TSu & TSu+

Thermal Hazard Screening



TSu Thermal screening unit

TSu+ Thermal screening unit + Vent Characterization Unit

Fast, reliable and cost-effective.
Identify explosion hazards rapidly.

TSu and TSu+ at a Glance

TSu

TSu+





TSu classic assembly

Vent Characterization Unit

TSu — Thermal screening

TSu+ — Thermal screening → Vent characterization

What each unit measures

What each unit measures	TSu	TSu+
Runaway onset temperature	●	●
Sample temperature profile and max T	●	●
Pressure profile and max p	●	●
Temperature and pressure increase rates (dT/dt, dp/dt)	●	●
Residual pressure after cool down	●	●
Sample tempering temperature at different pressures	○	●
Presence of foam during venting	○	●
Flow regime detection test	○	●

Key ranges

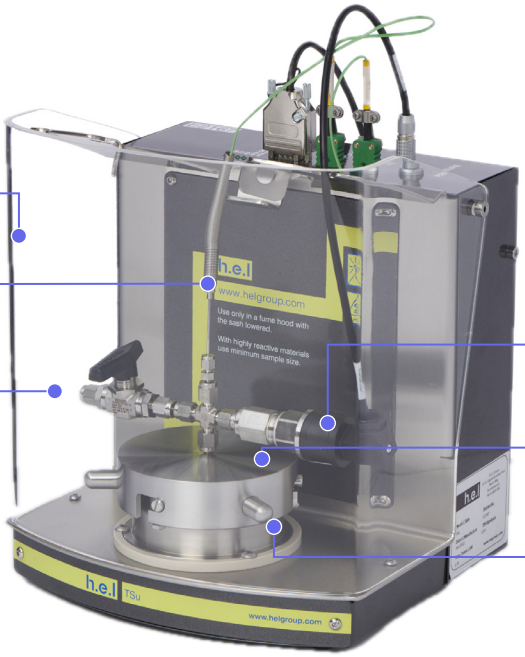
	TSu	TSu+
Thermal screening ambient–500 °C · to 200 bar (abs) · 0.5–10 mL sample	●	●
Vent characterization ambient–250 °C · to 100 bar (abs) · 300 mL vessel	○	●

Thermal Screening Unit

The TSu is a proven screening tool for solid and liquid chemical compounds. It detects the onset temperature of exothermic reactions and then records the runaway temperature and pressure hazard.



Metal spherical cells





Glass cell
For highly reactive or corrosive samples

Flexible sample size

Supports sample sizes from <0.5 g to >2 g, enabling representative testing even for non-homogeneous materials or reaction intermediates.

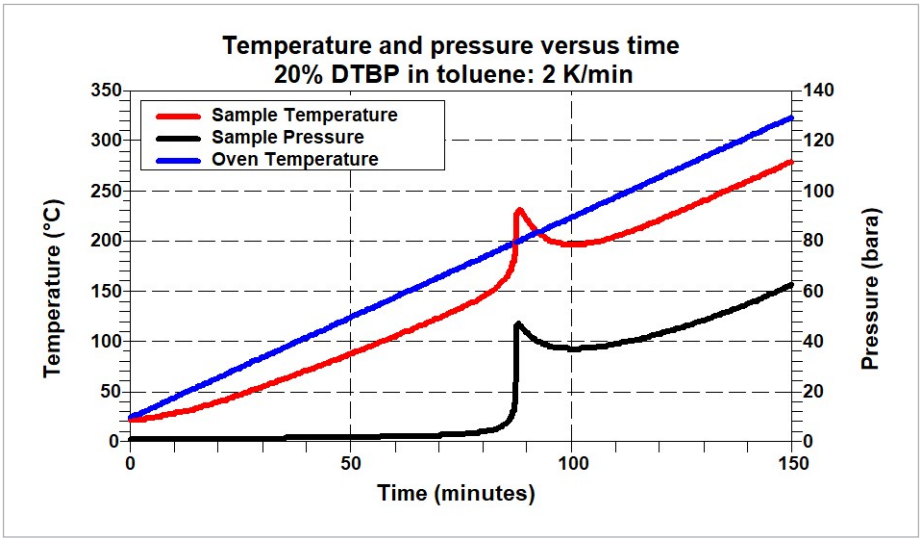
Reliable identification of runaway onset temperature

Onset temperatures measured with the TSu are consistent with data from advanced adiabatic calorimeters.

Explosion pressure hazard fully quantified

The rate of pressure rise and maximum pressure provide a direct indication of explosion risk.

Typical TSu test: sample temperature, oven temperature and pressure.

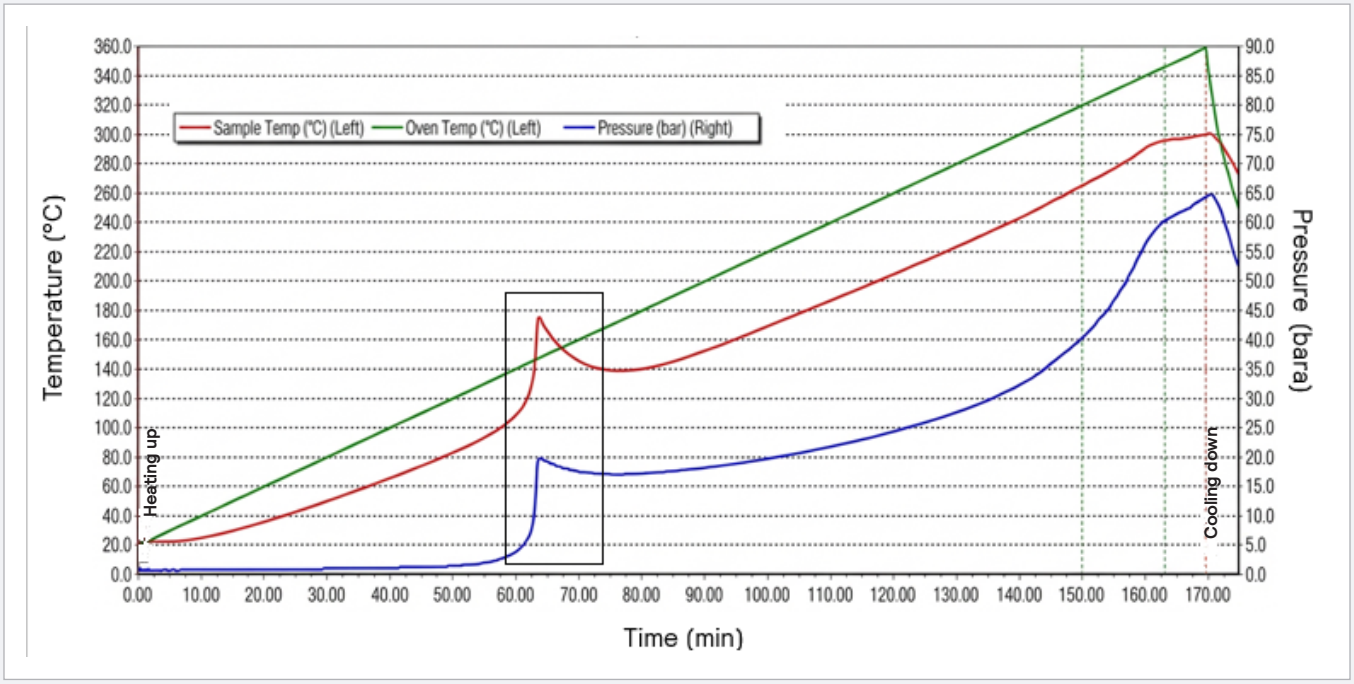


Typical TSu Data

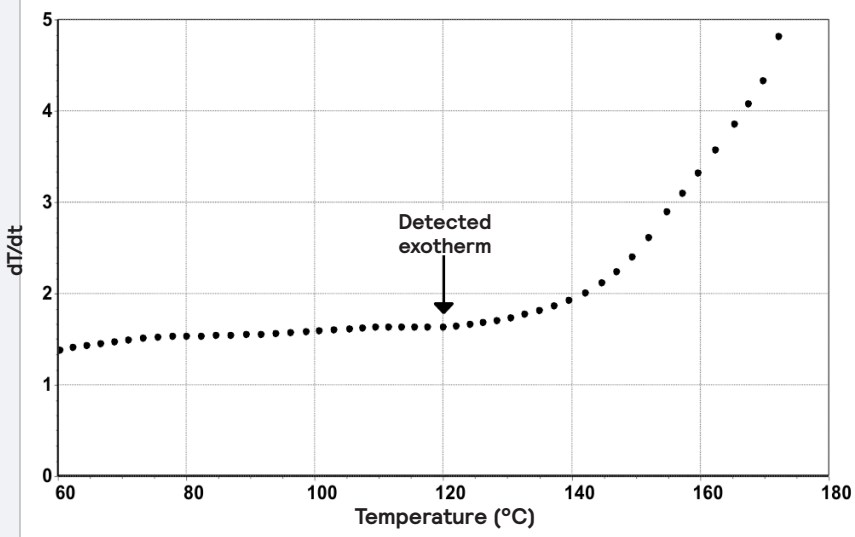
Exotherm Onset and Pressure

Though the test data spans nearly 3 hours, the region of most interest only takes ~15 minutes, indicated by the box. The exotherm onset is likely to be in this region as well as the incident severity, indicated by the maximum pressure and temperature and their respective rates.

Temperature and pressure recorded throughout the test.



Expanded view of the exotherm onset region.



Raw Data Elaboration

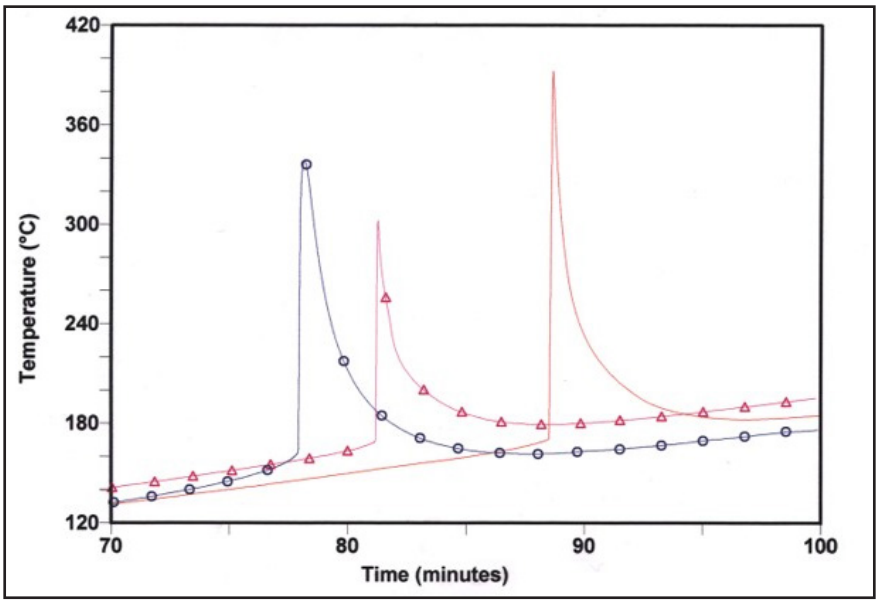
This shows an expansion of the exotherm onset region mentioned above, showing the exotherm onset temperature more clearly.

Automated routines were used to calculate second-order derivatives of temperature and pressure, enabling a sensitive determination of runaway onset temperature.

Comparing Similar Chemicals

The ease of use and speed of testing with the TSu, then data analysis, allows tests of similar chemicals to be done and compared easily. These results, for example, reveal differences in exotherm onset and in peak temperature between the samples.

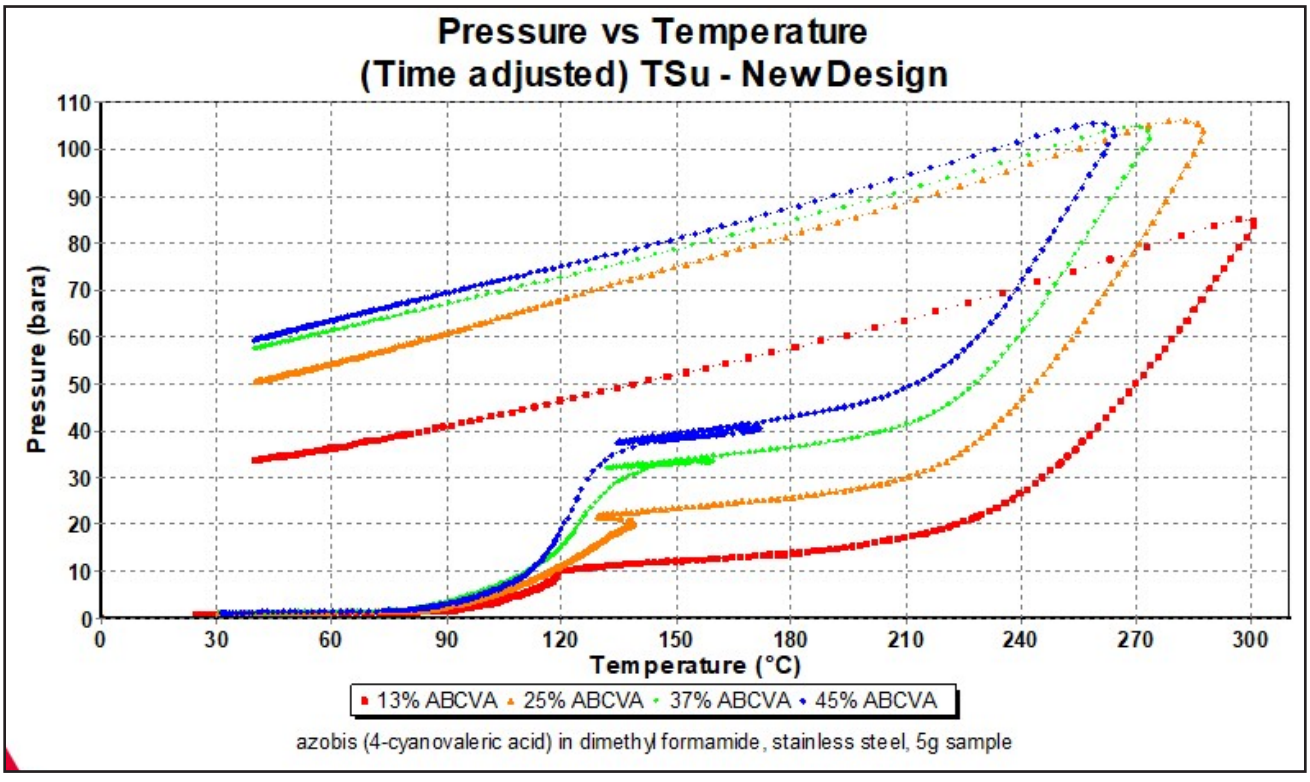
Thermal screening of a series of nitrocellulose dyes, heat rate 2 °C/min.



Effect of Concentration

Same chemical now, but at different concentrations, where pressure as a function of temperature is plotted. Very different features are revealed at different temperatures, but all leading to very high pressure. After the reaction is finished, the sample cool down is plotted, revealing pressures of 30 to 60 bar even at room temperature, almost certainly showing significant product decomposition.

Azobis (4-cyanovaleric acid) in dimethyl formamide: pressure vs temperature.



TSu+: Two Instruments in One

Screening station plus Vent Characterization Unit



If thermal screening indicates a potential hazard, assess safety vent performance to understand the key parameters influencing vent design and potential environmental impact.

Vent Sizing Using DIERS Methodology

Before sizing a vent, the properties of the discharged fluid must be assessed. DIERS (Design Institute for Emergency Relief Systems) established that the fluid type—either gas only or a two-phase gas–liquid mixture—determines the appropriate sizing method and required vent area.

The calculation also depends on the main cause of the pressure rise, typically non-condensable gas generated by liquid decomposition or vapor pressure from the reaction liquid.

Testing using the Vent Characterization Unit allows correct identification of the vented fluid properties needed, and supports selection of the correct vent-sizing method.

Vent Size Calculation

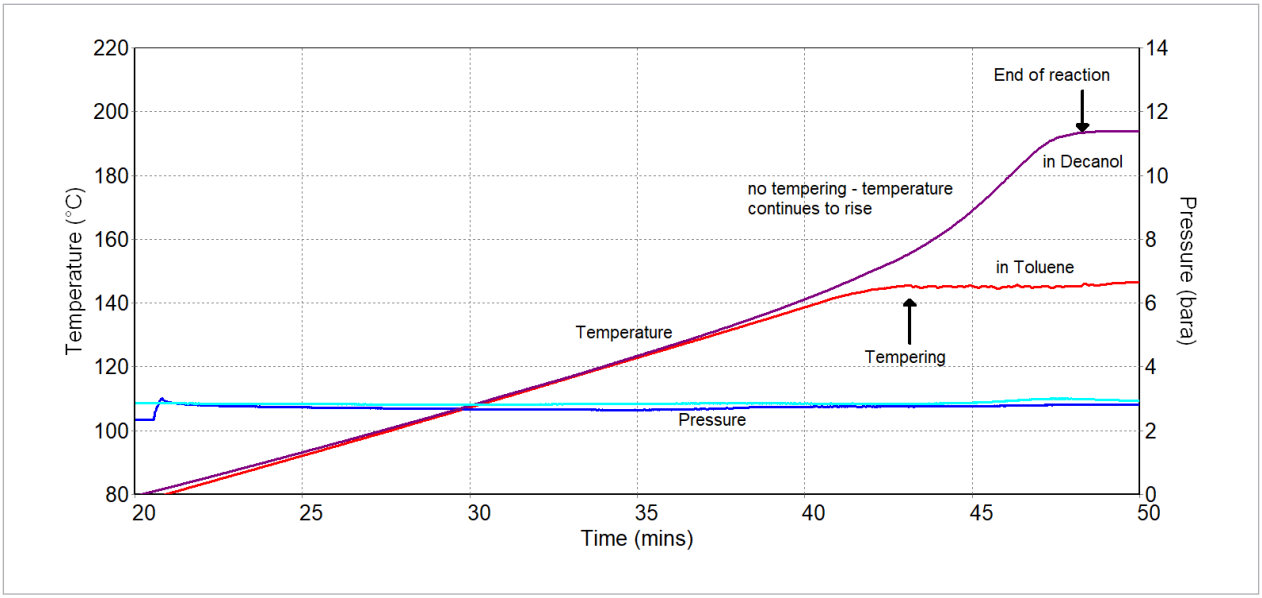
Vent sizing using DIERS methodology is typically done as follows:

- Analytical equations based on DIERS methodology
- Computer modeling based on DIERS methodology.

In all these calculation methods, vent phase data from the Vent Characterization Unit, similar to the Vapor or Foamy Phase Data shown opposite, is needed. This determines which calculation method is relevant.

Data from the TSu+ is not adiabatic and therefore cannot be used directly in the DIERS calculations.

Causes of Pressure Rise



The same reaction in toluene (tempering) and decanol (no tempering).

Determine what governs the pressure rise rate: liquid boiling or the rate of non-condensable gas generation. The answer decides the vent sizing method.

Data above shows both types of behavior, caused just by differences in solvent, which will lead to totally different vent sizes.

Vapor or Foamy Phase Data

Identify the nature of vented material: two-phase foam or single-phase fluid. The two photographs show a test cell venting a foamy fluid mixture, ultimately emptying the vessel. The result directly affects the vent size needed when scaling up, and the environmental impact.



During venting | After venting (near empty)

Foamy fluid data from the Vent Characterization Unit

Specifications

Parameter	TSu	TSu+
Test stations	Thermal screening station	Thermal screening station plus open-cell Vent Characterization Unit, on one base inside one protective enclosure
Direct measurement	Sample temperature and pressure, oven temperature	
Key data	Runaway onset temperature; sample temperature profile and max T; dT/dt and d^2T/dt^2; pressure profile and max p; dp/dt and d^2p/dt^2; residual pressure after cool down	As TSu, plus: Sample tempering temperature at different pressures Presence of foam during venting
Test cell construction materials	Stainless steel, Hastelloy, glass, titanium	
Sample volume	Typically from 0.5 to 10 mL	
Testing chamber	Stainless steel containment vessel with integral oven	TSu containment vessel with integral oven, plus 300 mL stainless steel pressure vessel with flexible heater
Temperature range	From ambient to 500 °C	TSu: from ambient to 500 °C Vent characterization: from ambient to 250 °C
Pressure range	From ambient to 200 bar (absolute)	TSu: from ambient to 200 bar (absolute) Vent characterization: from ambient to 100 bar (absolute)
Test operating modes	Ramp, isothermal, dual ramp, combination, custom profiles	As TSu, plus: variable pressure, open cell test, flow regime detection test
Software included	WinISO equipment control and data logging software; iQ data analysis and plotting software	
Data formats	.dat (proprietary) and .csv	
Dimensions (W × H × D)	24 × 28 × 23 cm	45 × 26 × 18 cm

Rows spanning both columns are common to the TSu and TSu+.

Test Cell Options

Test cell (packs of 5 unless marked single)	1/8" feed tube	1/4" feed tube
Stainless steel, standard	HEL032208	HEL028027
Stainless steel, side thermowell	HEL028032	HEL032204
Hastelloy, standard	HEL028028	HEL028029
Hastelloy, side thermowell	HEL032206	HEL032207
Titanium, standard	HEL017791 (single)	HEL032226
Titanium, side thermowell	–	HEL022649 (single)
Glass, side thermowell	HEL032209	HEL032210

Anti-reflux inserts for cells with 1/4" feed tube

Insert	Part number
Stainless steel (pack of 5)	HEL028131
Hastelloy (pack of 5)	HEL032211
Titanium (single)	HEL021002

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