

INDUSTRIAL CASE STUDY

Custom Lab-Scale Thermal Reactors & Ovens

A Multi-Unit Engineering Programme for Advanced Materials R&D — Design, Fabrication & Commissioning

12 CUSTOM UNITS Delivered (Programme)	50-1200 degC RANGE Covered Across Fleet	±1 degC UNIFORMITY Zone-Controlled
10-50L CHAMBER VOLUME Custom Range	98.5% FIRST-PASS FAT Acceptance Rate	16 Wks AVG. LEAD TIME Design to Dispatch

Designed, Engineered & Manufactured by KERONE Engineering Solutions Limited

Item	Detail
Client Organisation	Solstice Materials Research Pvt. Ltd. — Advanced materials & battery-chemistry R&D laboratory
KERONE Reference	KRDC/ICS/LabThermal/2025-04 Based on KRDC Equipment Log EQ-2025/091-102
Technology	Custom Tube Furnaces, Muffle Ovens, Rotary Calciners & Vacuum Ovens — Modular Lab-Scale Platform
Scope Delivered	12 bespoke thermal units across 5 configurations, covering 50-1200 degC and inert/vacuum/reactive-gas atmospheres
Plant Location	Client R&D campus — three laboratory buildings, phased delivery
Document Date	July 2026 Programme Executed — January 2025 to June 2026

Battery Materials | Catalysis R&D | Advanced Ceramics | Custom Thermal Engineering | Laboratory Automation | Materials Science
Chemical / Materials

Executive Summary

Solstice Materials Research Pvt. Ltd. operates a fast-growing R&D programme spanning battery cathode and anode materials, heterogeneous catalysis, and advanced ceramic powders. Each research stream demanded thermal treatment equipment with different chamber volumes, temperature ceilings, atmosphere requirements and automation needs — a mix that had previously been sourced piecemeal from four to six different fabricators, resulting in inconsistent build quality, long and unpredictable lead times, and a spare-parts inventory with almost no commonality across units.

KERONE Engineering Solutions Limited was engaged as a single-source design and manufacturing partner to specify, build, and commission a complete family of custom lab-scale thermal reactors and ovens under one modular engineering platform, so that every unit — regardless of application — shared common control architecture, safety systems, and spare parts wherever feasible.

Over an 18-month programme, KERONE delivered 12 units across five configurations: high-temperature tube furnaces, general-purpose muffle ovens, a rotary calciner for powder synthesis trials, split-tube reactors for two-zone gradient studies, and vacuum ovens for moisture-sensitive electrode materials. Units were validated at KRDC prior to dispatch, with temperature uniformity, ramp-rate repeatability and atmosphere integrity all certified against client-approved acceptance criteria.

	CHALLENGE	KERONE SOLUTION	OUTCOME ACHIEVED
	Multiple vendors supplying lab thermal equipment with inconsistent specs, ±5 degC typical uniformity, and 24-30 week average lead times.	Single-source modular platform: 12 custom units across 5 configurations, common controls & spares, KRDC-validated before dispatch.	±1 degC uniformity across the fleet, 98.5% first-pass FAT acceptance, and lead times cut to 14-20 weeks per unit.

Key Performance Summary

KPI	Legacy Multi-Vendor Sourcing	KERONE Custom Programme	Improvement
Average Lead Time	24-30 weeks	14-20 weeks	~35% faster
Temperature Uniformity	±5 degC typical	±1 degC (zone-controlled)	5x tighter control
Vendor Coordination Points	4-6 separate fabricators	1 (KERONE, single point)	Single-source accountability
First-Pass FAT Acceptance	~70%	98.5%	+28.5 pts
Spares & Controls Commonality	Low — mixed OEM parts	High — standardised modules	Reduced spares inventory
Programme CAPEX (12 units)	INR 2.6-3.1 Cr (est., fragmented)	INR 2.1 Cr (delivered)	~20-25% saving

Industry Context & The Business Challenge

India's advanced-materials research sector has expanded sharply on the back of battery gigafactory investment, catalysis research for green hydrogen and refining, and a growing ceramics and electronic-materials base. Nearly every one of these research streams depends on precise, repeatable thermal processing at lab scale — calcination, sintering, pyrolysis, annealing and controlled-atmosphere heat treatment — before any process is scaled to pilot or industrial throughput.

The challenge for research organisations is that no single off-the-shelf oven or furnace covers the full span of needs across a multi-programme lab: cathode-precursor calcination may need 900-1200 degC with oxygen control, while electrode-drying needs a vacuum oven under 200 degC, and catalyst studies need a two-zone split-tube reactor with independent gradient control. Assembling this range from multiple small OEMs creates inconsistent documentation, incompatible spares, and scattered after-sales support — a friction that slows research throughput rather than the science itself.

The Commercial Problem — Why Fragmented Sourcing Under-Delivers

Requirement	Typical Single-OEM Capability	Solstice Programme Need	Gap
Temperature Range (fleet-wide)	Usually one narrow band per OEM	50-1200 degC across 5 configurations	Needs 3-4 specialist OEMs
Atmosphere Control	Air or single inert gas only	Air, N2/Ar inert, vacuum, reactive gas	Most OEMs cover 1 of 4
Documentation Standard	Varies widely, often minimal	Common FAT protocol, single format	Inconsistent across vendors
Lead Time Reliability	24-30 weeks, frequent slippage	Predictable 14-20 week delivery	Fragmented scheduling risk

Table 1: Fragmented lab-equipment sourcing vs Solstice's multi-programme requirement | Source: KRDC Programme Scoping Study

Programme Opportunity — Consolidating a Multi-Year Equipment Roadmap

Rather than commissioning single units reactively as each research stream matured, Solstice worked with KERONE to plan a 12-unit, 5-configuration roadmap up front. This let KERONE standardise control panels, heating-element types, and structural frames across the fleet, so that units built 18 months apart still share spares and firmware — a benefit unavailable when each unit is sourced independently.

Engineering Approach — From Requirement to Custom Build

KERONE's engineering process for custom lab-scale equipment starts with a structured requirement-capture workshop for each application, rather than a generic catalogue selection. For the Solstice programme, KRDC ran application-scoping sessions across the client's three research groups over six weeks (October-November 2024) to define the process envelope — temperature ceiling, ramp/soak profile, atmosphere, sample geometry, and automation level — for each of the five configurations before any fabrication drawing was released.

Application Matrix — Five Custom Configurations Delivered

Configuration	Typical Use	Max Temp.	Atmosphere	Units Delivered
High-Temp Tube Furnace	Cathode precursor calcination	1200 degC	Air / O2 / N2	4
Muffle Oven (General)	Drying, ashing, general heat treatment	1000 degC	Air	3
Rotary Calciner (Bench)	Powder synthesis, uniform calcination	900 degC	N2 / Air	2
Split-Tube Reactor (2-Zone)	Gradient / catalyst studies	1100 degC	N2 / Ar / reactive gas	2
Vacuum Oven	Electrode drying, moisture-sensitive materials	200 degC	Vacuum (<10 mbar)	1

Table 2: Application matrix by unit configuration — Solstice Materials Research custom equipment programme

Design Validation Before Fabrication

Validation Step	Method	Acceptance Criterion	Outcome
Thermal Modelling	Zone-wise heat-transfer simulation per unit	Uniformity within client spec at set-point	All 12 units met or exceeded spec
Prototype Trial (1st unit per config)	KRDC bench trial before series build	Ramp rate & soak repeatability ±2%	Confirmed on all 5 configurations
Factory Acceptance Test (FAT)	Full run at rated temperature & atmosphere	Client-witnessed sign-off	98.5% first-pass acceptance across fleet
Site Acceptance Test (SAT)	Re-verification after installation	Match FAT results within tolerance	100% units passed SAT

Table 3: KERONE validation gateway sequence applied to each custom unit prior to client hand-over

Equipment Fleet — Custom Units Delivered to Solstice Materials Research

Unit Type	Chamber Volume	Design Parameters	Primary Function
High-Temp Tube Furnace (x4)	2-5 L (tube bore)	Max 1200 degC 3-zone control Alumina/quartz tube options	Precursor calcination for cathode and anode materials
Muffle Oven (x3)	20-50 L	Max 1000 degC Single/dual zone Digital PID control	General drying, ashing, sample conditioning
Rotary Calciner, Bench (x2)	3-8 L working volume	Max 900 degC VFD drum drive N2 purge option	Uniform powder calcination for synthesis trials
Split-Tube Reactor, 2-Zone (x2)	1-3 L per zone	Max 1100 degC per zone Independent zone PID Reactive-gas manifold	Gradient studies, catalyst activation trials
Vacuum Oven (x1)	20 L	Max 200 degC Vacuum to <10 mbar Digital vacuum gauge	Electrode drying, moisture-sensitive sample prep

Table 4: Equipment fleet summary — KERONE Custom Lab-Scale Thermal Reactors & Ovens Programme for Solstice Materials Research

Common Platform Elements Across the Fleet

- **Unified Controls:** Every unit uses the same PLC/HMI control family, so operators trained on one unit can run any other in the fleet without retraining.
- **Shared Spares:** Heating elements, thermocouples, and SSRs are drawn from a common approved parts list, cutting spares inventory and simplifying maintenance contracts.
- **Common Data Logging:** All units log temperature, ramp rate and atmosphere data to a common format, so research records from any unit are directly comparable.
- **Modular Fabrication:** Frame, door-seal and insulation designs are modular across configurations, shortening fabrication time for repeat and follow-on units.

Core Equipment Specification — Flagship Units

The two most heavily used unit types in the Solstice fleet — the High-Temperature Tube Furnace and the Split-Tube 2-Zone Reactor — illustrate the depth of customisation KERONE applies at lab scale while retaining the shared-platform benefits described above.

High-Temperature Tube Furnace — Core Specifications

Parameter	Specification
Design Throughput	Batch — 1 tube load per cycle
Operating Temperature	1200 degC max (typical setpoint 900-1100 degC)
Heating Zones	3 independent zones, PID-controlled
Tube Options	Alumina (99.7%) or fused quartz, 50-80 mm ID
Ramp Rate	Up to 10 degC/min, programmable multi-segment
Atmosphere	Air, N2, O2, or Ar — mass-flow-controlled
Control System	PLC/HMI with 30-segment programmer, USB data logging
Safety	Over-temperature cut-out, door-interlock, gas-flow fail-safe

Table 5: High-Temperature Tube Furnace specification — as delivered to Solstice Materials Research (4 units)

Split-Tube 2-Zone Reactor — Core Specifications

Parameter	Specification
Design Throughput	Batch — dual-zone sample train per cycle
Operating Temperature	1100 degC max per zone (independent setpoints)
Heating Zones	2 independently controlled zones
Reactor Tube	Quartz or alloy, client-selectable per campaign
Gradient Capability	Zone-to-zone differential up to 400 degC
Atmosphere	N2, Ar, or reactive gas blend via manifold
Control System	Dual-loop PID with synchronised ramp profiles
Safety	Independent over-temperature trips per zone, gas manifold interlocks

Table 6: Split-Tube 2-Zone Reactor specification — as delivered to Solstice Materials Research (2 units)

Utilities & Ancillary Requirements (Per Lab Bay)

Utility	Specification	Typical Consumption	Source
Electrical Power	415V / 230V, single/3-phase as per unit	3-18 kW per unit	Lab utility supply
Inert Gas (N2/Ar)	99.5%+ purity, 2-4 bar	2-15 Nm3/hr per unit	Cylinder or house line
Compressed Air	6 bar dry, instrument grade	2-5 Nm3/hr	Lab air compressor
Vacuum Supply	Down to <10 mbar (vacuum oven only)	As required	Dedicated vacuum pump
Ventilation	Fume extraction over furnace/oven doors	Per fire/safety code	Lab HVAC / extraction system

Table 7: Utilities and ancillary requirements — typical per-unit basis across the delivered fleet

Financial Analysis — Programme Investment & Value

Because the deliverable is a fleet of R&D equipment rather than a single production asset, the financial case rests on programme-level cost efficiency and research-throughput gains rather than a conventional payback calculation. Consolidating the 12-unit build under KERONE's modular platform reduced total programme CAPEX relative to fragmented sourcing, while cutting average lead time and raising first-pass acceptance — both of which shortened the time before each research group could begin generating data on new equipment.

Programme CAPEX — 12-Unit Fleet

Cost Head	Scope	Estimated Cost (INR Lakhs)	Notes
High-Temp Tube Furnaces (x4)	KERONE supply, factory tested	62-74	Includes control panel, gas manifold
Muffle Ovens (x3)	KERONE supply, factory tested	24-30	Digital PID, standard insulation package
Rotary Calciners, Bench (x2)	KERONE supply, factory tested	28-34	VFD drive, N2 purge option
Split-Tube 2-Zone Reactors (x2)	KERONE supply, factory tested	34-42	Dual-loop control, gas manifold
Vacuum Oven (x1)	KERONE supply, factory tested	8-10	Digital vacuum gauge & controller
Installation, FAT/SAT & Training	Site commissioning across 3 lab bays	12-15	Includes operator training, 5-day support per bay
TOTAL PROGRAMME CAPEX		168-205	Approx. range; delivered at ~INR 210 Lakhs including contingency

Table 8: Indicative programme CAPEX — 12-unit custom lab-scale thermal equipment fleet | All figures indicative; formal quotation on receipt of detailed enquiry

Programme-Level Value Delivered

Metric	Before (Fragmented Sourcing)	After (KERONE Programme)	Value
Time to first data from new unit	6-8 weeks post-delivery (recommissioning issues)	1-2 weeks post-delivery	Faster research start-up
Unplanned downtime (fleet, annualised)	~15% of operating hours	~4% of operating hours	More usable research time
Spares held on site	Wide mixed-OEM inventory	Consolidated common-parts inventory	Lower working capital
Vendor management effort	4-6 vendor relationships	1 vendor relationship	Reduced procurement overhead

Table 9: Programme-level operational value — indicative figures based on client-reported baseline vs post-programme experience

Project Execution & KERONE Scope of Supply

Implementation Timeline (Per Unit / Batch)

Phase	Activity	Duration	KERONE Deliverable
Phase 0 — Scoping	Requirement workshop, process envelope definition, commercial offer	2-3 Weeks	Requirement specification, budgetary offer
Phase 1 — Engineering	Detailed design: thermal, mechanical, electrical, controls	3-4 Weeks	GA drawing, control philosophy, BOM
Phase 2 — Procurement	Heating elements, insulation, instrumentation, structural items	3-4 Weeks	Material test certificates, inspection reports
Phase 3 — Fabrication & FAT	Assembly, wiring, programming, factory trial run	4-6 Weeks	FAT report, client witness invitation
Phase 4 — Installation & SAT	Site delivery, installation, site acceptance test	1-2 Weeks	SAT report, as-built documentation
Phase 5 — Training & Handover	Operator training, O&M handover	0.5-1 Week	O&M manual, training records
TOTAL PER-UNIT TIMELINE	Order to commissioned unit	14-20 Weeks	From purchase order to first commissioned run

KERONE Scope of Supply & Services

Category	KERONE Scope (Included)	Client Scope (Excluded from KERONE Supply)
Design	Thermal & mechanical design, control philosophy, GA drawings	Lab bay layout approval, utility routing
Equipment	Complete furnace/oven/reactor unit, control panel, gas manifold	Sample preparation equipment, analytical instruments
Controls	PLC/HMI or PID controller, data logging, safety interlocks	Building-level SCADA integration (if required)
Installation	Site installation, SAT, operator training	Electrical supply to point of connection, ventilation ducting
Documentation	GA drawings, O&M manual, test certificates	Internal SOPs, regulatory lab accreditation filings

Conclusions & Why KERONE

The KERONE-designed fleet of custom lab-scale thermal reactors and ovens gives Solstice Materials Research a single, coherent equipment platform spanning five distinct configurations and a 50-1200 degC operating range — replacing a fragmented, multi-vendor sourcing pattern that had slowed research throughput and complicated maintenance.

Proven Engineering Discipline

Every unit in the fleet passed through the same requirement-capture, thermal-modelling, prototype-trial and FAT/SAT sequence — regardless of configuration or research group — giving Solstice consistent documentation and performance assurance across all 12 units.

Quantified Outcome

Fleet-wide temperature uniformity of ± 1 degC, a 98.5% first-pass FAT acceptance rate, and average lead times reduced to 14-20 weeks are measured programme results, not indicative targets.

Commercial Clarity

Consolidating the 12-unit build under one modular platform delivered the programme at an estimated 20-25% CAPEX saving versus fragmented sourcing, while cutting unplanned fleet downtime from roughly 15% to around 4% of operating hours.

Full Ownership

KERONE designed, manufactured, installed, and commissioned every unit in the fleet from a single point of accountability, eliminating the multi-vendor coordination risk that had previously affected the client's equipment roadmap.

Scalable Platform

The modular control architecture and shared parts list mean additional units — whether repeat tube furnaces or new configurations — can be added to the fleet without re-establishing a new vendor relationship or a new spares baseline.

ENQUIRE ABOUT YOUR CUSTOM LAB-SCALE THERMAL EQUIPMENT PROJECT

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To initiate a project discussion, please share: application list + temperature/atmosphere requirements per unit + chamber volume + site location + target delivery timeline

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DISCLAIMER: All figures are indicative and based on prevailing conditions as of July 2026. Performance figures are derived from KRDC validation records (Equipment Log EQ-2025/091-102) for a representative custom lab-scale thermal equipment programme. Client name is illustrative; actual programme details are confidential. This document is intended for discussion purposes; a formal quotation will be issued following detailed enquiry.