RHI MAGNESITA

Supporting Glass Melting Sustainability with Refractory Innovation

Glassman Latinamerica, May 21, 2026

Presenter: Ignacio Ramirez Lozano

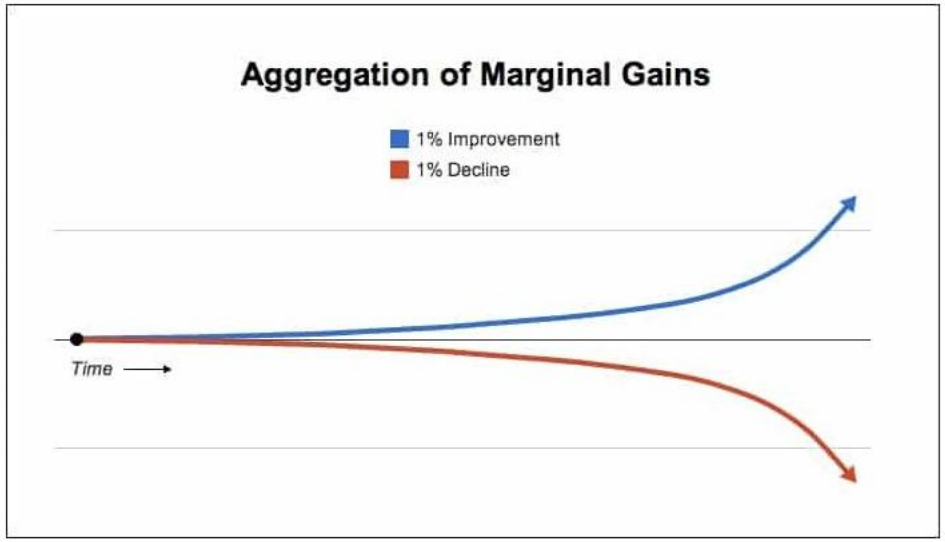
The Principle of Marginal Gains

The power of improving every tiny thing by 1%

Photo source: British Cycling

Sir Dave Brailsford turned Cycling into Great Britain´s most successful sports with this philosophy.
From 2007 to 2017

- 178 world championships
- 66 Olympic or Paralympic gold medals
- 5 Tour de France victories



Principle of Marginal Gains-Coach Improves Everything By One Percent | Limelight Consulting

Agenda

- RHI Magnesita Introduction
- INNOREG Checkerpack Concept Update
- The Melter´s Crown Emissivity Improvements

The global leader in refractories

There for you, wherever you need us

RESCO® PRODUCTS, INC.

2025 Aquisition
$250 MUSD revenue
Steel
Petrochemical
Non-ferrous

65 production sites
(incl. raw material sites)

12 recycling facilities

+100 countries shipped to worldwide

5 R&D hubs and centres

20,000
Employees

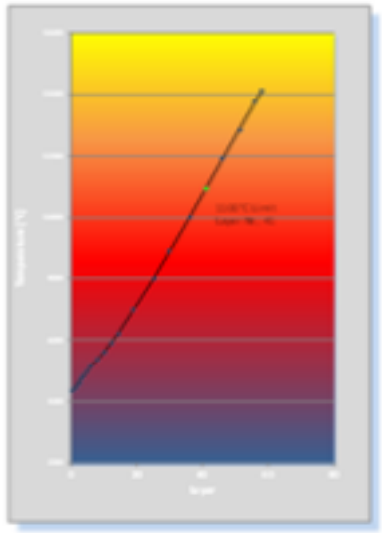
€ 3.5bn
2024 revenue

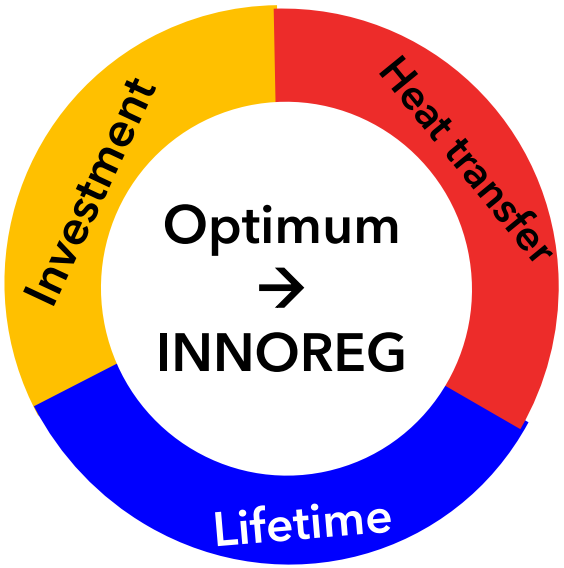
+ 1,700
Active patents

€ 83m
Investment in R&D and Technical Marketing

RHI Magnesita Regenerator Approach

INNOREG is a Toolbox aimed to design a tailor made regenerator, optimized for each customer





STEP 1 Customer Input

- Dimensions
- Expected Operating Conditions
- Furnace Experiences
  - Previous Lining Performance
  - Observed Corrosion or Clogging
  - Maintenance requirements
- Future Expectations

STEP 2 RHIM´s Analysis

- General Assessment; Fuel, Combustion, main corrosive components
- Clogging Potential Evaluation
- **R21 Thermal Model**

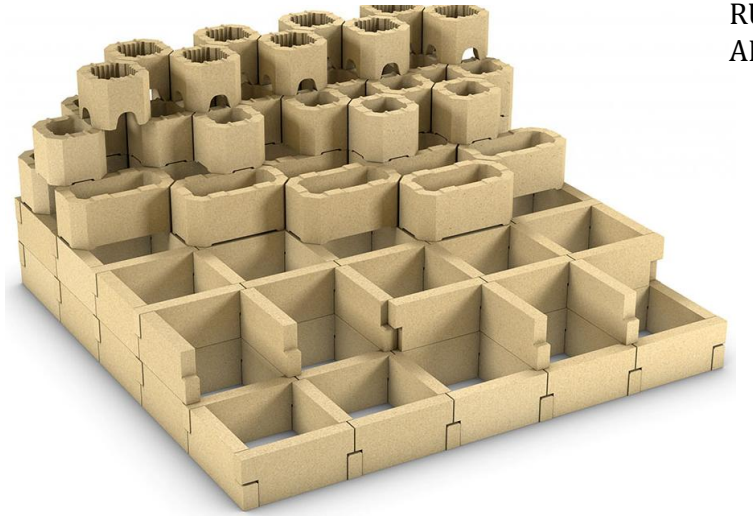
STEP 3 Recommendations

- Zone Layer Definition
- Grade & Shape Selection
- Clogging Risk Reduction
- Simplify Cleaning
- Casing Grade Configuration

Actual Solution

TLW is RHIM Standard since 2018

TL Industry Standard



Top Layers
RUBINAL VZ
DURITAL AZ58 TS
DURITAL RK10 TS
DURITAL K99 Extra

TG

Hot Zone
RUBINAL VZ
ANKER DG1

TL

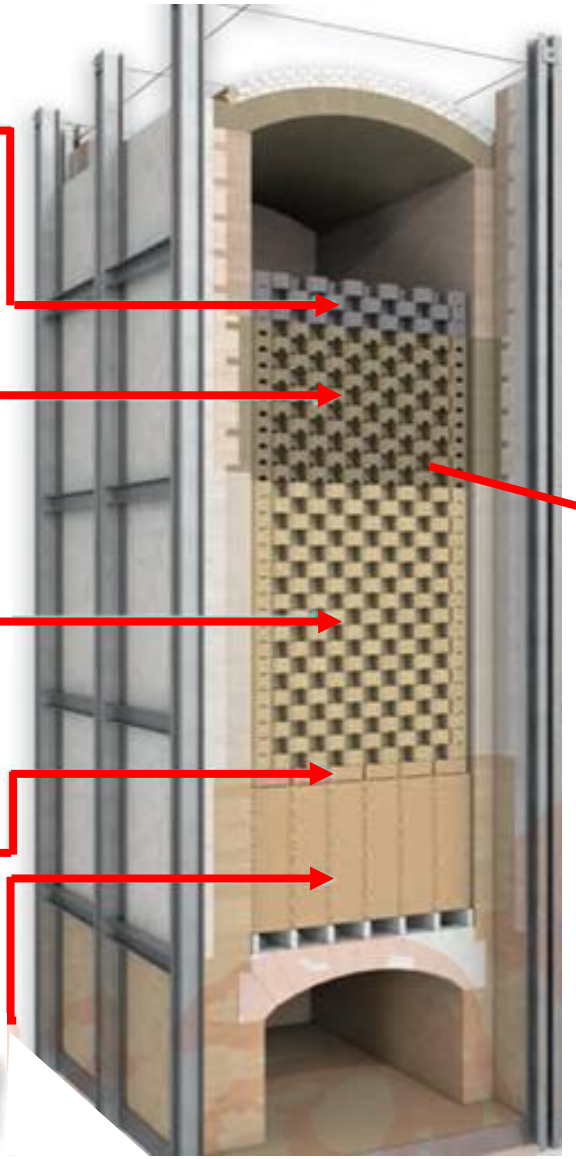
TLW

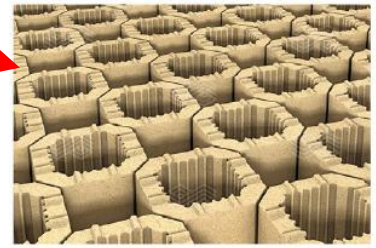
Condensation Zone
<1100° C
RUBINAL EZ
RUBINAL ESP

TG

TG32

LCP





LCP offers a larger flue cross section area to reduce the risk of clogging due to sodium sulfate

Checkerpack Concept Update

Energy Efficiency Improvements

Concept Updates

- *175mm tall Chimney Block Setting to 150mm*
- *TG to TLW in the Upper condensation zone*

Shape Developments

- *TGW*
- *TIP Checker Insert Piece*

TIP

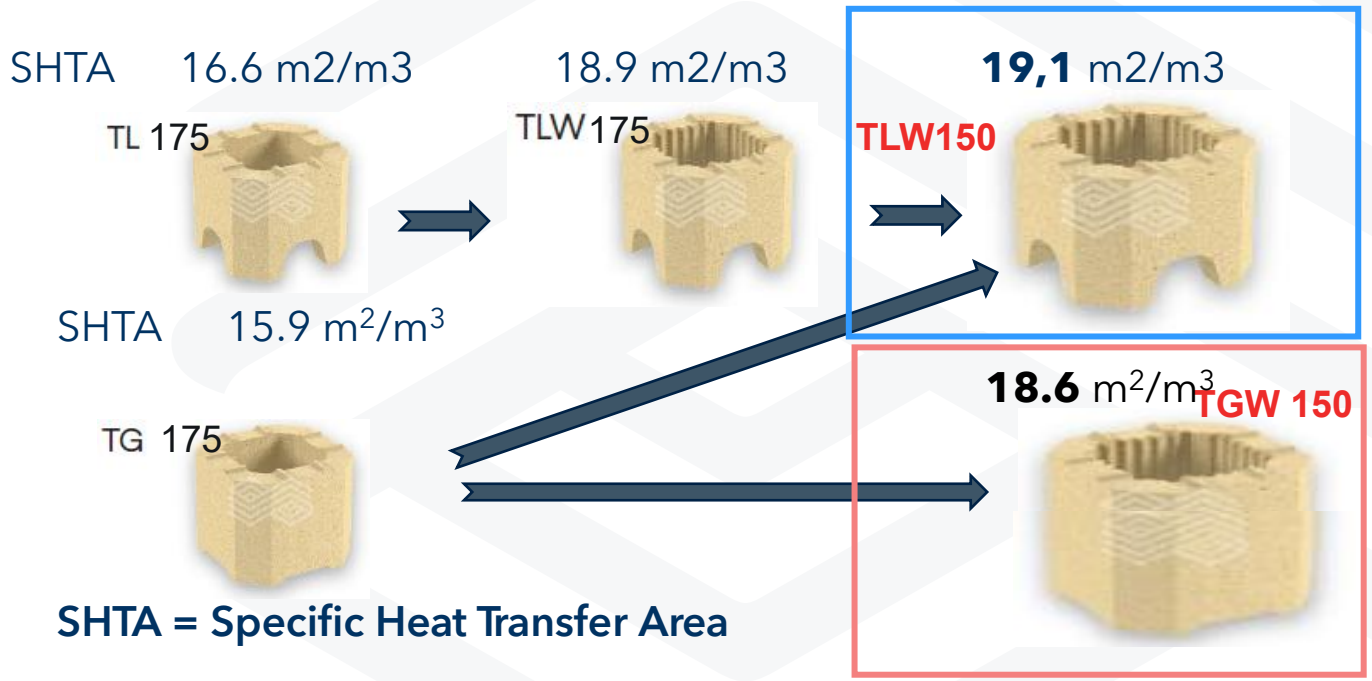
TGW150

TGW150

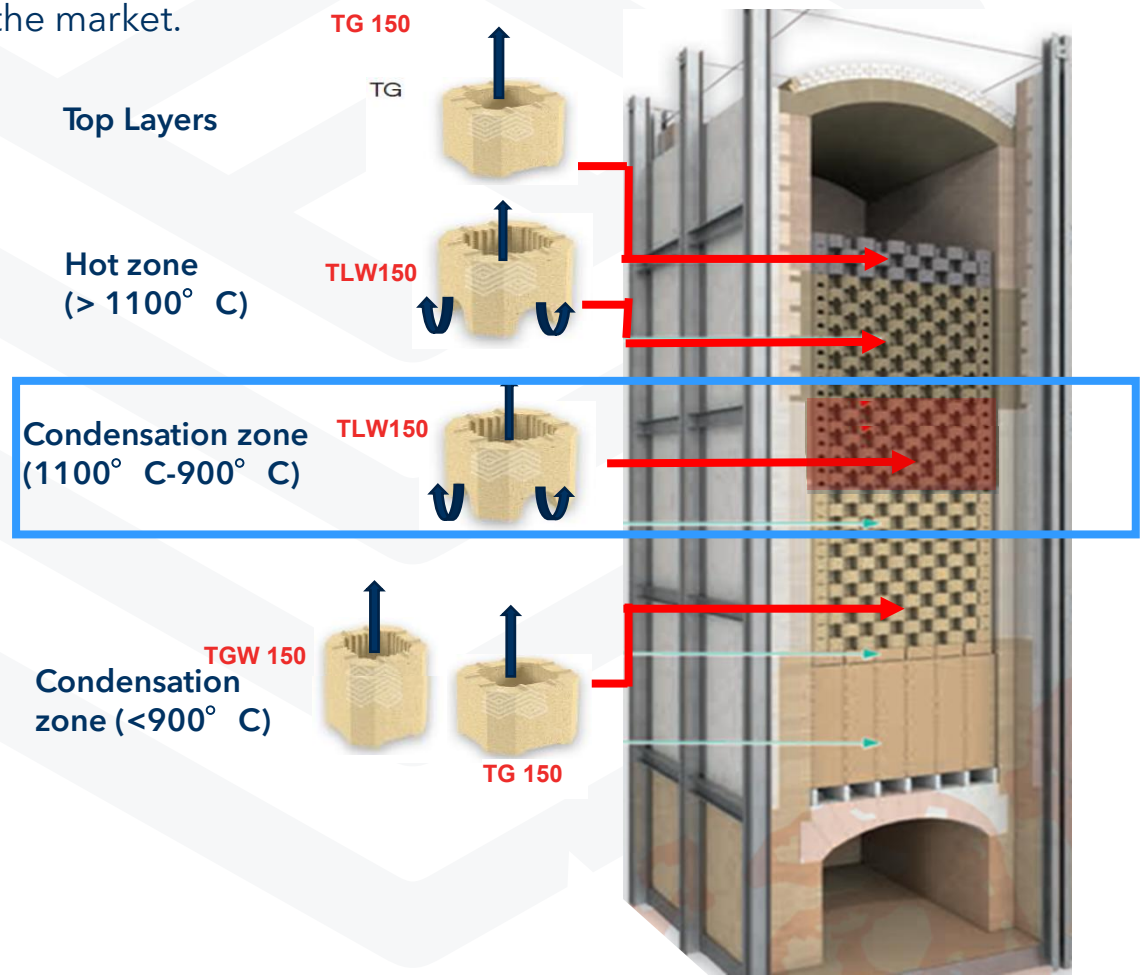
Checkerpack Concept Update

Regenerator High Efficiency Shapes

The TLW shape , introduced in 2018, is now RHI Magnesita´s standard shape for the hot zone, achieving the highest efficiencies among the checker settings available in the market.



SHTA = Specific Heat Transfer Area



Checkerpack Concept Update

Our New TIP-Shape

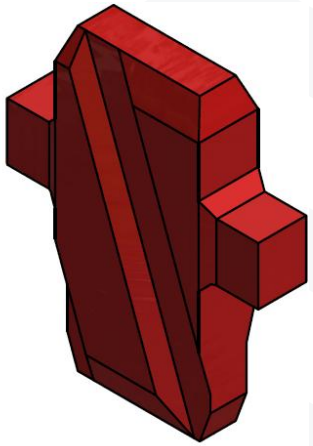
Only for the low clogging risk locations;

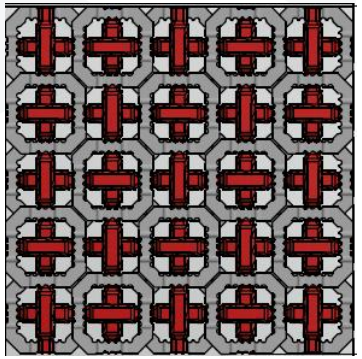
- The hot zone mostly gaseous phases
- The upper condensation zone presents only liquids

The insert piece TIP, allows reducing the flue only in the desired zones.

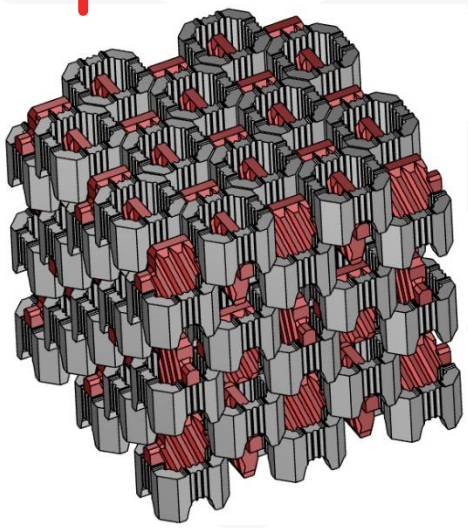
RHI Magnesita standard flue width is 142mm

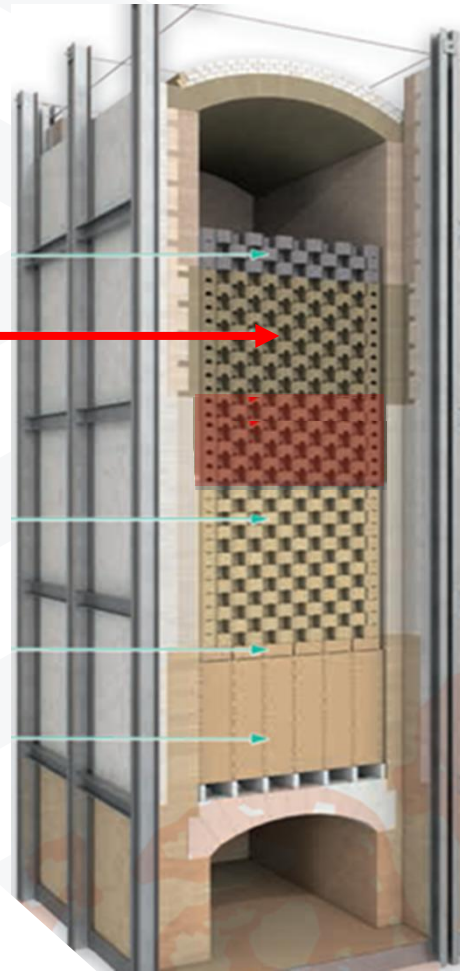
The TIP configuration presents the very high specific heat transfer area of 24.9 m^2/m^3





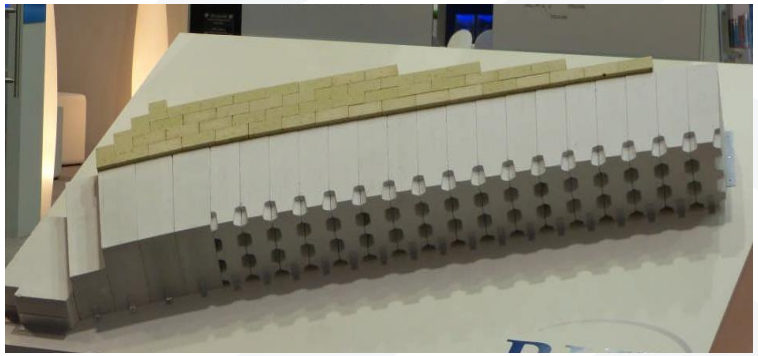
TIP



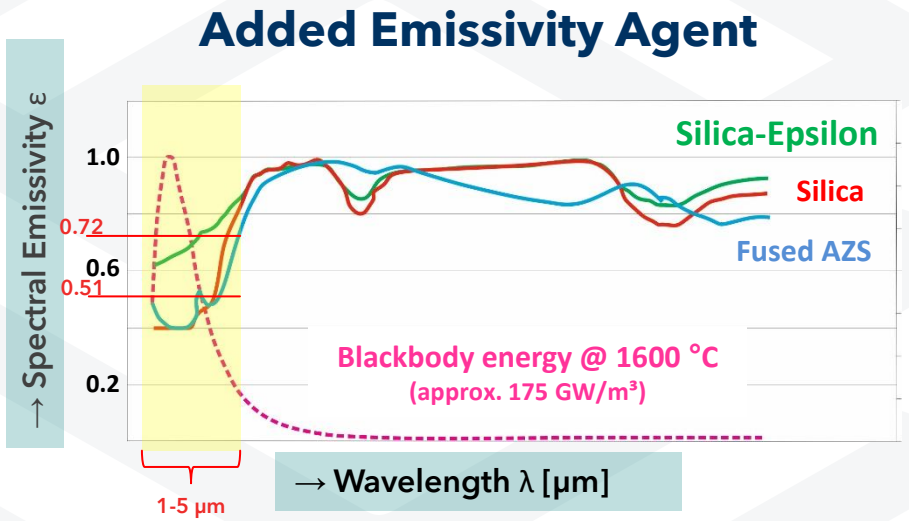


Melter´s Crown Emissivity Improvement

Honeycomb shape



Epsilon Silica Grade



Emissivity values :

0.51 Standard Silica

0.72 Silica + Emissivity Agent

> 80 % of the energy transmitted by radiation @ 1550-1600 °C is in the wavelength range of 1-5 µm.

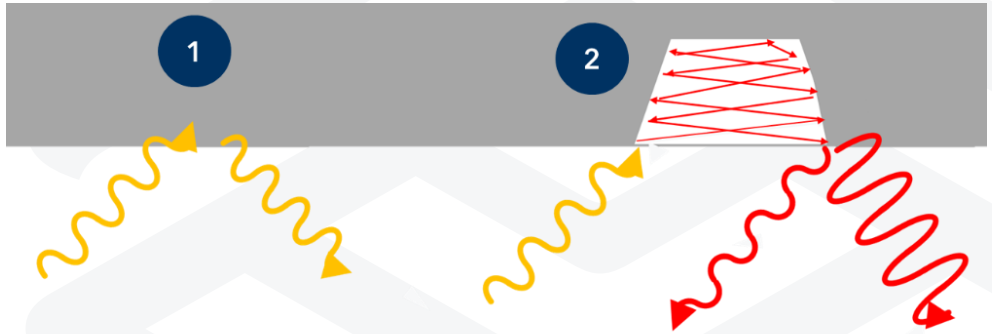
(Lab Measurements by the University of Duisburg)

The Honeycomb Crown

Emissivity Increase

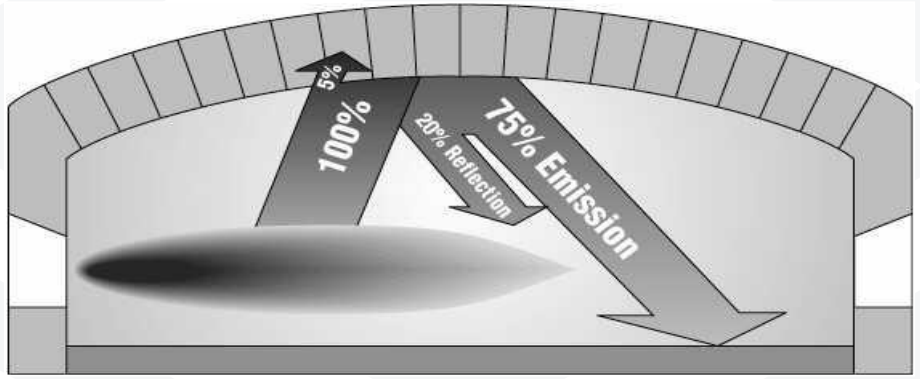
$$Q_{G,W} = A_w \cdot C_S \cdot \varepsilon_W (T^4_W - T^4_G)$$

Aw increased by 200%
εw is increased since the cavities change the radiation wavelength

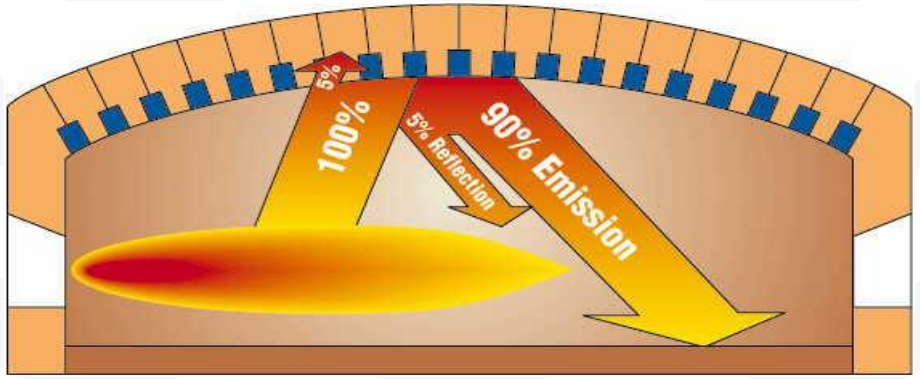


Emission and absorption of radiation for a determined gas molecule (combustion gases) happens in the same wavelength.

The waste gas has less available radiation at the original wavelength to re-absorb.



20% Waste Gas Energy

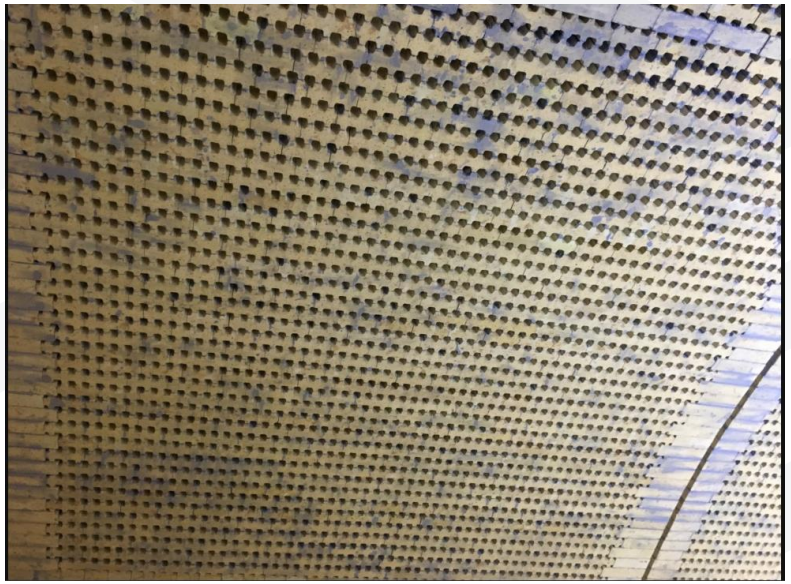


5% Waste Gas Energy

Honeycomb Shape Crowns– Field Results

The endoscopy shows that the cavities are brighter than the flat surface, improving the radiation wavelength

Our customers with a proven experience in Honeycomb crown application, **refer a 4% of fuel saving**



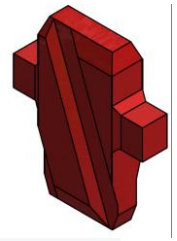
Above, a container glass melter crown with 6.5 years in service.

The observed corrosion is not different than traditional shaped crowns.

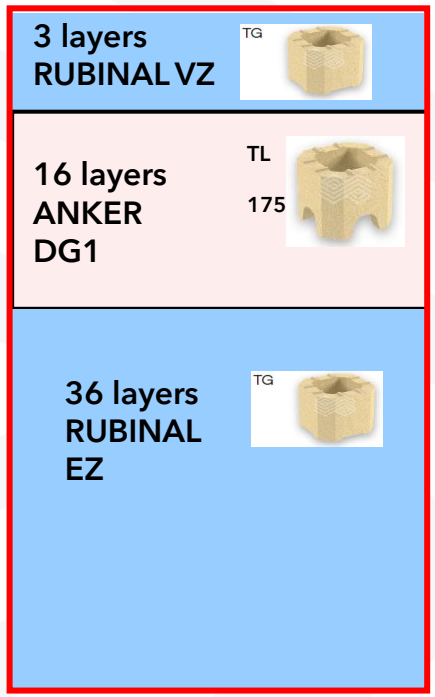
Potential Benefits

Checkerpack layout Comparison

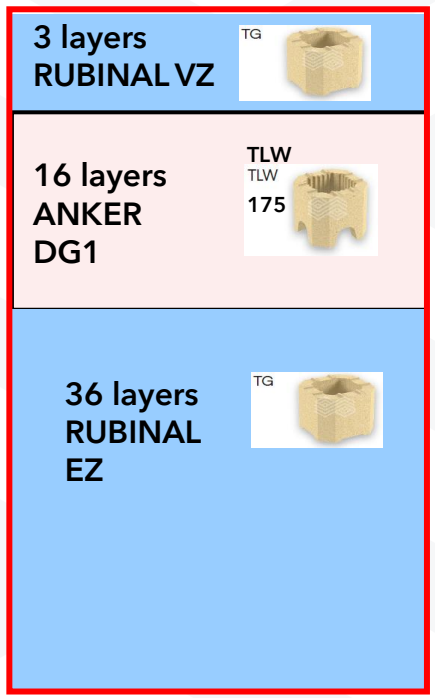
The figures given below are a real case example.



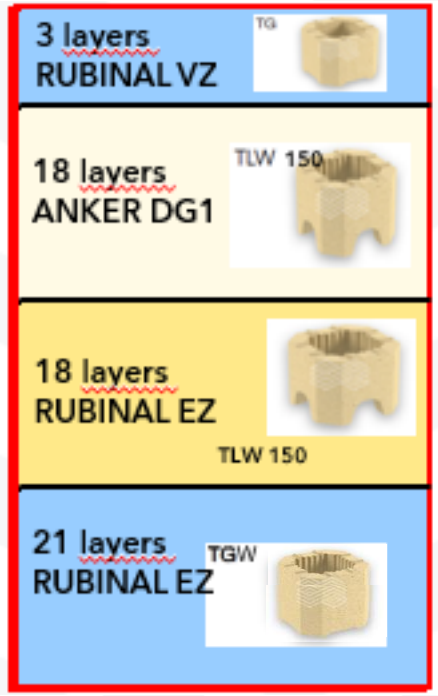
Customer data (furnace conditions)	
Furnace area	128,8 sqm
Regenerator depth	6590 mm
Regenerator width	4790 mm
Checker Height	9625 mm
Air Temp below rider arches	150°C
Temp Flue gases top checkers	1450°C
Reversal time	20 min
Fuel consumption (NG)	1677 Nm^3/hr
Furnace melting rate	450 tpd
Cullet ratio	70%
Batch Humidity	5%
Batch preheating	NO
O_2 excess in the waste gases	2%
Electric boosting	3600 KW



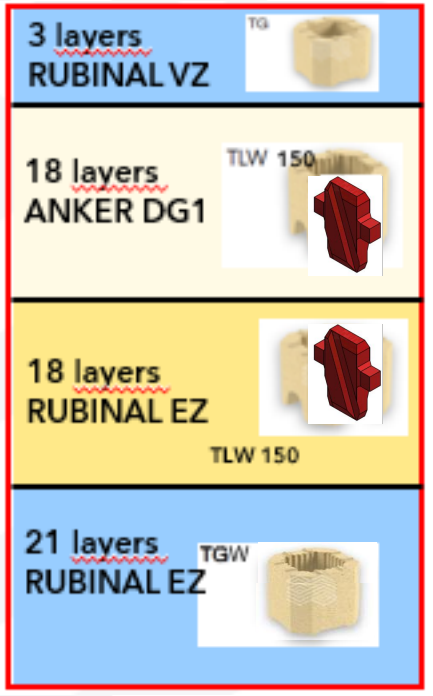
Industry Standard
175mm layers
TG VZ
TL DG1
TG EZ



RHIM since 2018
175mm layers
TG VZ
TLW DG1
TG EZ



RHIM NEW
150mm layers
TG VZ
TLW DG1
TLW EZ
TGW EZ



NEW with TIPs
150mm layers
TG VZ
TLW DG1 w/TIP
TLW EZ w/TIP
TGW EZ

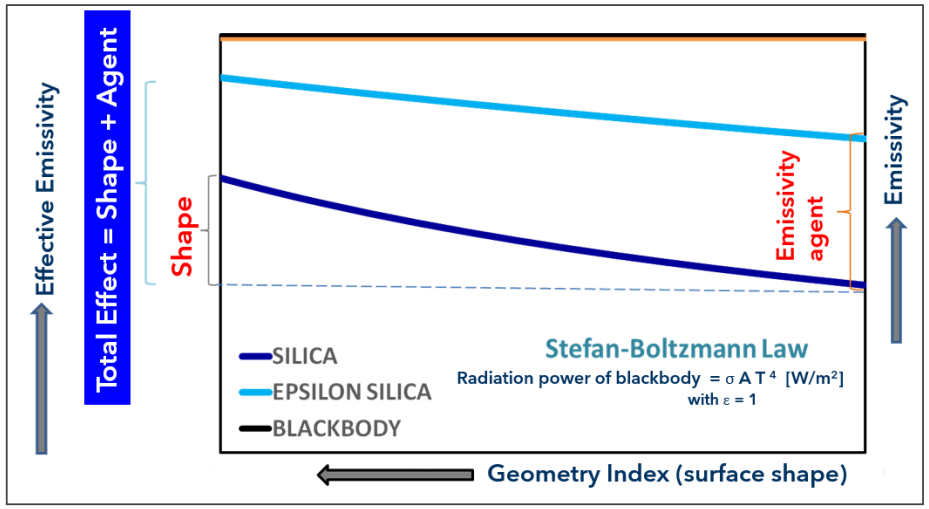
Potential Benefits
Checkerpack Comparison

$$\varepsilon = \frac{T_{out\ AIR} - T_{in\ AIR}}{T_{in\ FLUE\ GAS} - T_{in\ AIR}} < 1$$

CHECKER CONFIGURATION	EFFICIENCY	PREHEAT AIR TEMPERATURE	FUEL CONSUMPTION	ΔCO_2	Energy + CO_2= Savings $/Y*
Industry Standard TG14/175 TL14/175 TG14/175	90.0% 66.3	1.320°C	1.677 Nm3/h 516,400 GJ/year Reference	Reference	Reference
RHIM 2018 Standard TG14/175 **TLW14/175** TG14/175	90.7% 66.8	1329°C	-6 Nm3/h -2098 GJ/year -0.41%	117 T/year	$5,728+$3,234= $8,962 / year
RHIM New Standard TG14/15 **TLW14/15** **TLW14/15** **TGW14/15**	92.9% 68.6	1358°C	-27 Nm3/h -8,857 GJ/year **-1.72%**	-492 T/year	$24,180+$13,599= **$37,779 / year**
New Standard with TIPs TG14/15 **TLW14/15 +TIP** **TLW14/15 +TIP** **TGW14/15**	95.4% 70.5	1390°C	-50 Nm3/h -16,316 GJ/year **-3.16%**	-906 T/year	$44,543+$25,042= **$69,585 / year**

RGGI CO2 = 27.64 USD/tCO_2e (March 2026)
Cost of NG USA (Henry Hub) = 2.88 USD/MBTU (May 2026, 2.73 USD/GJ)

Potential Benefits
Increasing the Crown´s Emissivity



Same reference case used previously;

- 450 tpd
- 128.8 m2

	Estimated Energy Savings	Δ Fuel	ΔCO_2	Savings $/Y
Honeycomb Shape	**4 %**	-20,656 GJ/year	-1,148 T/year	$56,391+$31,731 = **$88,122 / year**
Epsilon Technology	**1.5 %**	-7,746 GJ/year	-430 T/year	$21,147+$11,885 **= $33,032 / year**

RGGI CO2 = 27.64 USD/tCO_2e (March 2026)
Cost of NG USA (Henry Hub) = 2.88 USD/MBTU (May 2026, 2.73 USD/GJ)

Winning the world cup was not about doing one thing 100% better, but about doing 100 things 1% better.”

Sir Clive Woodward

[Marginal gains make more money - Baker Richards]

RHI MAGNESITA

Thank you for your attention

Get in Touch

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