

Testing for frost formation in exhaust pipes when releasing safetyvalve.

The goal for the test is to show if there is any tendency to blocking or buildup of CO₂ frost formations during release of 60 bar pressure relief valve.

Setup

Safetyvalve type = Nuova 60 bar

Capacity = 4776 kg/h

Receiver volume = 130L

Receiver surface area = 2,0m²

The receiver is loaded with 20 kW heat (corresponding to an ambient of open fire = 10 kW/m²) by means of heated water circulating in the internal coil.

The output from the safetyvalve is connected to the header via 1.8 meter x ø36mm hose.

Discharge pipe lines from header to ambient via 11 meter x ø40mm pipe with 9 bends (elbows).

Discharge pipe is transparent for visualization.

Observations:

At the test the safety valve blows 10 kg CO₂ within 30 seconds, corresponding to 1200 kg/h (=47kW)

The released gas contains as expected some amount of snow. This is the thermodynamic consequence when expanding 60bar gas through a safetyvalve, where the expansion develops a volumenfraction of the snow of 0,1%. The massfraction of snow is 7%.

The very high velocity of the gas flow seems to eliminate the possible buildup of snow in the system, and hence the snow does not block the pipes or fittings.

The flexible hoses get very cold during the release, but do not get fragile.

The following figures show the setup.

The video "Release of 60 bar safetyvalve" shows the situation during the release.

The video "Pipe inspection" shows the empty transparent pipe, just after the release.

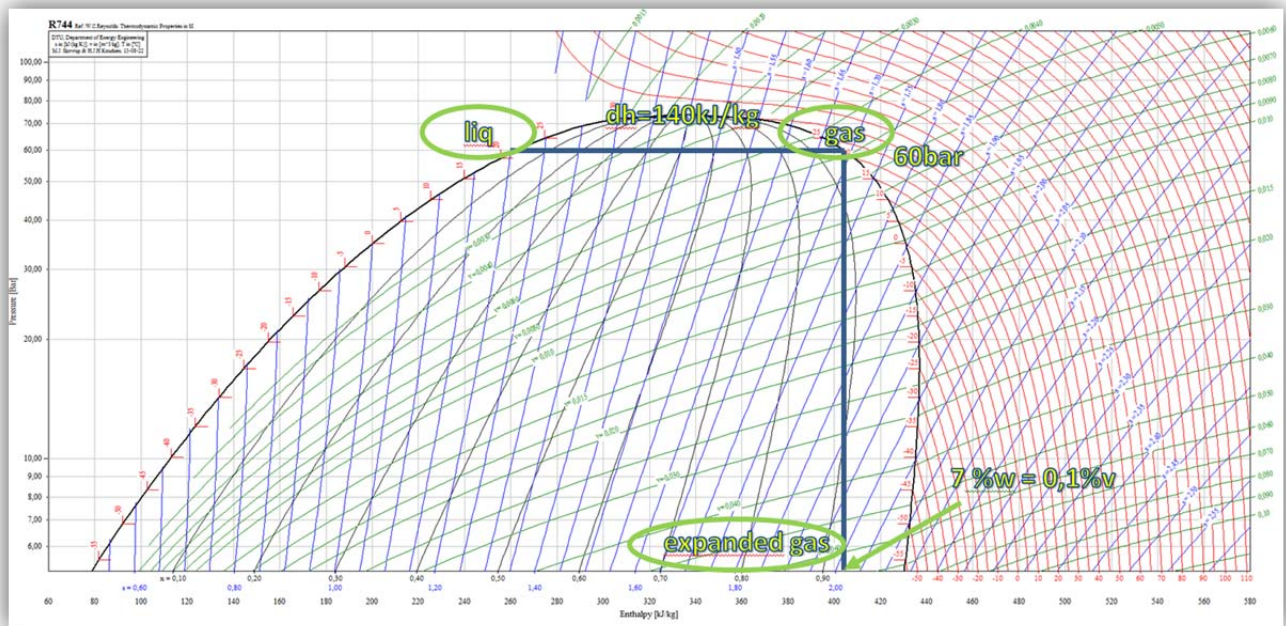


Figure 1: States of CO2 during heating and expansion.
 Heating process: transfer from "liq" to "gas" phase.
 Expanding process: transfer from "gas" to "expanded gas" phase.

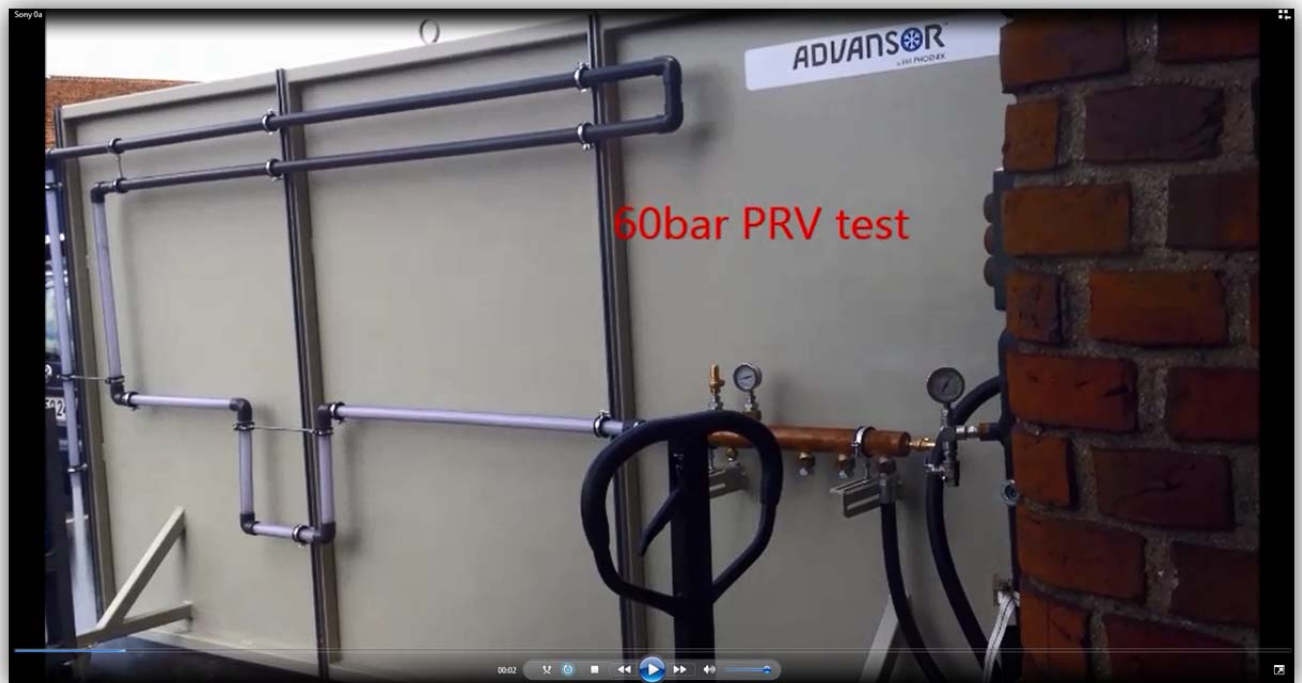


Figure 2: Picture of flow through pipe during PRV release.



Figure 3: No trace of stocked frost formation in the pipes after relief of PRV.



Figure 4: Hose is still flexible after relief of PRV and not fragile.