

Drying Tunnel Dynamics



**FIELD REPORT: INSIGHTS FOR
AUTOMOTIVE MANUFACTURERS**

ENERGY AND SUSTAINABILITY

**WHAT ENGINEERS & PLANT
MANAGERS NEED TO KNOW
ABOUT DRYING TUNNELS**

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Drying & Cooling Tunnels in Industrial Gluing & Adhesive Applications

Welcome to the September 2025 edition of the Cobeal bulletin, where we focus on industrial adhesives as the quiet backbone of modern manufacturing, from automotive interiors to packaging and textiles. The reliability of a bond often depends on precision environmental control during the drying stage. Yet many facilities still rely on variable or legacy systems that leave adhesives vulnerable to under-drying, over-drying, or uneven curing.

This edition explores the role of drying and cooling tunnels in adhesive performance. Drawing from field observations and cross-industry lessons: including Cobeal's precision drying tunnels used in automotive, confectionery, and pharmaceutical applications. We present engineering strategies for improving consistency, efficiency, and bond strength. Key findings emphasize the importance of balancing temperature ($\sim 24^{\circ}\text{C}$), relative humidity. ($\sim 35\% \text{ RH}$), laminar airflow ($0.2\text{-}0.4 \text{ m/s}$), and dwell time (reducing drying time by 30-50%) to achieve stable adhesion and reduce waste.

Background

Adhesives are increasingly replacing mechanical fasteners and welds across sectors. In automotive manufacturing alone, adhesives secure foam, plastic, and leather components, providing both structural integrity and acoustic comfort. The stakes are high: poor curing or inconsistent drying leads to delamination, clumping, cracking, or bond failure.

Cobeal's drying and cooling tunnels provide a controlled environment where water or solvent carriers in adhesives are removed at a pace that protects both the bond line and the substrate. In principle, these tunnels are similar to systems used in food processing or pharmaceutical conditioning: their purpose is not just to accelerate moisture removal, but to guide it in a way that preserves performance.

In this edition we'll explore common challenges like:

- **Under-drying:** surfaces remain tacky, leading to weak bonding.
- **Over-drying:** adhesives lose plasticity, crack, or fail to wet surfaces.
- **Uneven drying:** temperature or airflow gradients create weak spots.
- **Energy inefficiency:** uncontrolled systems waste utilities while delivering inconsistent outcomes.

Field observations are presented from a recent walkthrough of an automotive manufacturing facility, where several operational issues observed across the industry. These findings mirror challenges across sectors and emphasize the need for engineered tunnel environments.

We'll also share some of the lesser-known principles of adhesive drying. From ideal temperature, humidity, and airflow to load management and dwell time. Clients require scalable drying and cooling tunnels that protect the envelope, distribute the air, dehumidify water load, and control the system, while continuously monitoring and logging traceable data for quality assurance. Clients seek deep industry knowledge their environmental science partners whom they trust to translate these lessons, and that's precisely what Cobeal delivers.

Process & Tunnel Design for Automotive Adhesives



Air Handling and Diffuser Design

Uniform airflow at the product plane is the single biggest factor in drying uniformity. Boundary-layer theory shows the adhesive only “feels” the near-surface shear delivered by outer velocity UUU . Field notes confirmed uneven curing between center and edge of racks — a hallmark of diffuser imbalance.

- **Design rule:** Deliver 0.2–0.4 m/s laminar face velocity, uniform to $\pm 10\%$ across the load.
- **Example:** At 0.3 m/s over a 1 m² rack face, volumetric flow is 1,080 m³/hr. Doubling to 0.6 m/s increases mass-transfer coefficient h_{mh} $\sim 40\%$, but risks over-drying edges.

Instrumentation & Control

Visual inspection is no longer sufficient. Adhesive lines must operate with real-time monitoring of temperature, RH, and airflow velocity. Logged data supports OEM audits and ensures repeatability.

- **Design rule:** Install sensors at multiple rack positions (center + edges).
- **Example:** If center racks under-dry relative to edges; a simple RH probe array can catch the imbalance.

Envelope and Construction

Drying tunnels must function as sealed, insulated enclosures that hold precise RH and temperature. Sandwich panels with vapor barriers prevent infiltration that would destabilize humidity and increase energy use. In automotive settings where adhesives are applied to foam, plastics, and composites, this envelope is the first defense against seasonal drift in plant conditions.

- **Design rule:** Enclosure leakage $< 2\%$ of supply flow.
- **Example:** A 20 m³ tunnel with 4,000 m³/hr supply should leak no more than ~ 80 m³/hr to maintain RH $\pm 3\%$.

Dehumidification & Load Matching

Water removal capacity must match adhesive release. A single rack may offload several liters of water over a 10-minute cycle. If dehumidification is undersized, RH spikes, slowing drying and disturbing cure balance.

- **Design rule:** Size dehumidification capacity to peak load +20% margin.
- **Example:** If a batch releases 8 kg water/hr, design for 10 kg/hr extraction to hold RH steady.

Staged Drying Zones

A three-zone tunnel balances speed and quality:

1. **Flash-off (Zone 1):** $\sim 24^\circ\text{C}$, 35–40% RH, 0.2 m/s. Removes surface tack without skinning.
 2. **Bulk removal (Zone 2):** Same temperature, 30–35% RH, 0.3–0.4 m/s. Removes majority of water/solvent.
 3. **Conditioning (Zone 3):** $\sim 24^\circ\text{C}$, 35–40% RH, 0.2 m/s. Equalizes gradients, prepares for cure.
- **Example:** For PUR adhesives, $\sim 47\%$ water removal after Zone 2 yielded strongest bonds. Therefore, Zone 3 should stabilize the film before assembly.

Energy & Sustainability

Automotive OEMs demand not only quality but efficiency. Heat recovery and low-leakage design lower operating costs. Integration with plant HVAC reduces redundancy.

- **Design rule:** Recover at least 30% of sensible heat from exhaust via crossflow exchangers.

Summary of Tunnel Design Targets

- Enclosure leakage $< 2\%$ supply flow
- Laminar face velocity $0.2\text{--}0.4\text{ m/s}$, uniform to $\pm 10\%$
- RH mid-band $\sim 35\%$, tightly controlled
- Peak dehumidification capacity $\geq \text{water load} \times 1.2$
- Three zones: flash-off, bulk removal, conditioning
- Multi-point sensor logging for QA



COBEAL'S HOT AIR DRYING CONVEYOR BELT (COB-TFI SERIES)

Tunnel Furnace

Use case. Continuous hot-air drying and glue curing for automotive interiors, electronics encapsulation, and composite manufacturing. Forced-air circulation ensures uniformity across racks, while optional IR-assist modules further reduce cycle times and energy per part. Standard COB-TFI models operate up to 200°C, with a high-temperature package available to 300°C for demanding applications.

Performance summary

- **Operating temperature:** RT–200°C (standard); up to 300°C with HT option
- **Temperature control accuracy:** $\pm 1^\circ\text{C}$
- **Temperature uniformity:** $\pm 5^\circ\text{C}$ across the working zone ($\pm 2^\circ\text{C}$ available with high-uniformity package)
- **Heat-up to 150°C:** ~15 min (empty chamber)
- **Thermal recovery after loading:** ≤ 15 s to setpoint (steady operation)
- **Relative humidity (process air):** dry hot-air system; optional dehumidification modules available.
- **Energy efficiency:** 25% lower consumption with high-efficiency circulation vs static ovens; up to 30% further reduction when IR-assist modules are specified
- **Conveyor speed:** 0–4 m/min, closed-loop adjustable
- **Belt material:** stainless-steel mesh (standard); PVC or specialty belts on request

Mechanical & construction

- **Interior:** corrosion-resistant stainless steel (SUS304 standard; SUS201/316/316L available)
- **Exterior:** powder-coated cold-rolled steel
- **Insulation:** high-density mineral/ceramic fiber
- **Cooling:** modular downstream cooling zone for post-cure stabilization
- **Shell temperature:** low external surface temperature to minimize ambient heat load

Controls & safety

- **Controller:** programmable touch-screen HMI (PID + SSR + recipe timer)
- **Monitoring:** multi-point air temperature and conveyor speed; optional airflow and RH sensing
- **Data:** batch/run logging and export
- **Safety:** dual-channel E-stop, over-temp cutoff, door/interlock circuits; designed to integrate with ISO-compliant safety systems

Electrical & heating

- **Heating method:** electric (convection), optional IR-assist
- **Power/voltage:** see model table (3-phase; 220/480 typical, other voltages available)

Warranty: 1 year standard



INDUSTRIAL HIGH TEMPERATURE GLUE CURING OVEN FOR INDUSTRIAL DRYING

- **Temperature (thermometer)** → “RT–200°C (300°C optional)”
- **Accuracy (target icon)** → “ $\pm 1^\circ\text{C}$ ”
- **Speed (conveyor belt icon)** → “0–4 m/min”
- **Energy (leaf/lightning bolt)** → “25–30% savings”
- **Processes up to 120 panels/hour at 0.3 m/s conveyor speed (typical automotive foam substrates)**
- **ISO 9001, CE, RoHS, OSHA compliance**
- **Save up to 30% on energy costs vs. conventional ovens**
- **Payback in under 18 months for standard automotive line**
- **Global service network: 24/7 support**
- **Standard 1-year warranty, extended options available**
- **Maintenance and Service Plans available**



Applications

- Hardware electroplating
- Bottle moisture drying
- PBC (Printed circuit boards)
- Sticker glue curing
- Silicone vulcanization
- Car headlight accessories
- PE PP Material
- Phone case screening printing
- Teflon curing

Additional Options

- Stainless steel mesh belt
- Teflon mesh belt
- PVC belt
- Stainless steel chain conveyor belt

Features & Benefits

Control Panel

- Easy to operate control panel
- Includes individual heating zones to aid in temperature uniformity
- Independent temperature control
- Physical keys (tactile feedback)
- Environmentally sturdy (can operate in harsh environments)
- Simple and reliable
- Low power consumption for uninterrupted operation
- Touch screen available
- Data recording available

Stainless Steel Mesh

- Adjustable speed
- Corrosion resistance
- High temperature resistance

Adjustable plates

- Prevent heat loss
- Energy saving, high efficiency
- Adjustable air volume
- Customizable voltage

Internal stainless steel

- Fast heating
- Long service life
- Continuous constant temperature heating
- Stable performance

Product model	Internal dimension (H×W×D, mm)	External dimension (H×W×D, mm)	Temperature range (°C)	Power (kW)	Voltage (V)
COB-TFI-2600	2600 × 400 × 100	2600 × 450 × 1150	RT – 120 °C	9	220/480
COB-TFI-4000	4000 × 450 × 150	4000 × 850 × 950	RT – 150 °C	20	220/480
COB-TFI-9600	9600 × 800 × 200	9600 × 1000 × 1000	RT – 200 °C	36	220/480
COB-TFI-13500	13500 × 1000 × 150	13500 × 1100 × 900	RT – 150 °C	27	220/480

Insights for Automobile Manufacturers



Heat & Mass Transfer at the Adhesive Surface

When adhesive dries in the tunnel, two forces decide the pace and the quality of the result. The air outside the film: its temperature, humidity, and how evenly it moves and pulls moisture or solvent off the surface. The adhesive inside (its chemistry, thickness, and how easily volatiles can travel) feeds that surface. If the air speed or temperature is patchy across a rack, the surface removes moisture faster in some spots than others, and those differences show up later as uneven bond strength.


Drying always runs in two acts. At first the surface stays wet and the rate is set by the air: better airflow and the right temperature-humidity balance make this stage quick and stable. Once the surface starts to dry, the bottleneck shifts inside the film. Moisture now has to work its way out through the adhesive, which is slower. If the tunnel runs too hot and too dry early on, a dense “skin” forms, trapping moisture beneath it. That looks efficient at first but it can leave the bond brittle or under-cured.

Relative humidity is the quiet lever that keeps you out of trouble. Very dry air speeds flash-off but invites skinning; high humidity slows everything and risks weak bonds. A mid-range setpoint around the mid-30s keeps the rate high enough without damaging the film. Thickness matters, too. Thin layers remain governed by the air longer and finish predictably; thicker bond lines enter the slower, internal-diffusion stage sooner and need either longer dwell or multiple zones to even out internal moisture.

In practice, the tunnel should read as calm and disciplined rather than aggressive: uniform face velocity across the product plane, moderate temperature, controlled mid-band humidity, and a staged path from gentle flash-off to bulk removal to a brief conditioning period that lets internal gradients relax before parts leave the line. That recipe produces the thing automakers require - **repeatable bonds** - without the drama of chasing defects downstream.

“If the airflow is strong and even across the rack, evaporation is faster and more uniform. If velocity is uneven, drying will also be uneven, leading to weak spots in bond strength.”



A photograph of two men in a paint booth. The man on the left is wearing a white lab coat over a blue shirt and glasses, holding a clipboard and pen. The man on the right is wearing a white protective suit with a respirator mask hanging from his neck and holding a spray gun. They are standing next to a car that is partially covered with brown paper and black plastic. The background shows the interior of a paint booth with fluorescent lights on the ceiling.

“If you blast the adhesive too hard with hot, dry air early on, you shorten the first stage but risk forming a tough skin. That traps moisture underneath, extending the second stage and hurting film quality.”



In practice, tunnels for automotive adhesives should aim for the mid-band around 35%. Running “as dry as possible” backfires.

Relative humidity is one of those invisible settings that quietly decides whether adhesive bonds come out strong or fragile. The easiest way to think about it is to imagine leaving wet clothes to dry. On a desert day with very dry air, the fabric stiffens quickly, but if you feel inside, parts are still damp. The outside dried too fast, leaving moisture trapped. That’s what happens in a tunnel when humidity drops below about 30 percent. The surface of the adhesive film “skins over,” hardening before the solvent or water underneath can escape. The result is a brittle, unreliable bond that looks finished but fails in use.

Now picture hanging the same clothes on a humid summer day. Hours later, they’re still clammy. In the tunnel, that’s the equivalent of running above 60 percent humidity. The film can’t shed its moisture, cure slows to a crawl, and the bond line leaves the tunnel weak. Operators may assume more dwell time will solve it, but the underlying chemistry just won’t move until the air dries out.

The sweet spot is the middle range—about 35 to 40 percent relative humidity. Here, the air is dry enough to pull out water at a good pace, but moist enough to keep the film flexible as it dries. Bonds form more evenly, and the finish is consistent from part to part. In automotive production, that means dashboards that don’t delaminate, seals that stay flexible, and panels that pass quality checks without surprises.

It’s tempting to assume “the drier the better,” but the tunnel is not a desert—it’s a controlled process. By holding humidity in the middle band, manufacturers avoid brittle skins and incomplete cure, delivering bonds that are both fast to make and reliable in service.

Film Thickness and Solids Content

How thick the adhesive layer is—and how much solid material it carries—directly shapes how it dries in the tunnel. Thin films behave predictably: as long as the air is uniform, the drying rate is governed mostly by temperature, velocity, and humidity. These layers stay “air-side limited” for longer, meaning the airflow controls the pace. They dry faster, and the line can move with confidence.

Thicker bond lines tell a different story. Once the surface begins to set, the moisture or solvent underneath has a harder time escaping. The process shifts into a diffusion-limited stage much sooner. What looks solid on the outside can still be soft in the middle, leaving the joint vulnerable. The practical response is either to give these parts longer dwell time or to divide the tunnel into multiple zones, each tuned to ease out the remaining moisture step by step.

For automakers, this makes tunnel discipline non-negotiable. Air must move evenly across every rack to guarantee even bond strength. Too much velocity or overly dry air in the first zone risks skinning, while too little control in later zones leaves cores damp.

Cobeal’s well-designed tunnel read like a sequence: a flash-off zone with gentle air to take away surface tack, a bulk zone with stronger airflow to carry out most of the water or solvent, and a conditioning zone where the internal gradients are allowed to relax. When thickness is taken into account and dwell time is matched to the film, parts leave the tunnel consistent, reliable, and ready for the next assembly step.



Practical tunnel design rules for auto manufacturers

1. **Airflow uniformity is non-negotiable:** Even drying means even bond strength.
2. **Don’t overdry the surface:** Moderate airspeed and humidity prevent skinning.
3. **Stage the tunnel:**
 - **Flash-off zone:** Gentle air to remove tack without shocking the film.
 - **Bulk drying zone:** Controlled airflow to remove most water or solvent.
 - **Conditioning zone:** Gentle conditions that let internal moisture gradients relax.
4. **Match dwell time to adhesive thickness:** Thick films need longer or staged drying.

multi-bay tunnel

Specification (typical range for automotive applications)

- **Dimensions:** 3–30 m length × 3–5m width × 3 m height
- **Bays:** 2–12 segregated compartments, each accessible via roll-up or lift doors
- **Airflow:** zoned laminar, 0.25–0.45 m/s across the bay; bay-by-bay balancing
- **Temperature:** 18–26 °C, adjustable per bay
- **Relative humidity:** 25–45% (RH), programmable staging per type of material to dry
- **Dehumidification:** central desiccant wheel, 10–150 kg/hr removal
- **Air handling:** shared AHU with pre-filters and second stage filtration
- **Controls:** PLC with zone-level RH/temp probes and audit logging
- **Utilities:** steam, gas, or electric reactivation for desiccant; chilled water coils optional

Description

The COB-DT-1000 series is a high-capacity conditioning wall designed for medium to large-scale industrial processing. Each bay functions as a self-contained drying compartment while drawing from a centralized air handling and dehumidification system. By zoning airflow and humidity control, different products or stages of the same material can run in parallel without cross-contamination or process interference.

Bays are accessed by roll-up or lift doors, allowing operators to load and unload racks efficiently while maintaining isolation of neighboring zones. Air distribution is engineered to maintain uniform velocity across trays, ensuring consistent drying regardless of rack position. This modular approach reduces downtime, as individual bays can be taken offline for maintenance without halting the entire system.

Application

The COB-DT-1000 is ideally suited for facilities scaling up from single-room drying into multi-zone operations. It is particularly valuable for producers running multiple SKUs that require slightly different humidity or temperature curves. Common applications include dashboards as well as interior and exterior part. By combining capacity, flexibility, and reliability, the COB-DT-1000 enables automobile manufacturers to expand throughput while maintaining quality across diverse product lines.



Adhesive Curing Kinetics & Bond Formation



Drying is not the end of the story. For most automotive adhesives—especially the polyurethanes widely used in glass bonding, interior assemblies, and structural joints—the real performance comes from the chemical cure that follows. This cure is a two-part process: moisture from the air diffuses into the adhesive, and then a chemical reaction locks the material into place. If either side of that process is out of balance, bonds are weaker than they look.

Think of it this way: when a bead of polyurethane is laid into a windshield channel, it doesn't become strong just because the surface feels dry. Water molecules have to move into the bead and trigger a chemical reaction with the isocyanate groups inside. Studies show that higher humidity and temperature accelerate that reaction, while low humidity slows it down. In practice, that means the tunnel cannot be run “as dry as possible,” because starving the adhesive of moisture at the surface can leave the core slow to cure.

Recent work has confirmed what many operators already know from experience. At moderate humidity, the chemistry kicks in faster, bonds gain strength sooner, and throughput improves. Auto glass tests confirm that faster-curing formulations, or tunnels that manage the moisture balance correctly, reduce waiting times before a vehicle can move to the next station.



The story is similar for pressure-sensitive and structural adhesives. Even after the film looks set, strength continues to build over hours as chemical crosslinks form. In some systems, ultraviolet light or added crosslinkers speed this process, but the principle is the same: drying prepares the surface, while curing builds the backbone of the bond.

For manufacturers, the design lesson is straightforward. The tunnel should not aim to drive every drop of water out. Instead, it should deliver a controlled environment that leaves enough residual moisture for curing to proceed quickly once the part exits the drying zone. A staged approach—flash-off, bulk drying, conditioning—allows that balance to be struck.

The goal is not one hundred percent cure inside the tunnel. The goal is to achieve enough cure for safe handling and downstream processing, while setting up the chemistry to finish its work in the hours that follow. By tuning humidity, temperature, and airflow with curing in mind, automotive plants can cut cycle times, reduce rework, and produce bonds that meet both immediate handling needs and long-term durability standards.

What Engineers & Plant Managers Need to Know About Drying Tunnels

For engineers, the drying tunnel is not just temperature control with a conveyor belt, it's a process environment where heat, mass transfer, and chemical kinetics must line up. The single most common problem we see in plants is uneven airflow. If the face velocity across the rack varies by more than ± 10 percent, drying rates diverge, and so does bond strength. Field data confirms it: center racks often cure slower than edge racks because diffusers aren't balanced. The fix isn't more heat, it's engineered airflow distribution.

Relative humidity is just as critical. Below thirty percent, adhesives skin at the surface, locking moisture inside. Above sixty percent, bonds leave the tunnel under-cured. The defensible target (borne out in both lab studies and plant trials) is mid-band control at thirty-five to forty percent RH. This isn't a "soft" number. It's where both waterborne and solventborne adhesives maintain open time without defects, and it's achievable with properly sized dehumidification (designed to peak load plus twenty percent margin).

Engineers should also recognize that drying has two stages. The constant-rate period is governed by air; the falling-rate period is governed by the adhesive itself. Trying to push too much air too early only shortens the first stage and penalizes the second. A three-zone design (flash-off, bulk removal, conditioning) balances those forces. Real-world data shows that polyurethane adhesives reach their highest bond strengths when Zone 2 pulls off about half the water, and Zone 3 lets gradients relax before assembly.



Spec Call-Outs

- Air velocity: 0.2–0.4 m/s, uniform to $\pm 10\%$
- Relative humidity setpoint: 35–40% RH (peak load +20% dehumidification capacity)
- Temperature uniformity: ± 5 °C standard (± 2 °C with upgrade)
- Thermal recovery: ≤ 15 seconds to setpoint after loading
- Energy efficiency: 25% lower draw with circulation; up to 30% additional savings with IR assist

Building for Reliability & Auditability



Plant managers face a different but related concern: how to prove consistency to OEMs and auditors. Visual inspection is no longer acceptable. Tunnels must log temperature, RH, and airflow at multiple rack positions, not just one probe in the plenum. Multi-point sensing is the only way to catch edge vs center imbalance before it shows up as a failed peel test. Logged data not only satisfies audits but also lets managers troubleshoot faster and cut scrap.

Energy efficiency is another pressure point. Conventional static tunnels waste power reheating bulk air volumes. By contrast, forced-air tunnels with high-density insulation reduce baseline draw by about twenty-five percent. Adding IR assist cuts energy per part by up to thirty percent. This measured performance outperforms standard tunnel designs. For managers tasked with reducing CO₂ per vehicle, those savings can be defended with logged utility data.

Mechanical durability closes the loop. Stainless steel interiors resist chemical attack from adhesives and solvents, extending service life. Low shell temperatures reduce HVAC load in the shop, keeping operators safe and energy costs predictable. These details matter because they determine whether a tunnel is a reliable asset or a maintenance liability.

For both engineers and managers, the message is the same: Cobeal's drying tunnels are controllable systems upon which you can rely. When designed and operated with attention to airflow, RH, and staged drying, they deliver repeatable bonds, lower scrap, and lower energy bills. When ignored, they turn into chronic bottlenecks. The difference is not theory: it's design discipline and operational control.

Quality Assurance & Monitoring



A drying tunnel is only as good as its ability to repeat the same result, shift after shift. For adhesives, that means consistent bond strength across every rack, every part, and every production run. The only way to guarantee that is through measurement and monitoring built directly into the tunnel.

Single-point probes in the plenum tell you little more than whether the heater is on. What matters is the environment at the product plane: where airspeed, temperature, and humidity meet the adhesive surface. If airflow at the rack edge runs faster than at the center, drying rates diverge. If humidity spikes during a heavy load, bonds leave the tunnel under-cured. These differences are invisible to the naked eye but show up later as failed peel tests or rejected parts.

The technical solution is straightforward: multi-point sensing distributed across the tunnel's working zone. By logging temperature, humidity, and airflow at representative positions, the system can confirm uniformity in real time and trigger corrections when deviations appear. Data logging also gives plant managers a defensible record to present in OEM audits. This combined approach validates that every part has passed through controlled conditions.

Modern controls make this simple. A touch-screen HMI can trend process variables, export run data, and flag excursions instantly. For operators, that means fewer surprises at quality checkpoints. For engineers, it means real-time feedback on how tunnel settings translate into bond performance. And for managers, it means turning a black box into a transparent, auditable process step.

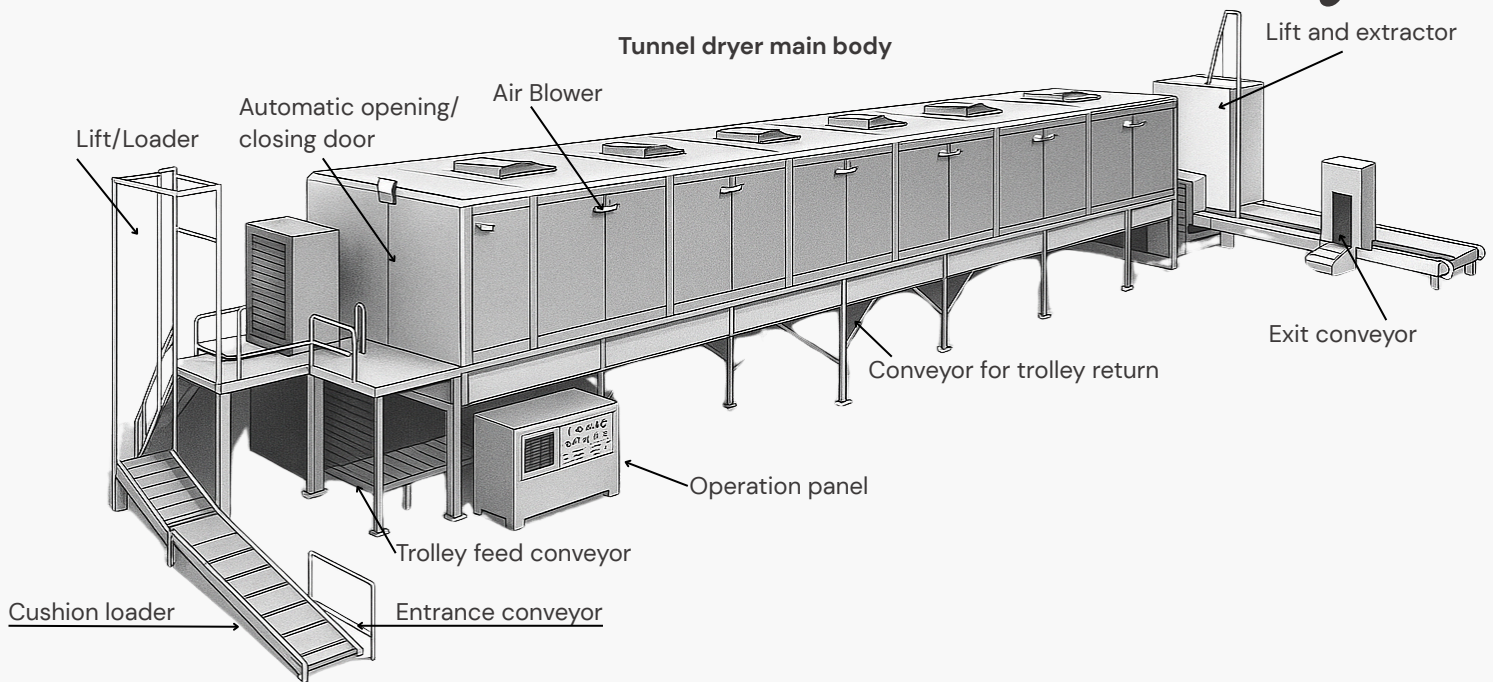
In practice, quality assurance in Cobeal's drying tunnels is not about catching problems after the fact. It's about preventing them by proving, and improving, uniform conditions at the film surface.

“OEM audits don’t ask if it
looked dry, they ask for logged
proof.”

This is what Cobeal delivers.



Maintenance & Serviceability



A drying tunnel has to perform day in and day out, but what keeps production moving isn't just airflow and temperature control, it's how easily the system can be maintained. For engineers and plant managers, downtime is the hidden cost that can dwarf energy savings if the tunnel isn't designed for access and service.

The first principle is **visibility**. Panels should open easily so operators can inspect belts, heaters, and circulation fans without dismantling half the machine. Clear sightlines and access ports reduce the need for specialized tools and shorten every service cycle. When filters or belts do need to be swapped, modular assemblies make the difference between a ten-minute pause and a half-shift outage.

Second is **cleanability**. Adhesives, coatings, and solvents inevitably leave residues. Stainless-steel interiors resist chemical attack and make wipe-downs quick. Smooth surfaces without unnecessary perforations or crevices prevent buildup, and removable trays under the conveyor catch drips before they harden into a maintenance headache.

Third is **reliability of components**. High-grade bearings, sealed motors, and corrosion-resistant belts extend intervals between failures. By pairing these with real-time monitoring of motor load and airflow, tunnels can move from reactive to predictive maintenance—spotting a fan imbalance or clogged filter before it compromises drying performance.

For managers, **serviceability ties directly to availability**. A tunnel that takes hours to bring back online after routine work is a liability. One that's built with quick-change parts and straightforward cleaning becomes a dependable asset. In the automotive environment, where takt times are unforgiving and line stoppages ripple across an entire plant, that difference defines whether a tunnel is simply equipment or a production guarantee.

Integration with Automotive Production Lines



In automotive manufacturing, every piece of equipment must fit into a tightly choreographed sequence. Drying tunnels cannot operate as stand-alone systems; they must integrate seamlessly with conveyors, takt time, and plant-level controls. The value of a tunnel is measured not only by its drying performance but by its ability to maintain pace and communication with the line.

The first integration point is **material handling**. Automotive production often relies on automated feeders, lifts, or robotic arms to place components on carriers. A tunnel must accept these inputs without introducing bottlenecks. Adjustable conveyor speeds (0–4 m/min with closed-loop control) allow the tunnel to match takt time, while modular belt designs support dashboards, door panels, glass assemblies, and electronics housings without retooling.

The second is **controls integration**. Programmable touch-screen HMIs with PID and SSR control loops allow operators to set and monitor materials, but true integration means linking the tunnel into the plant's MES/SCADA system. That enables live monitoring of temperature, RH, and airflow at multiple points in the tunnel, with deviations flagged instantly. Data export functions create digital records that flow directly into quality assurance systems, ensuring every part carries a traceable process history.

The third is line **balance and recovery**. Automotive plants cannot afford downtime when a tunnel requires service. Quick-change belts, modular blowers, and predictive maintenance monitoring shorten interventions, allowing the line to restart without long stoppages. Rapid thermal recovery (≤ 15 seconds to setpoint after loading) ensures that cycle time is not disrupted when production resumes.

Finally, integration includes **safety interlocks**. Tunnels must be tied into plant-level E-stops and lockout/tagout protocols, with dual-channel systems that meet ISO standards. This ensures that maintenance, audits, and emergency stops align with broader plant safety architecture.

In practice, integration means the tunnel doesn't just dry adhesive films, it becomes an invisible part of the production rhythm. When airflow, humidity, and cure are controlled in sync with takt time and quality reporting, the tunnel ceases to be a bottleneck and instead becomes a production guarantee.

Future-Proofing and Compliance



Automotive manufacturing is shaped not only by production targets but by the regulations and standards that surround them. A drying tunnel must therefore be more than a tool for today's adhesives; it must be a platform that anticipates tomorrow's requirements.

The first layer is **regulatory compliance**. Cobeal's tunnels are designed to integrate with ISO-compliant safety systems, including dual-channel E-stops, interlocks, and over-temperature cutoffs. As plants prepare for stricter global standards: ISO 13849, IEC 60204, and automotive-specific OEM safety requirements, these tunnels already meet or exceed baseline specifications, minimizing retrofit risk.

The second is **environmental compliance**. Regulations continue to tighten around VOC emissions, energy consumption, and carbon reporting. Cobeal's tunnels reduce energy per part by up to 30% compared to standard tunnels. High-density insulation keeps energy in the process, lowering baseline draw. For automotive clients operating under ISO 50001 or OEM sustainability reporting, these design features provide defensible metrics.

The third is **modular adaptability**. Adhesive chemistries evolve: waterborne, solventborne, PUR, UV-cured, and each brings its own drying and curing demands. Cobeal's modular tunnel architecture allows upgrades without full replacement: additional drying zones, high-uniformity kits, dehumidification modules, or IR assist can be added as new adhesives enter the production line. This ensures a single tunnel investment remains viable through adhesive and process transitions over a 10-15 year lifecycle.

The final layer is **digital readiness**. Cobeal's tunnels are not standalone assets; they're nodes in a connected plant. By logging temperature, airflow, and RH data at multiple points and making that information exportable, Cobeal's tunnels align with Industry 4.0 and OEM traceability requirements. That means compliance audits, quality reviews, and sustainability reports can be generated from actual process data, not estimates.

Future-proofing is about more than keeping pace. It's about giving plant managers and engineers confidence that Cobeal's tunnel will remain an asset, not a liability, as adhesives evolve, regulations tighten, and OEM demands rise. In this way, Cobeal's tunnel is not just a piece of equipment—it is **compliance built into the line, for the long term**.

Thank you!



At Cobeal, we design and deliver drying and curing systems that keep automotive production moving: reliably, efficiently, and with the technical rigor your process demands. If you'd like to discuss your application, request specifications, or schedule a plant assessment, our team is ready to help.

For technical inquiries, please include details on:

- Adhesive type (waterborne, solventborne, PUR, etc.)
- Typical bond line thickness and substrates
- Required takt time or line speed
- Existing process constraints (temperature limits, RH control, space)

Our engineers will work with you to size the right tunnel for your line, ensuring process stability and long-term compliance.

Check out our website: <https://cobeal.com/>