

Rapid Screening Device - RSD™

Technical Application Note 15

Cryogenic Operation of the RSD

Sodium Chloride Solutions



Introduction

The Cryogenic option for the RSD was tested with a simple sample series; water and Sodium Chloride (salt) solutions.

Using the cryogenic option the system was cooled to -120°C and then with the flow of liquid nitrogen cooled nitrogen gas maintained was heated at 1°C/min from a control temperature of -110°C. 1.0 +/- 0.05g of sample was used in glass vials. Pressure was not connected or measured.



The samples were: water, sodium chloride solutions at 20 gm/l, 100 gm/ml and 350 gm/ml (saturated solution). In addition an empty vial was used and the air temperature recorded from this 'sample'.

The data is illustrated in figures copied directly from the RSD data analysis software RSD-RAP. The data analysis channels 1-5 are respectively the samples listed above and are color coded: dark blue, red, green, light blue, yellow. It should be noted that the position of the sample in the sample holder relative to air circulation that is the heating mechanism will give small variations in temperature sample-to-sample. This is not discussed here.

Figure 1 shows the overall Temperature – Time profile for the five channels

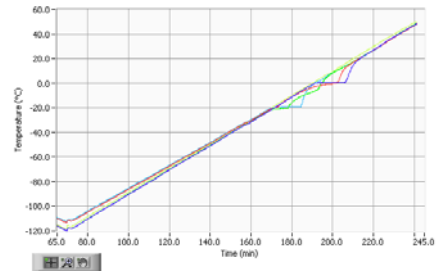


Figure 1

The sample melting profiles are clearly seen. For example with water there is melting at 0°C and this continues holding the temperature at 0°C for several minutes (almost 20 minutes) until it is assumed the entire sample has melted. Subsequently the temperature of the liquid water heats to the ramp temperature. A similar pattern is seen for the other samples.

Figure 2 shows a zoom of the data around the melting region

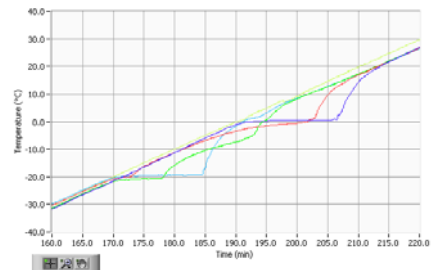


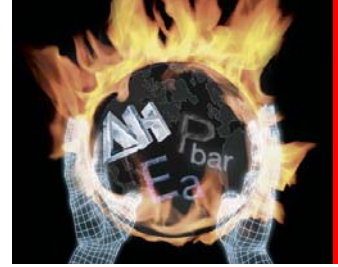
Figure 2

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Figures 3 and 4 show the system in heat-up with the samples in the solid state and in the liquid state. After melting (Figure 3) there is little difference between all three liquids – and these are at a lower temperature than the air 'sample'.

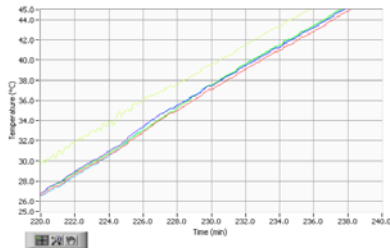


Figure 3

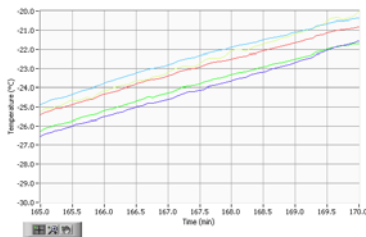


Figure 4

The onset of the melting of water is shown in Figure 5. The water used was not purified. This may explain the lead-in that can be seen from -1°C.

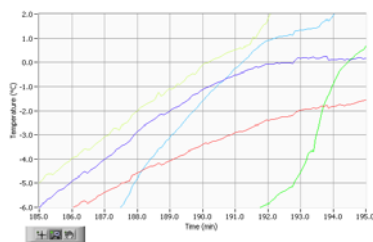


Figure 5

Figure 6 shows the onset of melting of the samples that are saturated and contain 100 gm/l sample. The saturated sample melts at -2 and the gm/l melts at -21°C and -19.5°C. In addition it appears that this melting has caused a small effect on the adjacent sample with 20 gm/l. The melting of a saturated salt solution is given as -21.1°C in the scientific literature. onset of a large sample mass and significant air flow. There is no ignition of the sample.

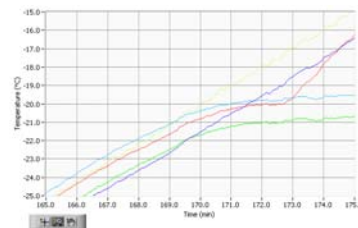


Figure 6

The sample with 20 gm/l shows a broader melting temperature range, the reason for this is unclear. The onset is seen in Figure 7, the full melting profile is shown in Figure 2.

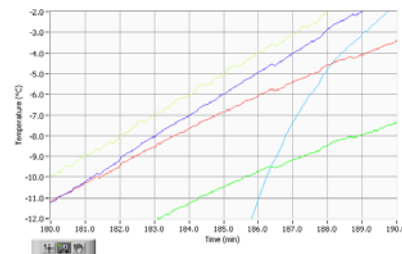


Figure 7

This document aims to show broadly the RSD operating at cryogenic temperatures. Further analysis or discussion is not presented here. Such work makes a nice and simple experiment to measure Colligative Properties – there are many web reported experiments and discussion on result calculation, see for example <http://chemweb.calpoly.edu/chem/125/125LabExp/FPDepression/>