator, so we decided to run some simple tests to observe the performance of the system.

The Motivation:
As is common in almost every area of business, it is desirable to complete projects in the shortest amount of time to maximize the productivity of equipment and employees. Because of this, Julabo USA and Julabo Labortechnik GmbH have developed the Presto series of heating and refrigerated circulators. With their powerful heating and cooling capacities, strong pumps, and minimal bath volumes, the Presto series of circulators can cut temperature-controlled experiment times almost in half, depending on the unit used and the application, in comparison to standard open bath circulators.

It is only natural to put the Ace Glass 2L reactor and the Presto LH85 together to test their performance.

The Solution:
Testing will be performed on the following system:

- Julabo Presto LH 85 heating and refrigerated circulator **(9 410 185)**
- Ace Glass Inc. 2 liter double-jacketed glass reactor
- Arrow electronic stirrer
- Julabo 1 meter triple insulated flexible metal tubing **(8 930 210)**
- Julabo HL80 heat transfer fluid (range: -85°C to 170°C) **(8 940120)**
- Julabo H5S heat transfer fluid (range: -50°C to 105°C) **(8 940 106)**
- Ethanol
- Pt100 external temperature sensor **(8 891 018)**
- Necessary fittings

Three simple tests will be performed in order to learn the behavior of the system.
The first test is a simple low temperature test to determine the lowest achievable reactor temperature.

The second test is a low temperature profile in which the reactor is heated from -40°C up to 20°C and then cooled back down to -40°C. The time necessary to achieve these temperature changes will be recorded to demonstrate the rapid dynamics of the circulator-reactor combination.

The final test is a high temperature profile in which the reactor is cooled from 100°C down to -40°C and then heated back up to 100°C. Again, the time necessary to achieve these temperature changes will be recorded.

Test Goal:
The goal of the tests are to determine:

- The lowest reactor temperature the combined system can attain
- The amount of time required to reach this minimum temperature
- The amount of time required to complete the low temperature profile
- The amount of time required to complete the high temperature profile

Test Results:
Note: All tests were performed with the Arrow electronic stirrer operating at 200 rpm. The bath fluid in all tests is Julabo HL80 heat transfer fluid.

In the first test, ethanol was used in the reactor. The initial reactor temperature was 20°C. The set point for the jacket temperature was then changed to -55°C. Figure 1 below shows the response of the system while cooling down to -55°C. A temperature of -55°C was reached in 21 minutes. The test was ended when the ethanol in the reactor reached -50°C in order to protect the glassware from excessively deep temperature. The reactor reached -50°C in 40 minutes.

In the second test, ethanol was used in the reactor. The response of the system during the low temperature profile can be seen in Figure 2 below. The system heated the reactor fluid from -40°C to 20°C in 60 minutes. The system then cooled the reactor back down to
-40°C in 53 minutes.

In the final test, Julabo H5S heat transfer fluid was used in the reactor. The response of the system during the high temperature profile can be seen in Figure 3 below. The system cooled the reactor from 100°C to
-40°C in 99 minutes. The system then heated the reactor back up to 100°C in 69 minutes.

Note: The recorded times are the times for the system to reach stability within ± 0.3°C of the set point temperature. With some overshoot, faster response times may be possible.

Conclusions:

Lowest achievable jacket temperature with LH 85 and 2 liter jacketed reactor: **-55°C**
Time to cool to lowest jacket temperature from ambient (20°C): 21 minutes
Time to cycle from -40°C to 20°C to -40°C: **113 minutes**
Time to cycle from 100°C to -40°C to 100°C: **168 minutes**

Figure 1: Ace Glass 2L Reactor with Presto LH85 (HL80 Bath Fluid, Ethanol Reactor Fluid)

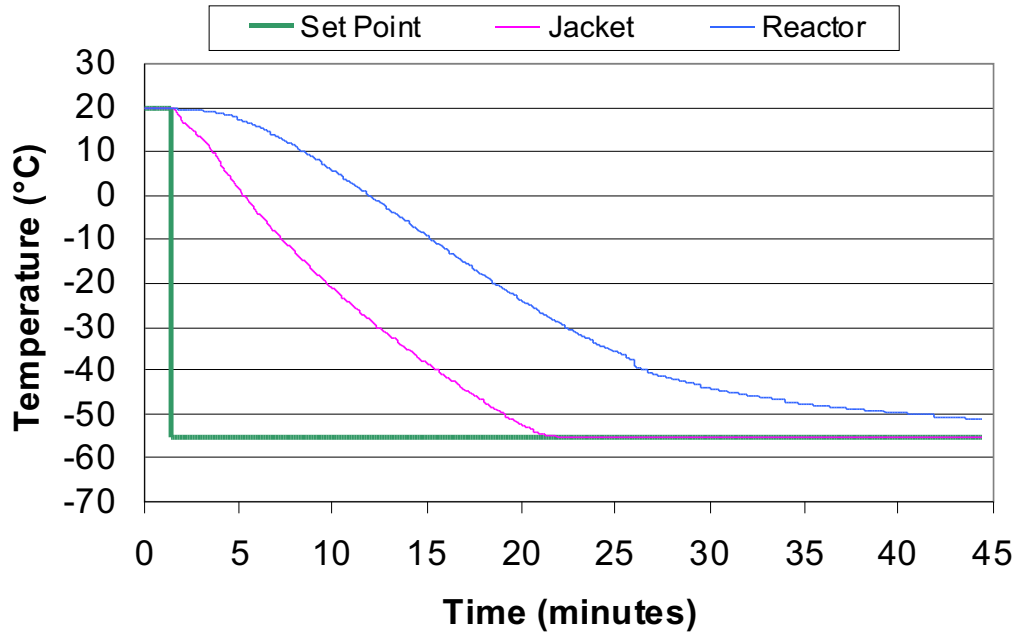
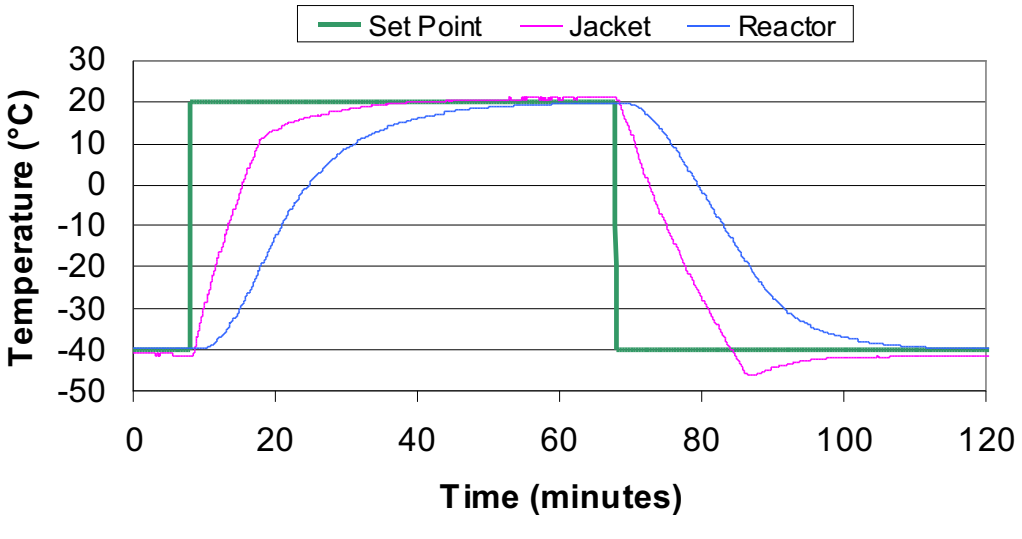
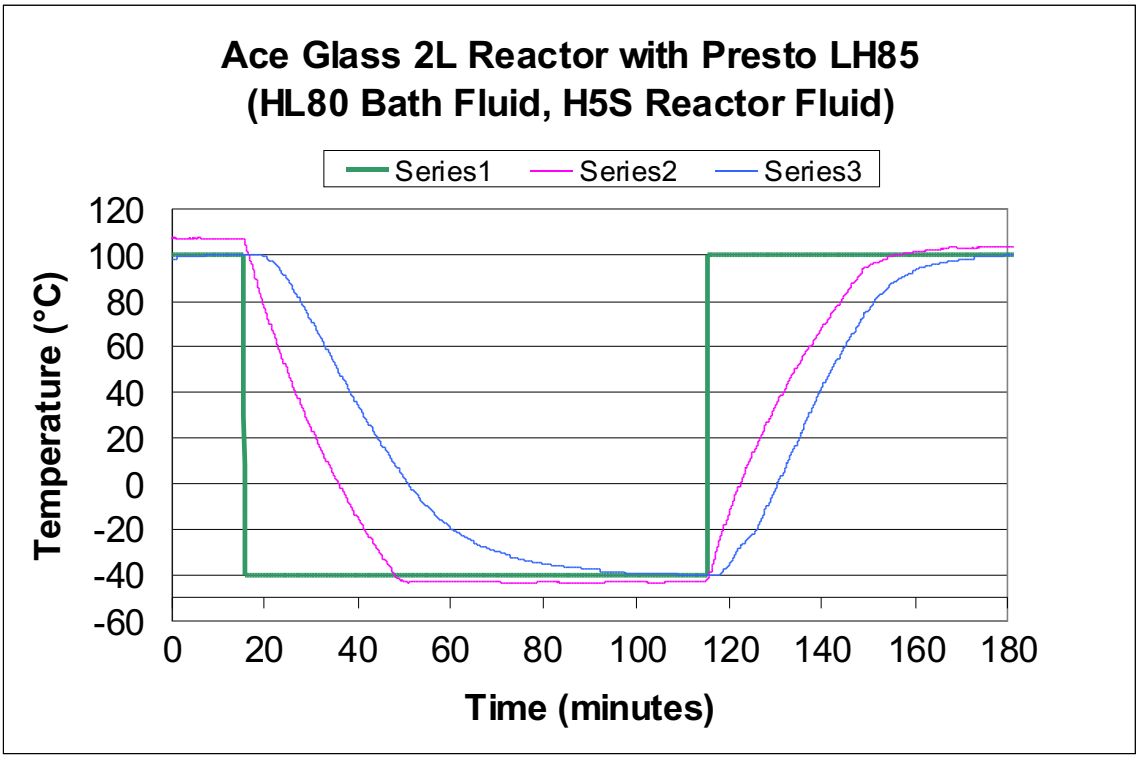


Figure 2: Ace Glass 2L Reactor with Presto LH85 (HL80 Bath Fluid, Ethanol Reactor Fluid)




Ace Glass 2L Reactor with Presto LH85
(HL80 Bath Fluid, H5S Reactor Fluid)
Series1
Series2
Series3
Temperature (°C)
120
100
80
60
40
20
0
-20
-40
-60
0
20
40
60
80
100
120
140
160
180
Time (minutes)