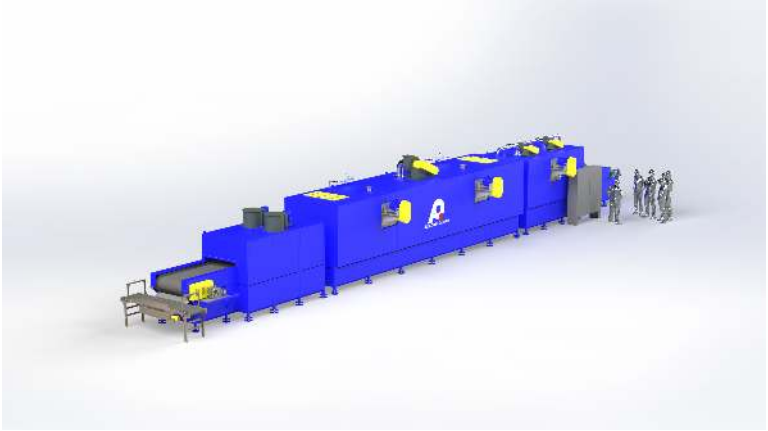
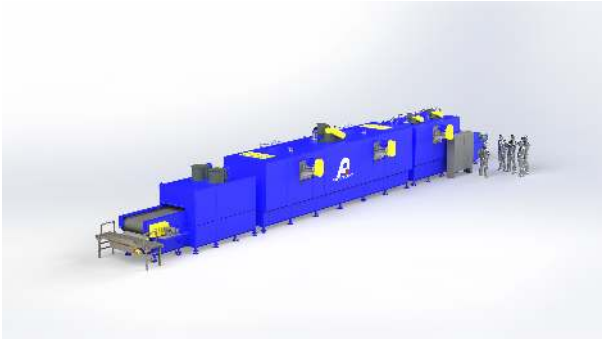


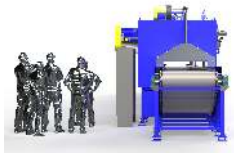
PRECISION QUINCY

CASE STUDY

Dual-Zone Conveyorized Coating Cure Oven for High-Throughput Fastener Finishing

Three-stage inline system combining a preheat oven, dual-zone high-heat cure oven, and forced-air cooler to process coated miscellaneous fasteners at up to approximately 9,000 lb/hr nominal throughput, using bottom-up vertical airflow, staged direct-fired heating, and integrated continuous handling with reversing unload.





OVERVIEW

The project for Allcoat was developed as a continuous conveyorized cure system for miscellaneous fasteners requiring a controlled preheat, elevated-temperature final cure, and post-process forced cooling prior to unload. The equipment was configured around a 48-inch conveyor surface with 3-inch side walls and a 60-inch conveyor elevation to support continuous product flow, high loading density, and straightforward integration into the customer's finishing operation.

The system architecture uses one preheat stage followed by a two-zone high-heat oven and an integral forced-air cooler. Bottom-up vertical airflow, high recirculation volume, direct-fired natural-gas heating, and tuned exhaust management were used to support coating cure performance while maintaining Class A safety requirements. The final concept combines durable insulated construction, staged combustion, adjustable airflow distribution, integrated controls, and a reversing unload conveyor to deliver a high-capacity continuous process platform optimized for coated fastener production.

CUSTOMER PROCESS REQUIREMENTS

The customer required a continuous in-line curing system for coated miscellaneous fasteners and similar coated small parts in a high-volume automotive supply environment. The line needed to support sustained production at approximately 9,000 lb/hr nominal throughput while fitting into a fully automated finishing operation with robotic loading and coordinated line control.

From a material-handling standpoint, the system needed to accept continuously loaded product, move it through preheat, final cure, and cooling, then discharge it in a controlled manner for downstream handling. The process required a wide conveyor path with side containment suitable for loose or bulk-handled fasteners, plus stable product transfer through each section of the line.

The customer process also required compatibility with a larger plant-wide automation architecture rather than a stand-alone manually operated oven. In practice, the curing equipment functions as one part of a broader automated coating line in which loading, unloading, and line coordination are handled in conjunction with a larger PLC-controlled system.

Facility and use requirements included elevated conveyor working height, safe operator access at loading and unloading, service access for maintenance, coordinated exhaust tie-ins, and a long linear arrangement compatible with the available plant layout. Because the application involves coating cure, the system also had to satisfy Class A process safety requirements appropriate for solvent-bearing work.

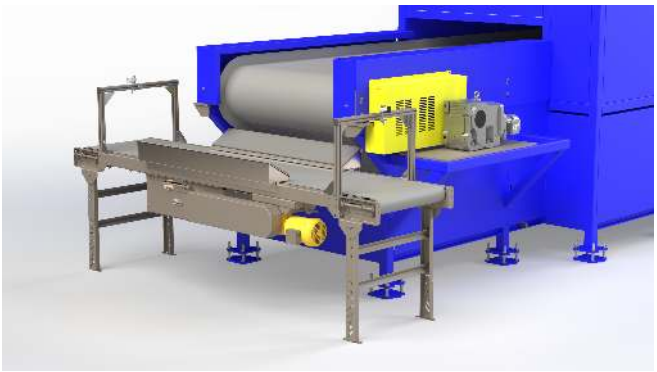
THERMAL / PHYSICAL PROCESS REQUIREMENTS

The thermal process required a staged cure profile consisting of an initial preheat stage followed by a higher-temperature final cure stage, then a forced-cooling stage to reduce product temperature before discharge. The preheat zone operates from 200°F to 350°F with a 450°F maximum design temperature. The dual-zone high-heat oven operates from 350°F to 700°F with an 850°F maximum design temperature.

To achieve coating cure across a dense moving bed of miscellaneous fasteners, the process required strong recirculated vertical airflow directed bottom-up through the load. The preheat section provides approximately 12,000 CFM of recirculated airflow, and the high-heat section provides approximately 24,000 CFM total recirculated airflow across the two cure zones. The stated supply-air temperature uniformity target is ±15°F.

The thermal design basis includes direct-fired natural-gas heating, staged by section. The preheat stage is rated at 1,500,000 BTU/hr. The high-heat section uses two heating zones rated at 1,500,000 BTU/hr each, for 3,000,000 BTU/hr total in the final cure oven.

The process basis also includes solvent-bearing coating cure at a maximum VOC loading of 0.5 gal/hr in each heated stage, requiring coordinated exhaust capacity for safe oven operation. At the nominal 12 in/min conveyor speed, the process provides approximately 12 minutes in preheat, 34 minutes in high heat, and 12 minutes in cooling, with an overall conveyor speed range of 6 to 30 in/min to support process flexibility.



EQUIPMENT CONCEPT & ARCHITECTURE

The final equipment concept is a three-stage conveyorized system made up of a preheat oven, a dual-zone high-heat cure oven, and an integral forced-air cooler with reversing unload capability. Product enters through the load section, passes through preheat, transitions into the two-zone cure oven, then moves through cooling before discharge.

The machine architecture uses a structural insulated shell design rather than light-gauge tongue-and-groove panel construction. The preheat oven uses 6-inch-thick insulated walls filled with 6 lb mineral wool. The high-heat oven uses a 10-inch wall system with 8 inches of 6 lb mineral wool plus 2 inches of 8 lb ceramic wool. The preheat section uses aluminized-steel interior and exterior construction, while the high-heat oven uses aluminized-steel exterior construction with a 304 stainless-steel interior. Proprietary separated inner and outer wall construction is used to accommodate thermal growth and limit external heat transfer.

Air delivery is provided through pressurized supply plenums with adjustable air ports and coordinated return plenums. The preheat section uses one NYB 278 PLR plug fan, and the high-heat oven uses two NYB 278 PLR plug fans. Heating is provided by Honeywell-Maxon OvenPak 415 direct-fired natural-gas burner systems. Exhaust is handled through dedicated exhaust takeoffs and roof-mounted exhausters, while the cooler uses high-volume forced-air intake and exhaust fans.

The handling architecture uses an 89R chain / B72 mesh belt conveyor with 3-inch side walls, manual catenary take-up, and Allen-Bradley PowerFlex 525 VFD-based speed control. The cooler discharge includes a reversing flat polyurethane unload conveyor with UHMW-lined stainless guides and bin-detection sensors for downstream transfer.

Controls and safety architecture are based on an Allen-Bradley CompactLogix platform with PanelView HMI, Ethernet-connected drives, flame safety, airflow proving, excess-temperature protection, gas pressure switches, stack light/alarm indication, and conveyor emergency stops. The overall system architecture aligns with NFPA 79, NFPA 86, and UL 508A open industrial control panel practices.

TECHNICAL SPECIFICATIONS

Oven Configuration	
Type	Continuous conveyorized preheat oven + dual-zone high-heat oven + forced-air cooler
Heated Zone Length	Preheat: 144 in chamber length; High heat: 408 in chamber length total across 2 zones
Width	48 in conveyor surface width
Clear Height Above Belt / Work Dimensions	10 in open height above conveyor surface; 55 in opening width
Equipment Overall Dimensions	Approx. 1026.16 in L x 145.94 in W x 151.87 in H
Inlet/Outlet Vestibules	External hooding before/after preheat; passive hood after high heat via cooler
Overall Length / Shipping	Approx. 85.5 ft overall line length; total system weight approx. 45,000 lb
Service Access	Side access doors on heated chambers; access panel on cooler; fan removal clearance behind fans
Explosion Relief	Explosion relief panels on high-heat oven

Thermal Heat Power System	
Operating Temperature	Preheat: 200–350°F; High heat: 350–700°F
Maximum Temperature	Preheat: 450°F; High heat: 850°F
Temperature Uniformity	±15°F
Heating Zones	1 preheat zone + 2 high-heat zones
Heat Source	Natural gas, direct fired
Heat Power	Preheat: 1,500,000 BTU/hr; High heat: 3,000,000 BTU/hr total
Emissions / Heat Control	Burner modulation via Kromschroder IC20E valve actuators; Honeywell-Maxon OvenPak 415 burners

Recirculation / Airflow System

Airflow Pattern	Vertical bottom-up airflow
Nozzle / Discharge Geometry	Adjustable laser-cut supply air ports with coordinated return plenum ports
Discharge Velocity	[Confirmed airflow pattern; discharge velocity not explicitly stated on GA/WD]
Fans	Preheat: 1 recirc fan; High heat: 2 recirc fans
Fan Motor	Preheat: 15 HP; High heat: 15 HP each

Exhaust System

Minimum Exhaust	Preheat/hood: 1300 CFM + hood collection; High heat: 1600 CFM
Maximum Exhaust Capability	Cooler: two 12,000 CFM fans for forced cooling intake/exhaust
Control	Dedicated exhaust fans with airflow proving; cooler fans on VFDs
Basis	Class A coated fastener cure, 0.5 gal/hr VOC load per heated stage

Conveyor / Handling System

Configuration	Main oven conveyor with reversing unload conveyor
Drive	Main conveyor: 0.33 HP gear motor; unload: 0.5 HP gear motor
VFDs	Allen-Bradley PowerFlex 525 on main conveyor, unload conveyor, cooler intake fan, and cooler exhaust fan
Take-Up / Tensioning	Catenary take-up with manual adjustment; threaded/manual belt tension adjustment
Tracking	Positive sprocket engagement with guide rails
Drive Interface	PLC/Ethernet integrated drive control
Belt / Cart / Rail Return	External belt return path; reversing unload conveyor with UHMW-lined stainless guides
Conveyor / Load Capacity	6–30 in/min; nominal 12 in/min; 38.71 lb/sq ft loading; 12,000 lb total evenly distributed

Construction Materials / Finish

Primary Structure	Carbon steel structural frame internal to insulated walls

Interior	Preheat: aluminized steel; High heat: 304 stainless steel
Exterior	Aluminized steel
Paint / Finish	PQ Gray exterior; ANSI 61 gray control panel
Thermal Isolation	Preheat: 6 in wall with 6 lb mineral wool; High heat: 10 in wall with 8 in 6 lb mineral wool + 2 in 8 lb ceramic wool

Safety & Compliance

NFPA 86 Classification	Class A
Burner / Heater Safety Hardware	Dungs flame safety and gas trains, proof-of-closure, airflow switches, gas pressure switches, excess-temperature controllers
Safety Notes	NFPA 79 / NFPA 86 / UL 508A open industrial control panel approach; conveyor E-stops; stack light and audible alarm; high-heat explosion relief panels

Controls & Electrical

PLC	Allen-Bradley CompactLogix 1769-L36ERM
HMI / Drives / Major Controls Notes	10 in PanelView 800 HMI; unmanaged Ethernet switch; PowerFlex 525 VFDs; Gefran 650L excess-temperature controllers; Dold safety relay; Dungs flame safety; 480/3/60; full load amps 116

Process Notes

Process Notes	Coating cure for miscellaneous fasteners with preheat, high-heat cure, and forced cooling
Testing / Validation	Factory pre-assembly, pre-wiring, pre-test, balance, and oven uniformity adjustment/testing
Future / Expansion Notes	Reversing unload with bin-detection sensors included; field exhaust and site-specific code requirements by customer

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