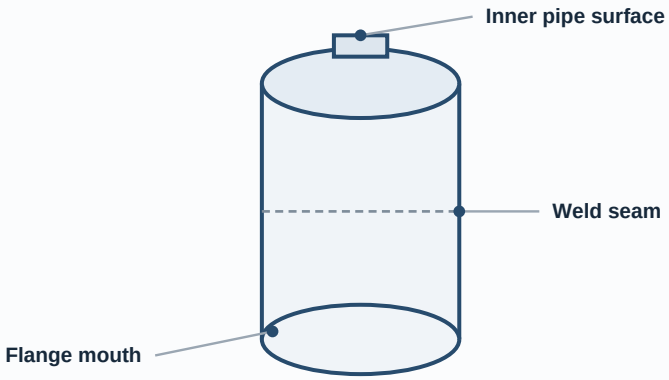
UNDERSTAND THE SURFACE BEFORE DESIGNING THE COATING.

Exhaust Muffler & EGR / Heat Exchanger (Inner Surface) — Hot exhaust gases (up to ~800 °C), thermal shock, acidic condensate and high-temperature oxidation. Before designing the right coating, we evaluate the material chemistry, the geometry and the service conditions together.

PART DIAGRAM — EXHAUST MUFFLER & EGR / HEAT EXCHANGER (INNER SURFACE)



COATING CROSS-SECTION



Five questions define a coating system

1. **MATERIAL**
   Heat-resistant steel / stainless or aluminised steel body, welded. Exposed to high-temperature oxidation and acidic condensate.

2. **SURFACE**
   Oil, scale and oxide are removed; weld zones and the inner surface are prepared for vitreous enamel adhesion.

3. **GEOMETRY**
   Pipe interiors and weld seams require continuous, pore-free coverage; CTE matching across different sections and crack-free behaviour under thermal shock are critical.

4. **SERVICE CONDITIONS**
   Hot exhaust gases (up to ~800 °C), thermal shock, acidic condensate and high-temperature oxidation

5. **PRODUCTION TARGET**
   Medium volume; a pore-free inner coating resistant to thermal shock and acidic condensate.

CONCLUSION: For the Exhaust Muffler & EGR / Heat Exchanger, the goal is not just a good-looking finish; it is a pore-free, oxidation-resistant enamel inner surface that withstands hot gas, thermal shock and acidic condensate.

FROM SURFACE TO PROCESS ENGINEERING FLOW

The Exhaust Muffler & EGR / Heat Exchanger cannot be coated like just any part. A sound process needs measurement, pretreatment, the right coating selection, application and verification to work together.

01	02	03	04	05	06
ANALYSIS	**PRETREATMENT**	**ENAMEL**	**APPLICATION**	**FIRING**	**VERIFICATION**
Substrate + surface	Cleaning + surface	Chemistry + coat	Electrostatics + flow	Time + temperature	Test + record

A. Surface Characterisation

The condition of the substrate surface (cleanliness, roughness, oxide/scale and any weld zones) is determined. The right process starts with the right definition of the surface.

MEASURABLE INPUTS
Surface cleanliness • roughness • weld marks

B. Pretreatment Design

Degreasing and surface preparation; special preparation for the different microstructure of the weld zone ensures uniform adhesion.

CORE TARGET
Clean, active, uniform, repeatable surface

C. Enamel System Selection

A vitreous (porcelain) enamel chemistry resistant to high temperature and thermal shock is selected; CTE matching targets compressive stress on cooling and resistance to acidic condensate.

DECISION CRITERIA
Durability • appearance • service life • cost

D. Application Engineering

Electrostatic powder enamel is applied to the inner surface and fired onto the steel at ~780–850 °C; charge and motion recipe are set for continuous, pore-free coverage along the weld seams.

GEOMETRY EFFECT
Weld seam • Inner pipe surface • Flange mouth

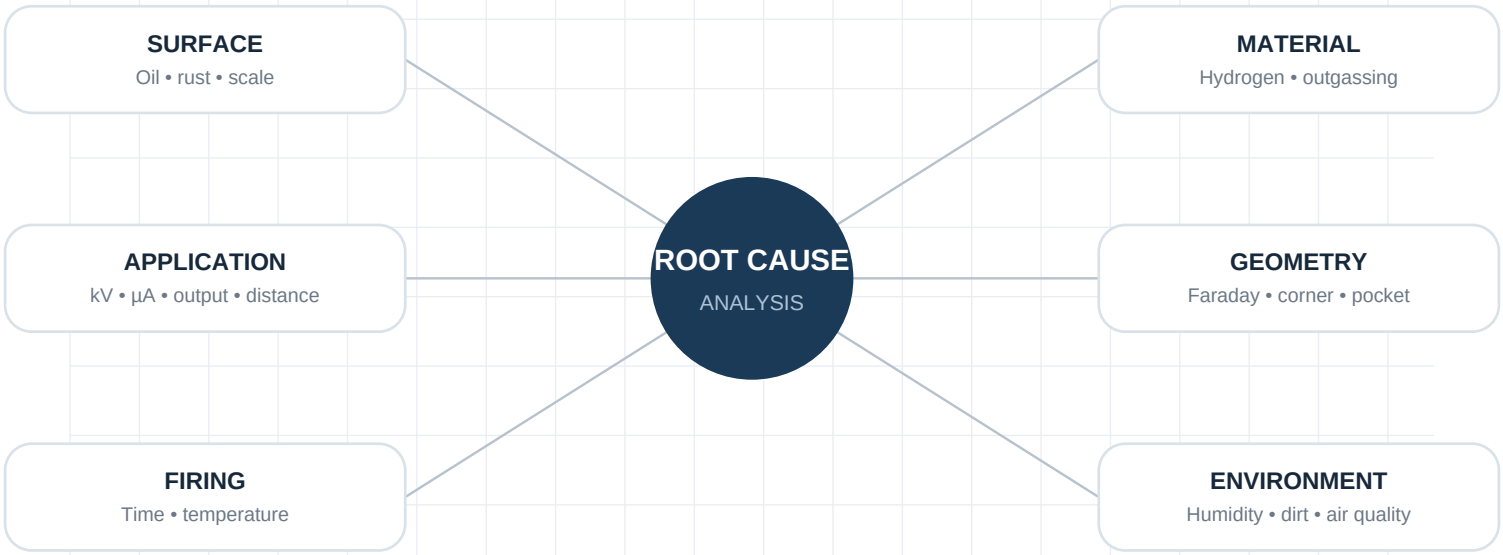
Managing the process with data, not by eye

µm	°C	kV / µA	Ω
COAT THICKNESS	**FIRING TEMPERATURE**	**ELECTROSTATIC CHARGE**	**GROUNDING**
Enamel coat uniformity	Actual firing condition	Transfer and penetration	Charge dissipation and stability

ENGINEERING PRINCIPLE In the Exhaust Muffler & EGR / Heat Exchanger process, we define a process window rather than a single parameter. The aim is to reproduce the same surface quality across different shifts and part conditions.

A SURFACE DEFECT IS A SYMPTOM, NOT THE ROOT CAUSE

Enamel defects rarely come from a single setting. The same symptom may stem from surface preparation, the steel structure, electrostatic behaviour, coat thickness or firing.



Common defects and diagnostic approach

POOR ADHESION

The enamel detaches from the substrate or fails the impact test.

CHECK: surface / pretreatment / firing

FISH-SCALING

Scale-shaped enamel spalling appears after firing.

CHECK: steel / hydrogen / firing

PINHOLE / BLISTER

Pinholes or blisters form on the surface.

CHECK: dirt / gas / humidity / oven

FARADAY ZONE

Insufficient penetration in deep corners and pockets.

CHECK: geometry / kV-µA / air

BACK-IONIZATION

Star/blister defects from overcharging.

CHECK: current / distance / thickness

UNEVEN THICKNESS

Thin and thick areas on the same part.

CHECK: position / motion / output

DIAGNOSTIC PROTOCOL

1 Define the symptom → **2** Measure the data → **3** Isolate the cause → **4** Test one variable → **5** Standardise

A GOOD SURFACE PROCESS must be measurable • repeatable • traceable • optimisable. This approach is the basis of part-specific application guides for parts such as the Exhaust Muffler & EGR / Heat Exchanger.

THE RIGHT EQUIPMENT, AT THE RIGHT SCALE.

For the Exhaust Muffler & EGR / Heat Exchanger, production volume drives the equipment choice. At low and medium volume, manual systems give flexibility; in series production, automatic systems apply the same recipe to every part.

LOW / MEDIUM VOLUME

Manual application



Smart (Powder Enamel)
Control unit for powder enamel application.



Powder Enamel Gun
Manual gun suited to enamel powder.



Powder Enamel Injectors
Feeding for abrasive enamel powder.



Powder Enamel Booth
Part-specific manual application booth.



Box Enamel Furnace
Firing in batch production.

SERIES PRODUCTION

Automatic line



Smart Automatic Powder Enamel
Line application with automatic guns.



OWL + Smart AI
Zone-by-zone application on corners, cavities and difficult areas.



Reciprocator
Automates the gun motion.



Automatic Powder Enamel Booth
In-line application and powder recovery.



Ultrasonic Recovery
Sieves recovered powder and separates foreign metal.



Powder Enamel Firing Furnace
Continuous firing, U-type or line-type.

OWL INTEGRATION In difficult areas such as weld seam, inner pipe surface, flange mouth, OWL applies targeted, zone-by-zone coating with a Smart AI recipe. For details, see the “OWL — Cavity” application sheet.

PROJECT SUPPORT Share your line, your part and your production target, and we will define the equipment selection and the booth, oven and conveyor layout together. strong3000.com · info@strong3000.com · WhatsApp +90 537 353 54 19