

EMISSHIELD®

Kiln optimization with high-emissivity coatings

Principle · Measurement concept · Case data from Bellenberg, Engels/TCKI and Jacobi

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Sales Manager Europe

EMISSHIELD® – Origin in space technology

High-emissivity technology for extreme thermal conditions – subsequently transferred to industrial high-temperature processes.



NASA origin Technology to improve the thermal performance of materials under extreme conditions.

“Space Certified” The technology was developed for space applications and transferred to applications on Earth.

Space Technology Hall of Fame Inducted in 2021



EMISSHIELD® in the kiln:

More radiant heat – lower process temperatures – measurable efficiency gains

$\epsilon \approx 0,9$

More radiant heat

Emisshield increases the emissivity of the kiln surface and improves re-radiation towards the cooler kiln load.

-40°C to -200°C^*

Process potential

At Engels/TCKI, the peak setpoint was reduced from $1,080^{\circ}\text{C}$ to $1,040^{\circ}\text{C}$ while maintaining comparable product quality.

* Result after coating a thermal afterburning unit

3 to 6%

Energy savings

Engels Oeffelt/TCKI: 3.1%
Jacobi Tonwerke: 4 to 5%
IZF laboratory batch kiln: 6%
Bellenberg brickworks: 6%

Emissivity (ϵ)

A measure of the ability of a body to emit or absorb energy compared with a black body at the same temperature.

WHY EMISSHIELD WORKS

The key is radiant heat transfer, not insulation.

Uncoated
refractory surface

$$\epsilon \approx 0,2-0,5$$

at kiln
operating temperatures



With Emisshield®

$$\epsilon \approx 0,9$$

more absorption and
re-emission towards the load

In the kiln, this means:

- more radiant energy reaches the kiln load
- refractory material stores less heat
- potential for lower setpoints and more uniform heating

$$Q = \epsilon \cdot \sigma \cdot A \cdot (T1^4 - T2^4)$$

Q = re-radiated energy absorbed by the kiln load [W/m²]

ε = emissivity factor of the coating

σ = Stefan-Boltzmann constant [W/m²K⁴]

A = surface area

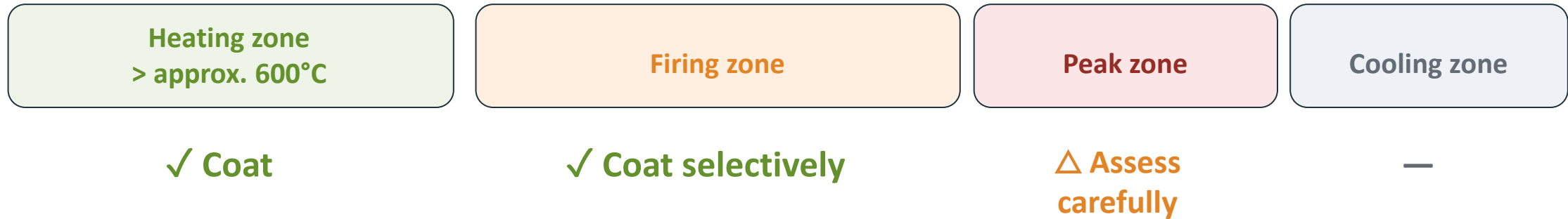
T1 = wall temperature [K]

T2 = load temperature (e.g. bricks in a tunnel kiln) [K]

The higher ε and the greater the temperature difference between the kiln atmosphere and the load, the greater the heat transfer.

WHERE TO COAT – AND WHERE NOT?

Kiln direction →



If the temperature difference between the product and kiln atmosphere is < 50°C, the coating becomes less effective. Assess whether coating may still be worthwhile (e.g. in terms of reject rate or product quality).

Refractory infiltration → **Potassium**

High potassium levels can cause the spalling off of refractory layer with the coating. Root cause: water (as transport medium for the coating) causes a chemical reaction with potassium)

KILN OPTIMIZATION

The benefits result from a controlled before-and-after process.

1

Baseline

Energy,
temperature
profile,
product quality,
emissions

2

Apply coating

suitable preheating
and firing zones

3

Stabilize

Bring the kiln back
to stable operation

4

Optimize firing curve

Gradually reduce peak
and preheating
temperatures

5

Measure again

Repeat Datapaq
and energy
balance

6

Ensure quality

Color, dimensions,
water absorption

WHAT NEEDS TO BE MEASURED?

Four measurement areas are sufficient if measured comparably before and after optimization.

1. PRODUCT TEMPERATURE

Place Datapaq thermocouples in outer and inner stacks, distributed across height and width.

2. ENERGY FLOWS

Record gas consumption of kiln and dryer, as well as flue-gas and kiln/dryer air flows.

3. PRODUCT QUALITY

Sample products from outer and inner stacks: water absorption, dimensions and visual quality.

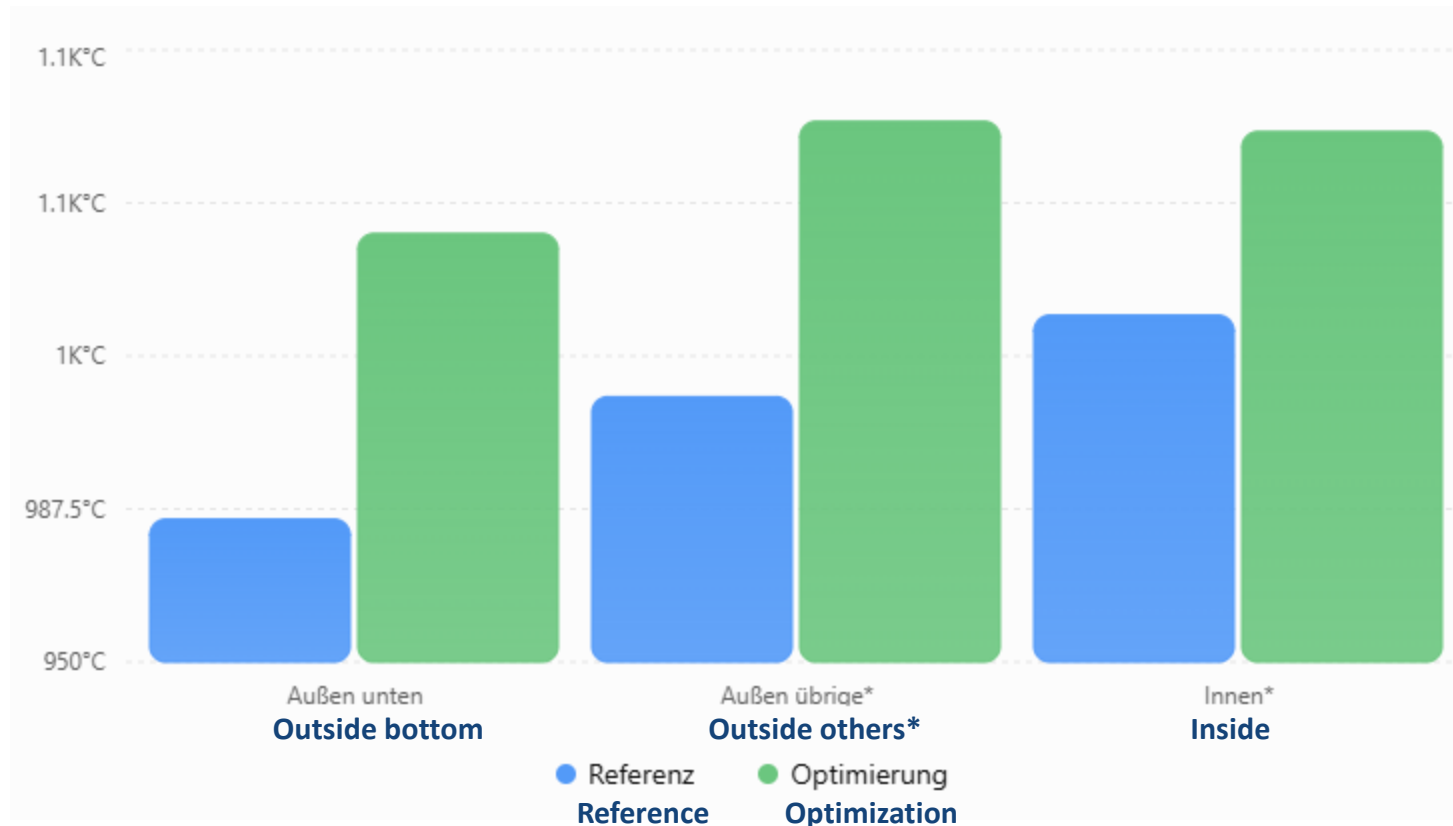
4. COMPARABILITY

Keep throughput and loading as constant as possible; repeat measurements after recipe changes.

Important: Do not focus only on the setpoint – actual product temperatures, energy flows and product quality are decisive.

ENGELS / TCKI: WHAT WAS ACTUALLY MEASURED?

1. PRODUCT TEMPERATURE



Temperature setpoint
Reference measurement: 1010°C

Temperature setpoint
Optimization measurement: 1040°C

→ Smaller temperature difference between the inner and outer stacks after coating

ENGELS / TCKI: WHAT WAS ACTUALLY MEASURED?

2. ENERGY FLOWS - RESULTS DURING THE OPTIMIZATION PHASE

-40 °C

Peak setpoint
1,080 → 1,040°C

-15 %

Net specific
kiln gas consumption*

≈ -3,1 %*

Specific gas consumption in 2024
vs. 20-year trend

Interpreting the result:*

Gas consumption in 2024 over 10 months after applying Emisshield. The start-up phase and firing-curve adjustments are included; a further reduction is expected after full optimization.

ENGELS / TCKI: WHAT WAS ACTUALLY MEASURED?

3. PRODUCT QUALITY - DURING THE OPTIMIZATION PHASE

Lengte afmetingen			Lengte afmetingen		
Positie wagen	Referentie	Optimalisatie	Positie wagen	Referentie	Optimalisatie
	[mm]	[mm]		[mm]	[mm]
R24-1	215.0	209.5	R13-1	215.0	207.5
R24-2	214.0	210.5	R13-2	214.5	207.5
R24-3	214.0	208.5	R13-3	213.5	209.5
R24-4	215.0	209.0	R13-4	213.5	210.0
R24-5	215.0	209.0	R13-5	214.0	209.5
R24-6	214.0	210.5	R13-6	215.0	208.0
R24-7	214.0	209.5	R13-7	213.0	207.5
R24-8	214.5	210.0	R13-8	214.0	210.5
R24-9	214.0	212.5	R13-9	214.5	210.0
R24-10	215.0	213.5	R13-10	216.0	211.0
Gemiddelde	214.5	210.3	Gemiddelde	214.3	209.1
Min	214.0	208.5	Min	213.0	207.5
Max	215.0	213.5	Max	216.0	211.0
Stdev 10x	0.50	1.60	Stdev 10x	0.89	1.35
Stdev 8, 9 en 10	0.50	1.80	Stdev 8, 9 en 10	1.04	0.50
Vrijwillige wateropname			Vrijwillige wateropname		
Positie wagen	Referentie	Optimalisatie	Positie wagen	Referentie	Optimalisatie
	[%]	[%]		[%]	[%]
R24-1	14	9	R13-1	14	9
R24-2	14	9	R13-2	13	8
R24-3	14	8	R13-3	14	8
R24-4	14	8	R13-4	13	8
R24-5	11	8	R13-5	14	8
R24-6	14	8	R13-6	15	7
R24-7	14	9	R13-7	13	8
R24-8	15	10	R13-8	14	9
R24-9	14	11	R13-9	14	8
R24-10	14	11	R13-10	14	9
Gemiddelde	13.8	9.1	Gemiddelde	13.8	8.2
Min	11.0	8.0	Min	13.0	7.0
Max	15.0	11.0	Max	15.0	9.0
Stdev 10x	1.03	1.20	Stdev 10x	0.63	0.63
Stdev 8, 9 en 10	0.58	0.58	Stdev 8, 9 en 10	0.00	0.58

Observations:

Dimensions: **smaller**

SD 0.5 → 1.6 (inner)

SD 0.9 → 1.4 (outer)

Water absorption: **lower**

SD 0.58 → 0.58 (inner)

SD 1.0 → 1.2 (outer)

Results after optimization:

After reducing the temperature setpoints, dimensions and water absorption are again within the range of the reference measurements.

CASE HISTORIES

CASE HISTORY: ZIEGELWERK BELLENBERG

Long-term reference since February 2021



400 m²

coated area

2021 → 2026

annual inspections

Coated areas

- Walls from kiln-car bottom level and ceiling
- Preheating zone from approx. 600°C to the end of the firing zone
- Coating extended in 2026 (from 500°C) and Touch-up

7.5% energy savings after kiln optimization, revised to 6% in the long-term comparison

CASE HISTORY: ZIEGELWERK BELLENBERG

Annual inspection and documentation

2022



2023



98 %

of the coated area intact;
no loss of performance. Flame impingement
damaged the refractory material, resulting in
spalling.



2024

2025

Customer statement 2026

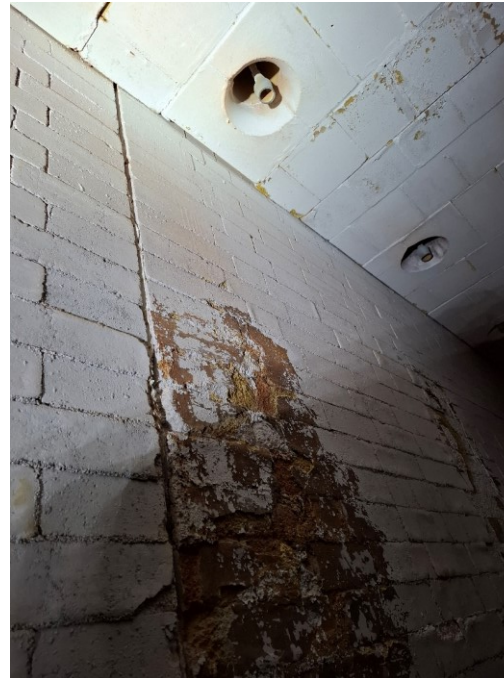
*"Since the coating was applied in 2021,
refractory bricks did not have to be
replaced again until 2026; before
coating, replacement was annual.
In addition: more uniform heating and
fewer rejects."*

CASE HISTORY: ZIEGELWERK BELLENBERG

Local refractory damage/coating spalling



LOCAL SPALLING OF REFRACTORY MATERIAL



FLAME IMPINGEMENT



"TOUCH-UP"

CASE HISTORY: JACOBI TONWERKE - BILSHAUSEN

116 m²

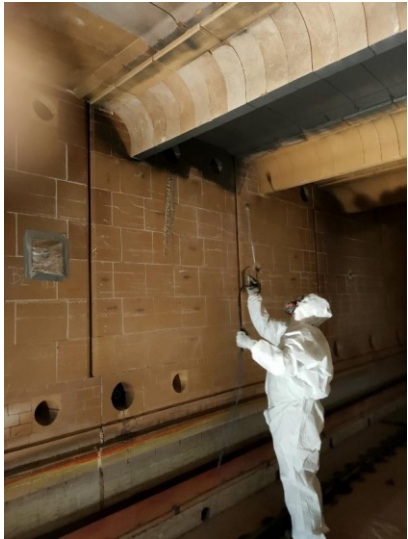
coated area

-3 %

Rejects

-6 %

Energy
consumption



Quality assurance

- Surface: exceptionally clean, no loose material
- Thermocouples masked to avoid affecting measurements
- Airless application; mixing times, temperatures and humidity documented
- ASTM 3359 adhesion tests: excellent adhesion

CASE HISTORY: STEULER GROUP - NORDCERAM BREMERHAVEN

SACMI roller kiln · Gas · max. 1,220°C



Subsequently, all roller kilns in the Steuler Group were coated (3 in Bremerhaven, 2 in Mühlacker and 4 in Leisnig)

250 m²

coated area

+4 %

Production

-6 %

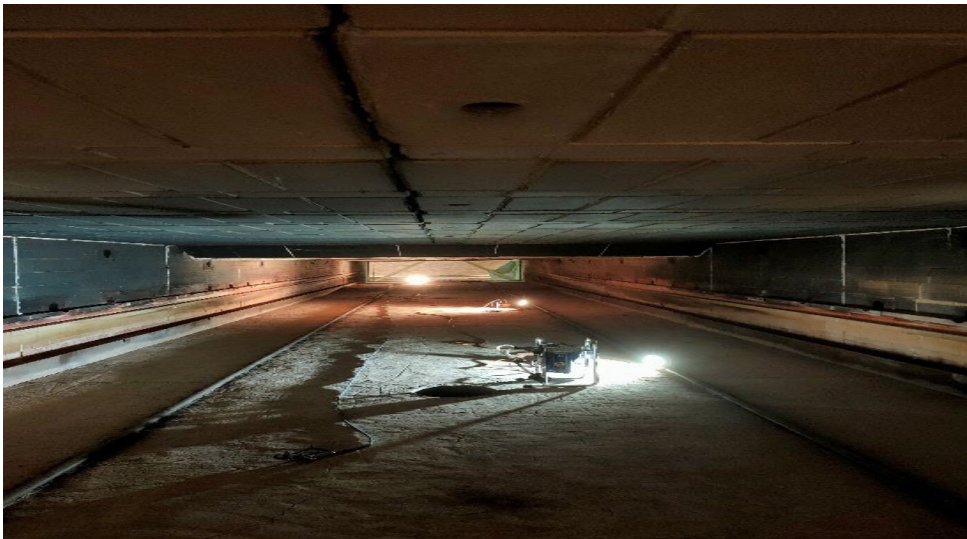
Energy
consumption

Observations / measures

- Applied in July 2022: walls and ceiling.
- Preheating zone from 600°C to the end of the burner zone.
- Additional benefit reported in the case history: more uniform heating.

CASE HISTORY: CREATON GUTTAU

Tunnel kiln – Gas – 1100°C – oxidizing and reducing



Subsequently, the second kiln at CREATON Gutttau was coated, as well as additional kilns in Roggden and Lenti (Hungary).

235 m²

coated area

3,5–6 %

Energy savings

+50 °C*

Flue-gas
temperature

Observations / measures

- Applied in November 2021
- Preheating zone from 600°C and burner zone.
- ***Flue-gas temperature increased by 50°C (before optimization).**
- After evaluating kiln data: burners switched off and firing setpoints reduced for each brick format

CASE HISTORY: WALTHER DACHZIEGEL - LANGENZENN

STROHMENGER Tunnel kiln – gas – max 1020°C



205 m²

coated area

+8 %

Production

-4 %

Energy
consumption

Observations / measures

- Applied in February 2022
- Loading the lowest cassette level was not possible before coating due to quality problems.
- Improved temperature distribution after coating improved product quality, allowing the lowest cassette level to be loaded.
- Lower energy consumption despite increased production.

CASE HISTORY: INSTITUTE FOR BRICK AND TILE RESEARCH

Laboratory kiln – gas – ceramic fiber – max 1100°C



before coating



after coating
in August 2020

5 m²

coated area

-6 %

Energy
consumption

CONFIRMATION

DATUM
24.05.2026

In September 2020, we had our fiber-lined laboratory kiln coated with Emisshield. The kiln is fired with natural gas, although numerous firings using hydrogen as a fuel have already been conducted. Several tests conducted immediately after the coating revealed an energy savings of 6%.

All products of the heavy clay ceramics industry are fired in the kiln, including porous masonry bricks, paving clinkers, facing bricks, and roof tiles. The latter come in natural red, engobed, or glazed varieties, meaning the coating is subjected to constantly changing atmospheres. The kiln operates in batch mode, involving continuous heating and cooling cycles.

To date, no damage to the coating has been detected, despite the constantly changing thermal loads under a wide variety of atmospheres.

Eckhard Rimpel
Deputy Manager

SUMMARY

COATING PROJECT WORKFLOW

A Measure before

- Datapaq temperature profile
- Gas/energy flows
- Product quality
- Throughput & loading

B Plan and execute

- Complete project questionnaire
- Select zones by ΔT
- Check substrate
- Protect thermocouples
- Quality inspection after coating

C Optimize afterwards

- Stabilize kiln
- Adjust temperature curves step by step
- Reduce kiln setpoints
- Datapaq temperature profile
- Check product quality

D Long-term checks

- Energy monitoring
- Visual inspection during kiln shutdown

WHY EMISSHIELD?

1

Green Technology

High emissivity improves radiant heat transfer – particularly with large temperature differences and low-emissivity surfaces (ceramic fiber).
Reduces carbon footprint and harmful emissions



2

Evidence

More than 50 projects; involvement of renowned institutes (IZF, TCKI) and customer references (Bellenberg brickworks, Jacobi Tonwerke, CREATON Gutttau, Engels Oeffelt, etc.).

ROI ~ 1 year

3

Durability

After five years of operation, 98% of the coating at Bellenberg brickworks remains fully intact.
No deterioration in product quality and/or energy savings.

4

Independent data

Figures, data and facts from IZF, TCKI, Thermwin Technologies, WBU, Ghent University (<https://improof.cerfacs.fr>) support its effectiveness.

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