SnowStorm Reactor Report

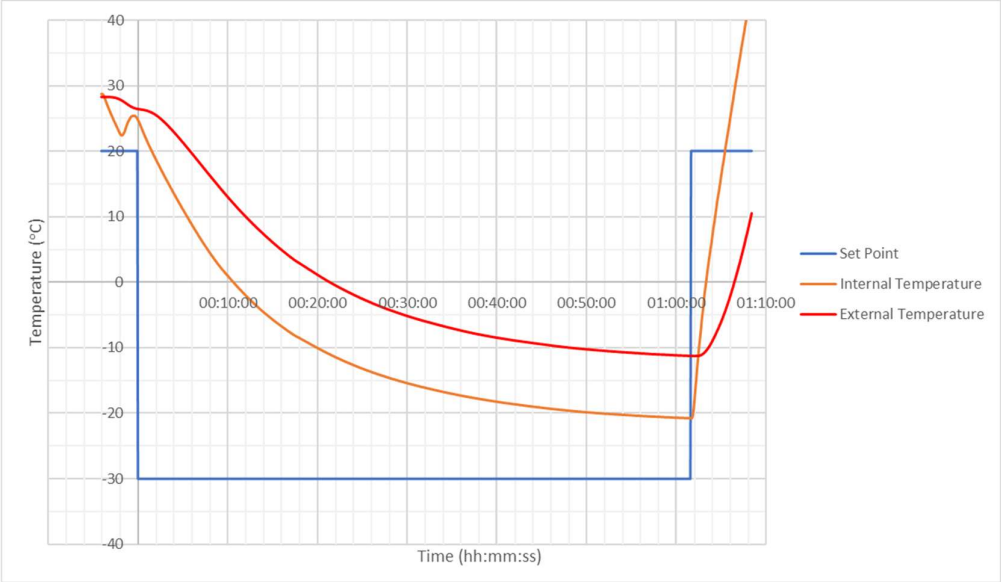
With the Julabo MAGIO 450F.

The SnowStorm Reactor is a cooling block designed for use with temperature control units (TCUs) to maintain constant ambient or low temperatures. The lowest temperature the SnowStorm Reactor is highly dependent on the TCU used, and other factors. Several set-ups were tested with the Julabo MAGIO 450F to investigate the impact of these factors on the performance of the SnowStorm Reactor.

The initial temperature was set to 20 °C, before changing the set point to -30 °C. This was later documented as time 00:00:00 (hh:mm:ss), although initial temperatures of the flask contents varied between experiments. A 100 mL flask was filled with 50 mL silicon oil, with no stirring, and temperature coupling was directly in the silicon oil. The MAGIO settings were set to prioritise cooling/heating speed over reducing overshoot.

The first experiment was to evaluate the cooling speed of the SnowStorm Reactor with the MAGIO on its own.

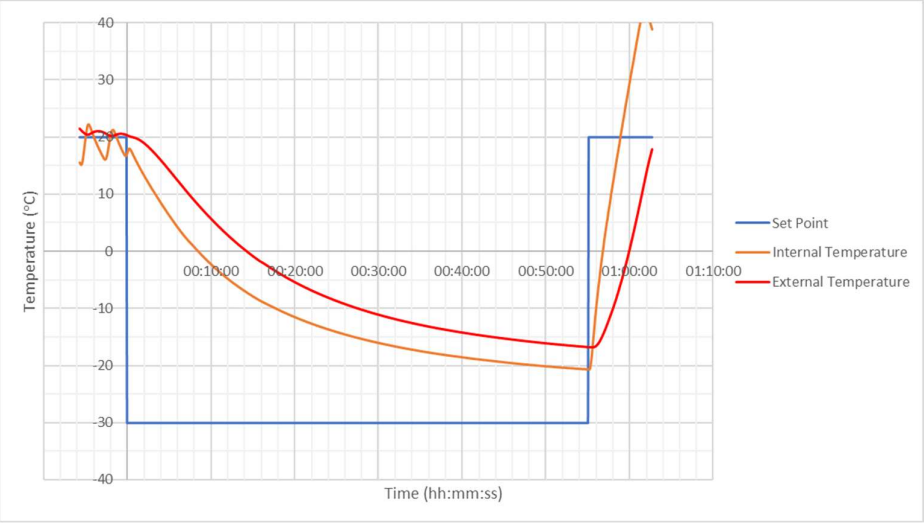
Figure 1: The cooling rate of 50 mL silicon oil over time using the SnowStorm Reactor and Julabo MAGIO 450F.



As shown in Figure 1, the starting temperature of the solution was 26.4 °C. The flask contents reached -10 °C at 00:48:25, and at 00:55:00, the temperature of the silicon oil within the flask was -10.74 °C. Although the temperature was still decreasing past 1:00:00, the rate of decrease was significanty reduced.

The second experiment was to evaluate the cooling speed of the SnowStorm Reactor in combination with the glass dome. The additional barrier between the flask contents being cooled, and the atmosphere should reduce the amount of ambient heat being transferred into the cooling oil, thereby increasing the cooling efficiency. This was carried out without nitrogen purging of the glass dome.

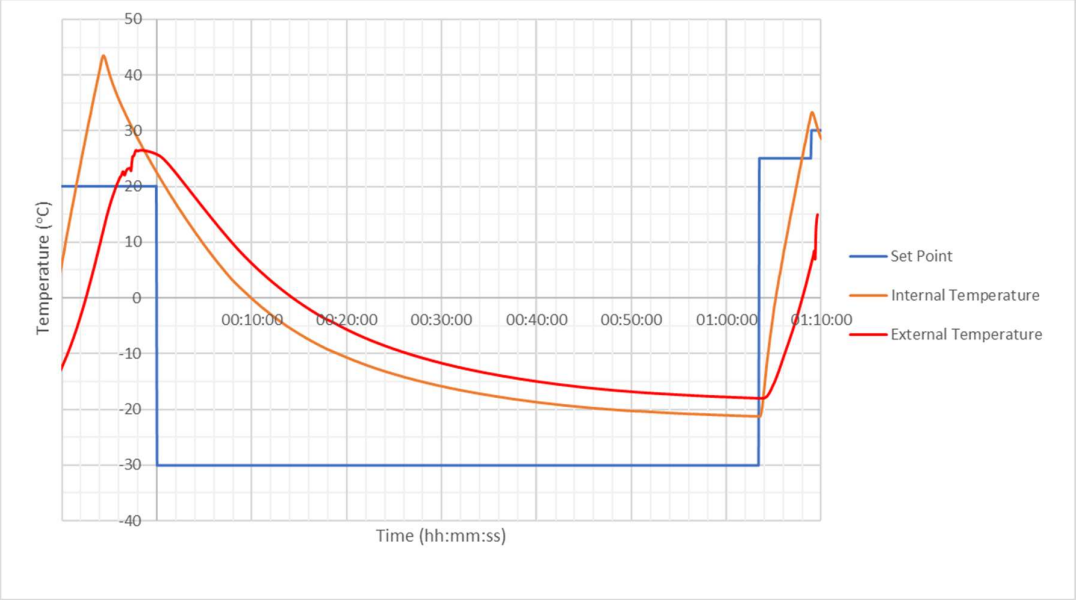
Figure 2: The cooling rate of 50 mL silicon oil over time using the SnowStorm Reactor with the glass dome and Julabo MAGIO 450F.



As shown in Figure 2, the starting temperature of the solution was 20.31 °C. The flask contents reached -10 °C at 00:27:35, and at 00:55:00, the temperature of the silicon oil within the flask was -16.76. This showed a reduced difference in temperature between the internal silicon oil of the MAGIO 450F and the external flask contents.

The third experiment was to evaluate the SnowStorm Reactor and glass dome set up, plus some additional silicon oil between the DrySyn insert and the 100 mL flask. This is meant to increase the contact area between the surfaces, supposedly increasing the heat transfer efficiency.

Figure 3: The cooling rate of 50 mL silicon oil over time using the SnowStorm Reactor with the glass dome, silicon oil insert lubricant and Julabo MAGIO 450F.



As shown in Figure 3, the starting temperature of the solution was 25.68 °C. The flask contents reached -10 °C at 00:26:25, and at 00:55:00, the temperature of the silicon oil within the flask was -17.4. This showed an improved rate of cooling against the SnowStorm Reactor both with and without the glass dome.

The times taken to reach 0, -5, -10, and -15 where applicable were compiled into Table 1. This shows that the time to reach -10 °C from 0 °C was consecutively lower for each experiment. Whilst this took 27 min for first test, this only took 00:13:15 for the second, and 00:12:05for the third. This shows that both the glass dome and silicon oil within the inserts decrease the time taken for the SnowStorm Reactor to reach low temperatures.

Table 1: Comparative times taken to reach the temperatures 0, -5, -10, and -15 °C when the set point was -30 °C.

Temperature °C	Test 1	Cumulative difference °C	Test 2	Cumulative difference °C	Test 3	Cumulative difference °C
0	00:21:25	-	00:14:20	-	00:14:20	-
-5	00:29:45	00:08:20	00:19:35	00:05:15	00:19:15	00:04:55
-10	00:48:25	00:27:00	00:27:35	00:13:15	00:26:25	00:12:05
-15	-	-	00:43:40	00:29:20	00:40:00	00:25:40

The efficiency of the SnowStorm Reactor with the MAGIO 450F can be seen by the difference between the internal temperature, that of the silicon oil within the MAGIO 450F, and the external temperature, that of the silicon oil being cooled within the flask. This demonstrates how effective the heat transfer is. The information in Table 2 shows that the difference decreases by adding both the glass dome and the silicon oil in the insert. This means that there is less wasted energy when using the SnowStorm Reacor with the glass dome and/or silicon oil against the flask.

Table 2: The external temperature of the flask contents against the internal temperature of the MAGIO 450F silicon oil.

External Temperature °C	Test 1 Internal Temperature °C	Temperature difference °C	Test 2 Internal Temperature °C	Temperature difference °C	Test 3 Internal Temperature °C	Temperature difference °C
0	-11.02	-11.02	-7.28	-7.28	-5.76	-5.76
-5	-15.29	-10.29	-11.29	-6.29	-10.14	-5.14
-10	-19.63	-9.63	-15.21	-5.21	-14.35	-4.35
-15			-19.24	-4.24	-18.77	-3.77

Therefore, the SnowStorm Reactor is capable of reaching -10 °C from room temperature within 1 hour. With the glass dome, the performance is improved further allowing temperatures as low as -15 °C within the hour. Alternatively, the glass dome enables cooling to -10 °C within 30 minutes. The addition of silicon oil within the DrySyn insert also increases the cooling efficiency by increasing the surface contact and enables quicker cooling times.