Unistat® tango

Temperature control of the process mass in the Radleys Reactor-Ready Duo

Requirement

The case study demonstrates the capabilities of the Unistat tango controlling the temperature of the process mass in the Radleys Reactor-Ready Duo.
Comprising of two 1l reactors, one glass jacketed the other vacuum insulated, we carried out a case study to demonstrate the abilities of the Unistat tango to control each reactor separately and then both together.

Method

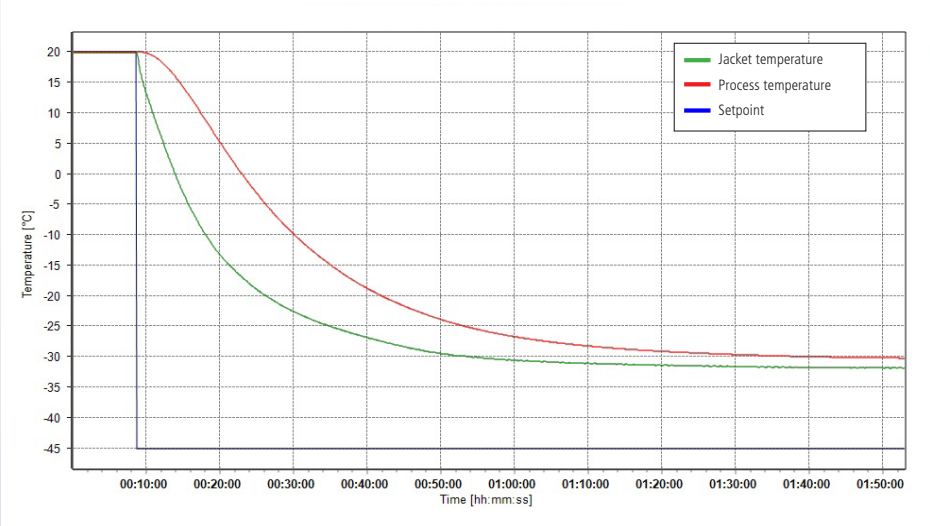
To achieve this, a manifold was used to split and /or isolate the flow of the heat transfer fluid (HTF) to each reactor.
It is important to note that a ball valve was used only on the inlet of each reactor to prevent the risk of thermal expansion destroying the reactor. By isolating only the inlet, any expansion / contraction of the HTF inside the jacket will be absorbed safely by the expansion tank on the Unistat tango.

Setup details

Temperature range:	-45 … +250°C
Cooling power:	0,7 kW @ 0°C 0,4 kW @ -20°C 0,6 kW @ -40°C
Heating power:	3,0 kW
Hoses:	6 x M16 metal Insulated
Manifild:	2 x 3-way manifold with 2 x ball valves on the outlet
HTF:	M60.115/200.05
Reactor:	1l glass jacketed, 1l glass vacuum insulated
Reactor content:	M20.195/235.20
Reactor stirrer speed:	130 rpm
Control:	Process
Amb. temperature:	+22°C

Results: Vacuum Insulated Reactor (1l)

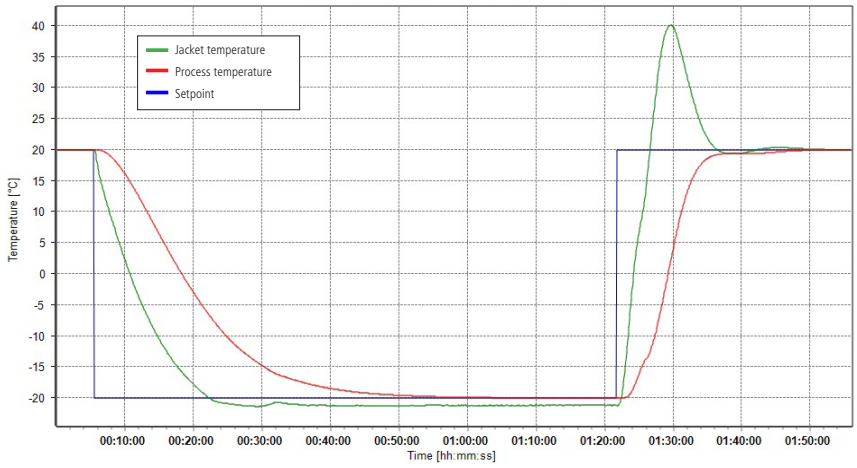
1. Lowest achievable temperature in the reaction mass:
The graphic below shows the minimum achievable temperature in the reaction mass to be -31,7°C



2. Performance:

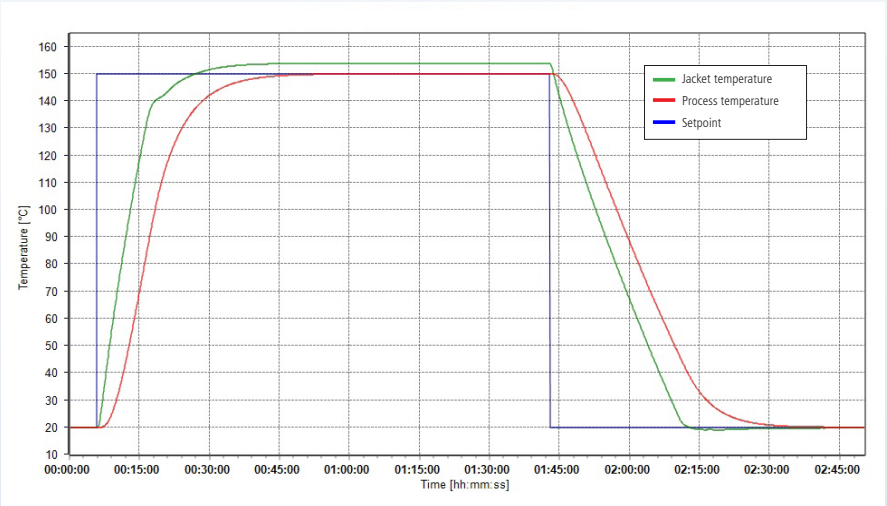
Temperature Control from +20°C to -20°C and back to +20°C

Start T	End T	Time taken	Av. Ramp Rate
+20°C	-20°C	49 minutes	0,8 K/Min
-20°C	+20°C	25 minutes	1,6 K/min



Temperature Control: from +20°C to +150°C and back to +20°C

Start T	End T	Time taken	Av. Ramp Rate
+20°C	+150°C	36 minutes	3,6 K/Min
+150°C	+20°C	43 minutes	3,0 K/min



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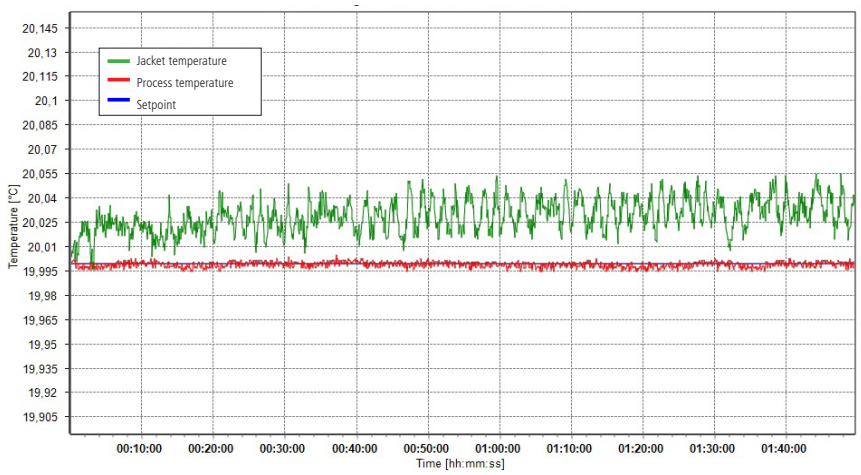
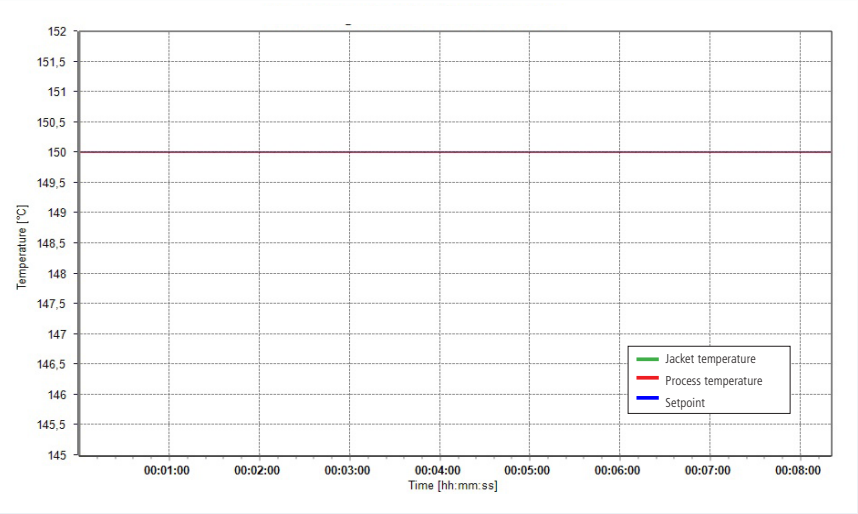
3. Stability

The graphic below shows that stability of the process mass at +20°C as being better than +/- 0.01K



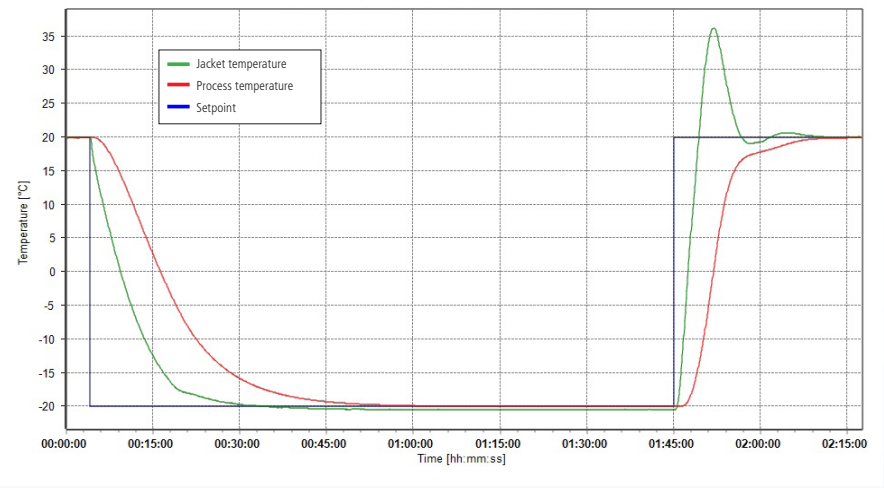
The graphic below shows the stability of the process mass at +150°C is +/- 0.03K



Results: Jacketed Uninsulated Reactor (1l)

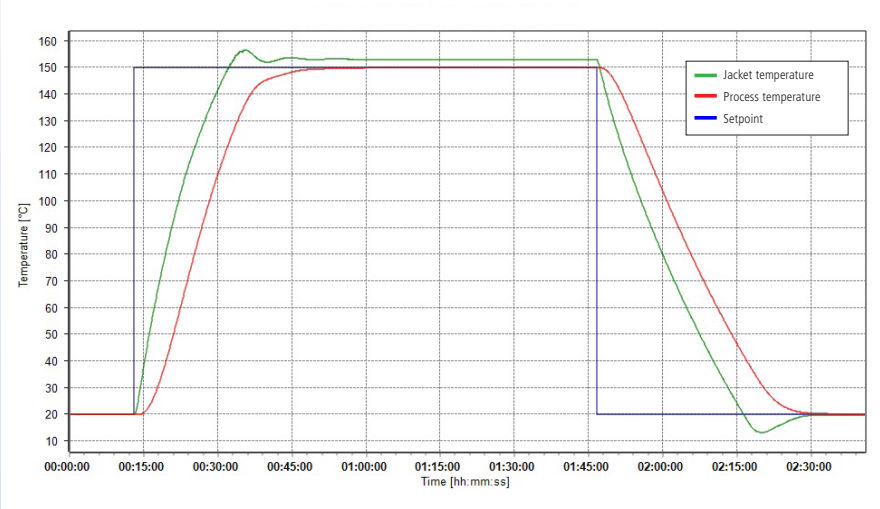
1. Performance:
Temperature Control from +20°C to -20°C and back to +20°C

Start T	End T	Time taken	Av. Ramp Rate
+20°C	-20°C	57 minutes	0,7 K/Min
-20°C	+20°C	24 minutes	1,7 K/min



Temperature Control: from +20°C to +150°C and back to +20°C

Start T	End T	Time taken	Av. Ramp Rate
+20°C	+150°C	37 minutes	3,5 K/Min
+150°C	+20°C	44 minutes	3,0 K/min



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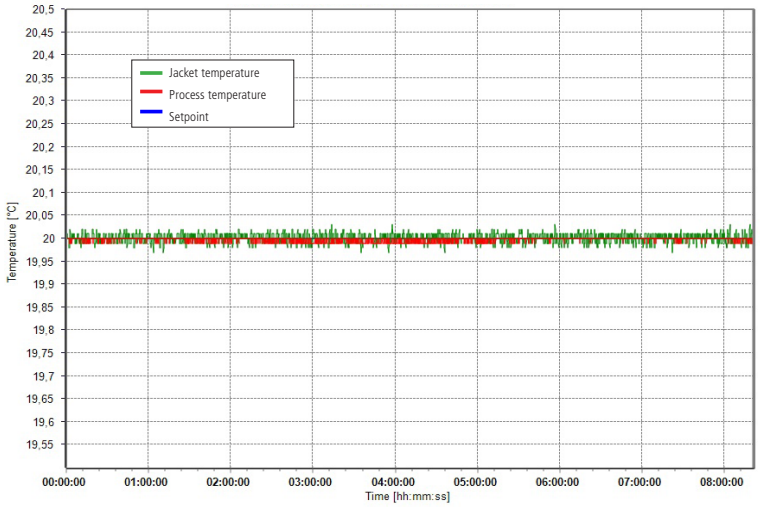
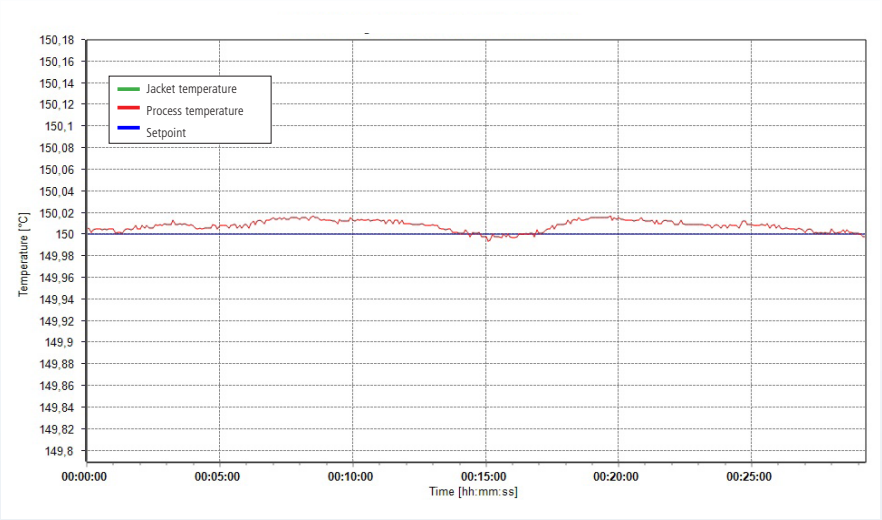
2. Stability

The graphic below shows that stability of the process mass at +20°C as being better than +/- 0,005K



The graphic below shows the stability of the process mass at +150°C is +/- 0,02K

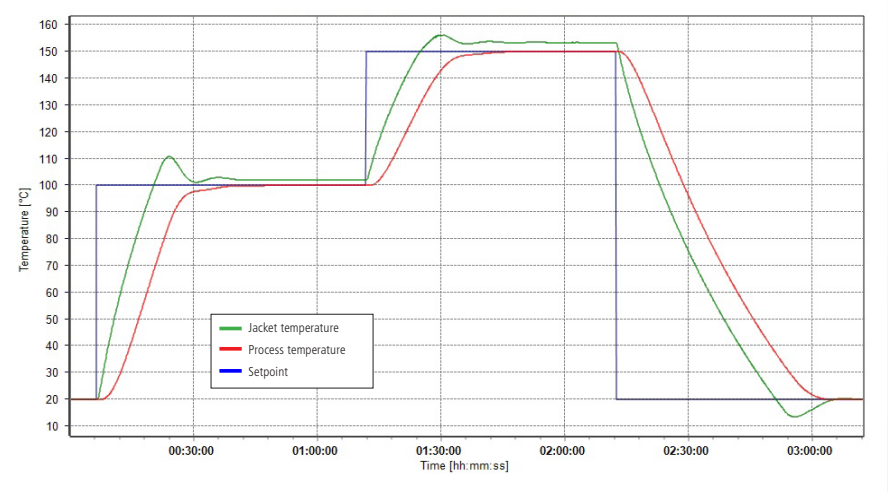


Results: Both Reactors Operated Simultaneously

1. Performance:
Temperature Control from +20°C to +100°C, then to +150°C and back to +20°C

The graphic below shows the performance as the Unistat tango heats both reactors from +20°C to +100°C then to +150°C and back to +20°C.
The purpose of this test was to demonstrate the effect and the difference in temperature between the process mass in each reactor.
Both ball valves from the manifold were opened to circulate HTF through the jackets of the "control" reactor (the jacketed uninsulated reactor) and to the vacuum insulated reactor (the "passive" reactor).
Under Process Control with the Pt100 sensor located in the reaction mass of the 1l jacketed "control" reactor, a set-point of +100°C was entered into the Pilot One Controller.
Once the "control" reactor was stable at +100°C, a period of 30-minutes passed to give the "passive" reactor time to stabilise before the temperature in the reaction mass of each reactor was recorded.
The process was repeated at a set-point of +150°C.

Start T	End T	Time taken	Av. Ramp Rate
+20°C	+100°C	30 minutes	2,7 K/Min
+100°C	+150°C	30 minutes	1,7 K/min
+150°C	+20°C	51 minutes	2,5 K/min



2. Process Mass Temperature Comparison:

Set-Point	Uninsulated reactor "Control"	Vacuum Insulated Reactor "Passive"
+100°C	+100°C	+95,8°C
+150°C	+150°C	+145,1°C

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