WHAT IS THERMAL RUNAWAY? WHY DSC ALONE ISN'T ENOUGH

What is Thermal Runaway?

Thermal runaway is a self-accelerating, uncontrolled exothermic reaction. It occurs when the heat generated by a chemical reaction exceeds the system's ability to remove (cooling capacity) it. As temperature rises, reaction rates increase, which in turn generates more heat—creating a **positive feedback loop** that (can lead to decomposition which in turn can lead to) fire, explosion, or toxic gas release.

Common causes include:

- Uncontrolled exothermic reactions
- Poor mixing or cooling
- Impurities or catalyst residue
- Scale-up without proper thermal analysis

What DSC Tells You?

Differential Scanning Calorimetry (DSC) measures heat flow in or out of a sample as it is heated, cooled, or held isothermally. It helps detect:

- Onset temperature of decomposition
- Heat of reaction (enthalpy)
- Melting point and glass transition
- Crystallization behaviour

DSC is excellent for initial screening, especially for small sample sizes under controlled conditions. It alerts you to the presence of exothermic behaviour and provides early warnings.

Why DSC Alone Isn't Enough

While DSC gives useful thermal fingerprints, it doesn't replicate real-world conditions such as:

- Pressure buildup inside a sealed reactor or vessel
- Large-scale heat accumulation
- Runaway kinetics under adiabatic conditions

That's where advanced calorimetric techniques come in.

Complementary Testing: RC1, ARC

At GVS Cibatech, we combine DSC data with Reaction Calorimetry (RC1), Accelerating Rate Calorimetry (ARC) method to provide a complete safety profile.

Technique	Key Insight
RC1 Calorimetry	Real-time heat flow in lab-scale reactors, identifying reaction enthalpies and heat accumulation.
Accelerating Rate Calorimetry (ARC)	Measures time to maximum rate (TMR), self-heating rates, and maximum pressure—essential for runaway risk.

Our Integrated Approach

At GVS Cibatech, we believe in a multi-tiered approach to thermal safety. DSC is just (the essential) starting point. Our process safety experts build a detailed thermal hazard profile using multiple calorimetric techniques to guide clients on:

- Safe scale-up
- Reactor design
- Emergency planning
- HAZOP & risk assessments

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