

Chemglass® 20L Reactor controlled with Julabo FPW91-SP

by Staff Engineer, Julabo USA, Inc.



The Objective:

To optimize the heat-up and cool-down time of a 20L jacketed glass reactor controlled by a Julabo FPW91-SP Ultralow circulator.



The Motivation:

Fast temperature control of a large lab-scale apparatus can significantly increase experimental cycles. Due to the limitation of glass reactors on rate of ΔT or lowest allowable temperature, it is advantageous to optimize another aspect of the system, namely the Julabo temperature controller.



The Solution:

To heat or cool more rapidly, control parameters must be optimized. This is easily performed by turning on the Julabo self-tuning Intelligent Cascade Control feature (ICC) that automatically generates new sets of PID parameters. Julabo's customer applications, ranging from glass reactors to thermal blocks, can depend on our self-tuning controller right out of the box!

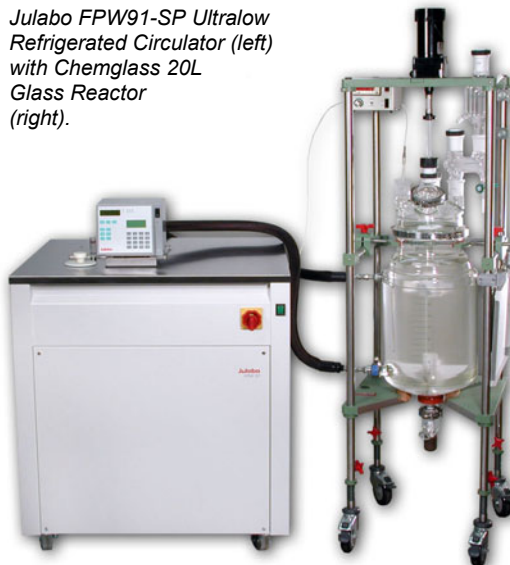
In the event of unique applications under unusual operating conditions, Julabo's technical support team can always offer further assistance, as outlined in the following pages.

Test Goal & Summary:

Run a temperature profile of the following setpoints & record the data:

- 1) +20°C
- 2) -50°C

Julabo FPW91-SP Ultralow Refrigerated Circulator (left) with Chemglass 20L Glass Reactor (right).



$X_p=0.2$, $T_n=1500$, $T_v=97$.

It took 120 minutes to cool from +20...-50°C and 145 minutes to heat from -50...+20°C. The table below summarizes the results before and after new PID parameters:

	Heat-up (min)	Cool-down (min)
Old PIDs	250	175
New PIDs	145	120

Ensure 'ID=Off' in the Configuration sub-menu. Record the PID parameters X_p , T_n , and T_v for this initial run. Then, a new set of parameters is produced and can be entered into the Julabo controller. Repeat the temperature profile of +20...-50 ...+20°C.

Note that a band limit of 50K (the difference between internal & external sensors) was imposed on the temperature controller due to the limitations of the glass reactor.

Test Results & Conclusion:

Figures 1(a) and (b) are the initial cool-down and heat-up curves made with the following unchanged PIDs:

$X_p=0.6$, $T_n=1965$, $T_v=97$.

It took 175 minutes to cool from +20...-50°C and 250 minutes to heat from -50...+20°C.

Figures 2(a) and (b) show an improved cool-down and heat-up performance after the following new PIDs were used:

The new parameters reduced the heat-up time by 105 minutes and the cool-down by 55 minutes. Therefore, the cycle time from +20...-50...+20°C was reduced by 2 hour and 40 minutes.

After the above testing using ethanol as bath fluid, the reactor & circulating medium were replaced with silicone oil. Figure 3 displays a heat-up and cool-down curve for temperatures above ambient (+20...+100...+20°C) using silicone oil. It took 180 minutes to heat the reactor to +100°C and 120 minutes to cool it down to +20°C.

In conclusion, optimized PIDs is the key to effective temperature control.



Actual test set-up with data acquisition in progress.

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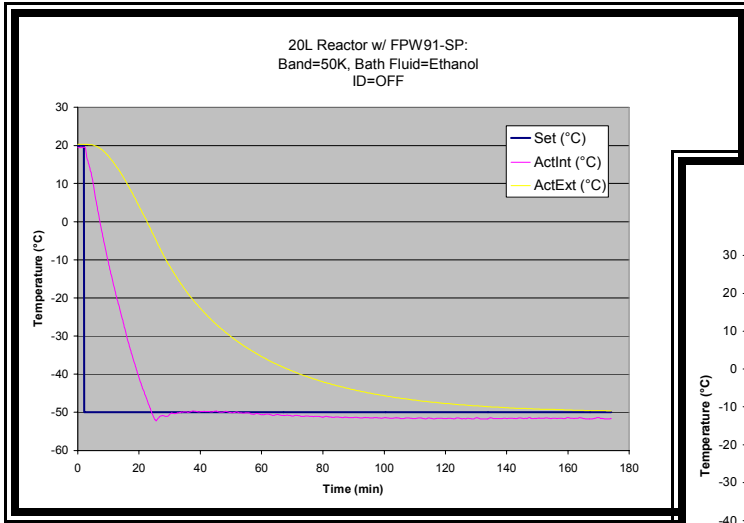


Figure 1(a): Initial Cool-down Curve, PIDs Not Optimized.
Set=Setpoint, ActInt=FPW91 Bath Temp, ActExt=Reactor Temp.

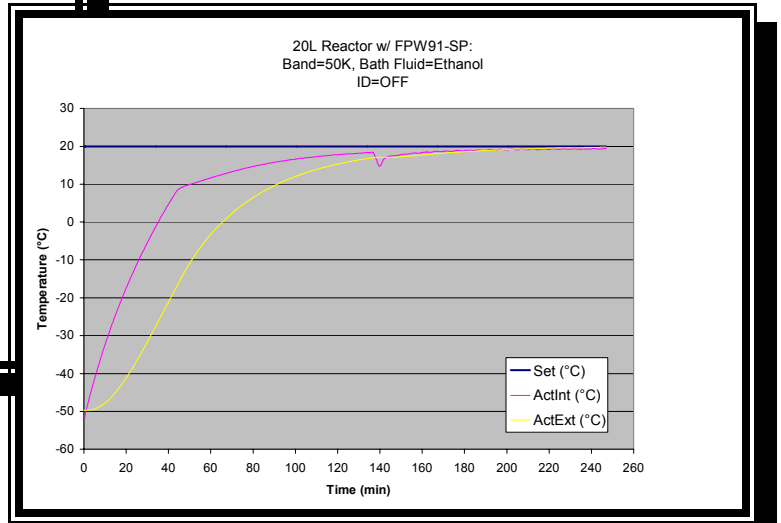


Figure 1(b): Initial Heat-up Curve, PIDs Not Optimized.

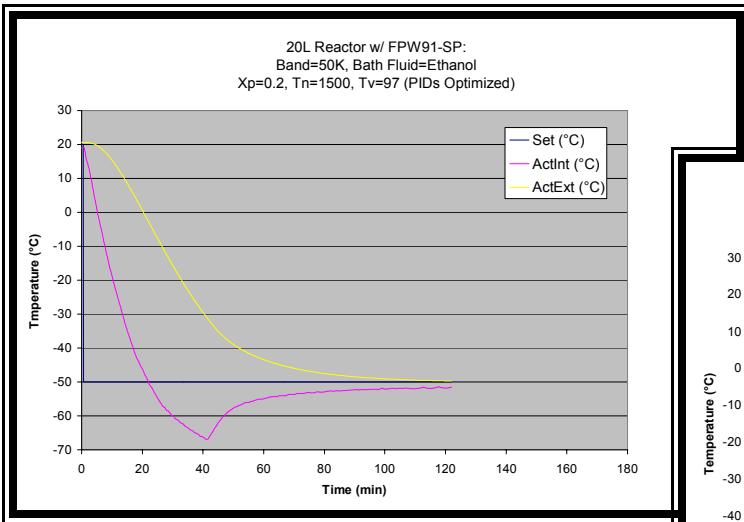


Figure 2(a): Cool-down Curve with Optimized PIDs.

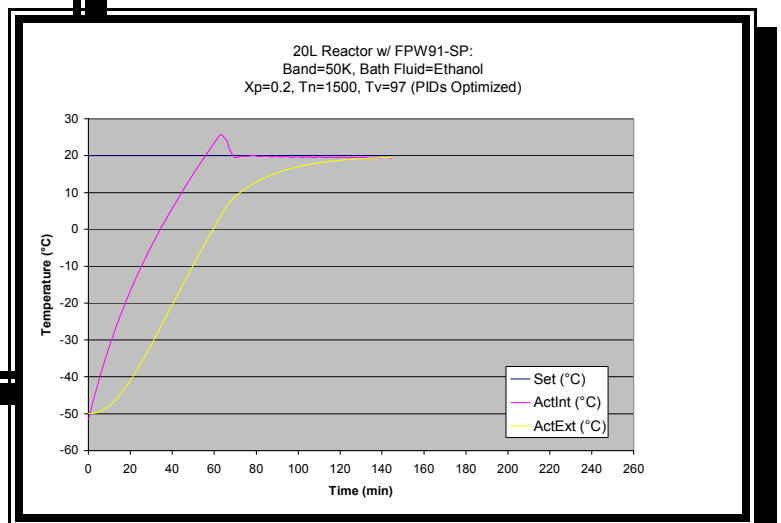


Figure 2(b): Heat-up Curve with Optimized PIDs.

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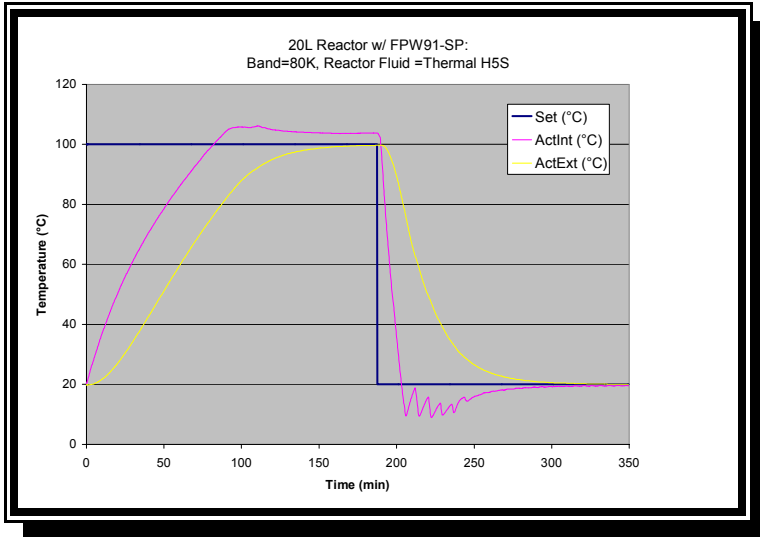


Figure 3: Heat-up Curve using Silicone Oil in Reactor (Thermal H5S), and Jacket (Thermal H10S) with New PIDs.