GLASSMAN EUROPE 2025
14-15 May 2025, Istanbul, Turkey

IMPROVEMENTS

in glass melting technology to meet sustainability requirements

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HORN GLASS INDUSTRIES

WHO WE ARE

HORN is a medium-sized company with many years of experience in **planning**, **manufacturing** and **building** glass melting **furnaces as well as turn-key** glass plants.

FACTS

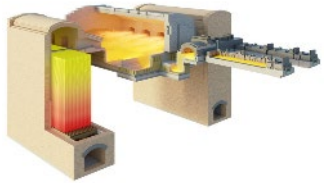
- Turnover: between 60 and 140 million euros
- About 475 employees worldwide
- 650 customers in 75 countries
- Approx. 15 – 20 major furnace projects per year
- Approx. 35,000 t/d of glass produced by HORN
- > 60 e-Fusion melting boostings in operation
- > 1,000 HORN burners in operation
- 150 HORN furnaces in operation worldwide
- 11 turn-key plants in operation
- > 150 automations in operation

TRENDS & CONTENT

REDUCING THE CARBON FOOTPRINT

End Fired

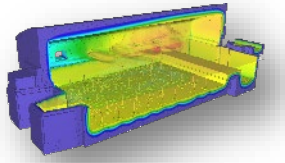
Cross Fired

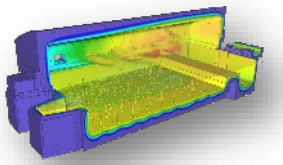


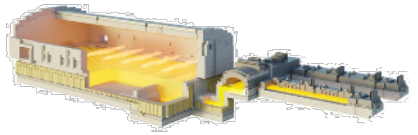
Recu

Oxy-Gas

All electric





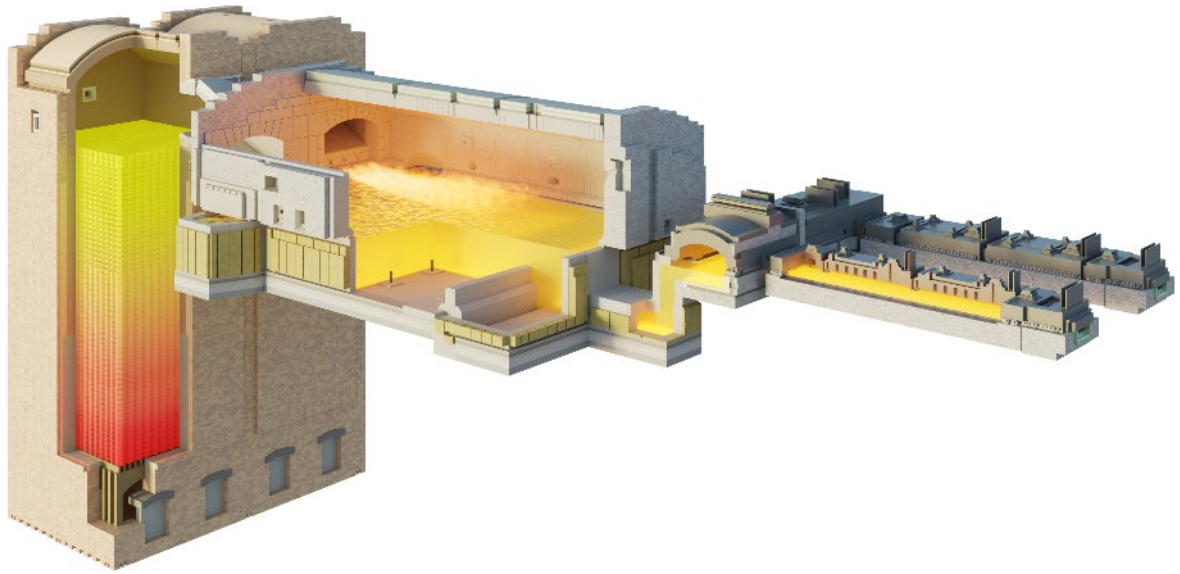


OPTIMIZED HYBRID SUPER-HYBRID H_2/O_2 LARGE AEF

FURNACES

ECO END FIRED FURNACES < 3GJ/TO (<717 KCAL/KG)

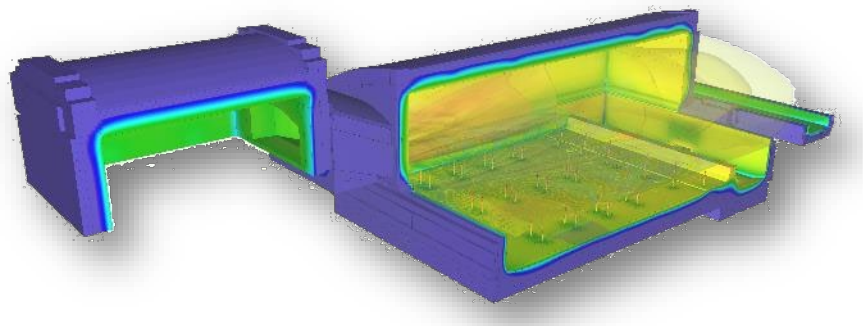
- Lowest energy consumption
- Cullet share >85%
- Bottom boosting >10% with double electrodes
- HORN pusher batch charger with semi-closed doghouse
- Advanced insulation concept for furnace/regenerator
- Optimized design of regenerator / port neck / superstructure / glass bath



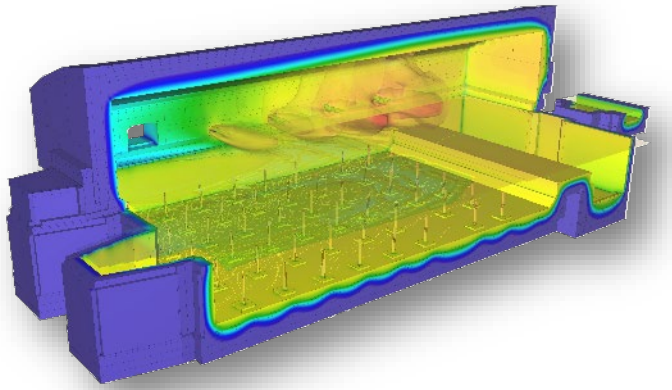
FURNACES

HYBRID FURNACES – ELECTRICAL SHARE UP TO 50%

- Based on proven technology
  Hybrid – End Fired Furnace EFF
  Hybrid – Oxy Gas Furnace OXY
- Security of invest



Hybrid - EFF

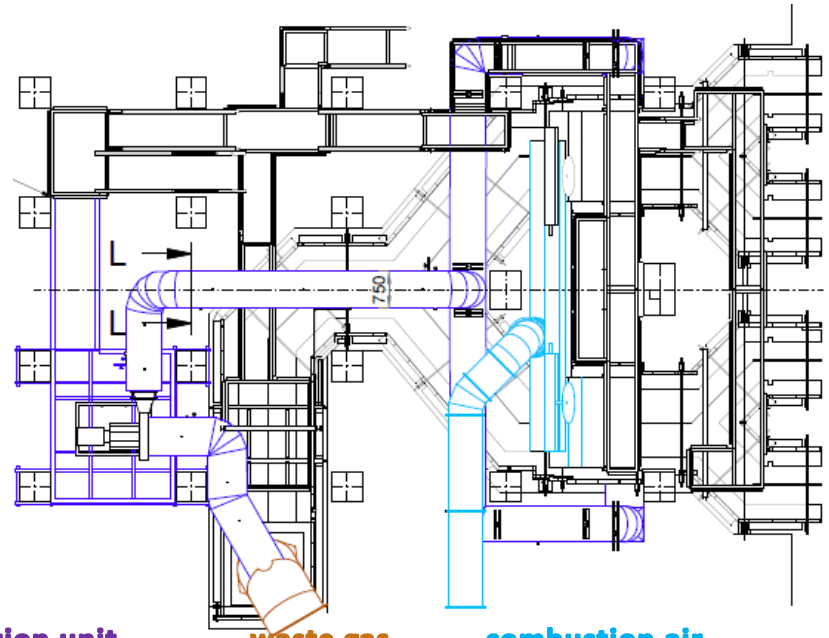


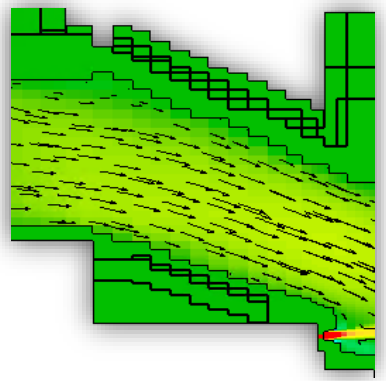
Hybrid - OXY

FURNACES

END FIRED HYBRID FURNACES – ELECTRICAL SHARE UP TO 40%

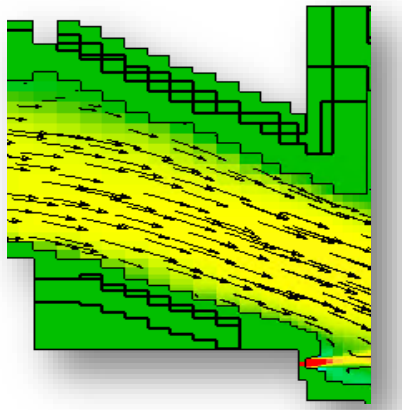
- Partial recirculation of waste gases into combustion air (about 20% recirculation) @ EFF
- Recirculation increases the velocity of combustion air > normal flame length





Without recirculation

> low air velocity @ 40% E.



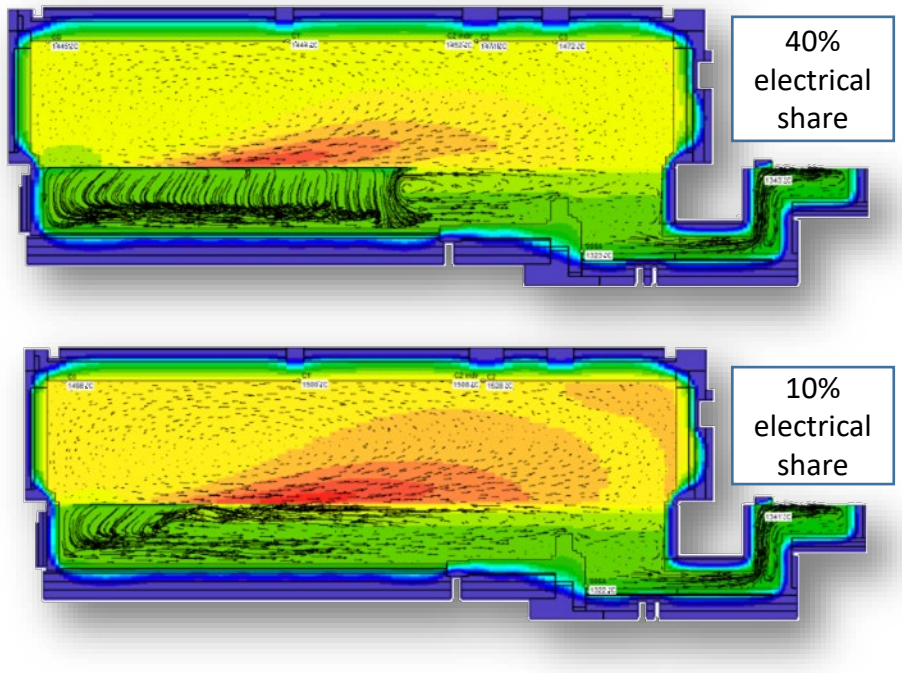
With recirculation

> normal air velocity @ 40% E.

FURNACES

HYBRID FURNACES – ELECTRICAL SHARE UP TO 50%

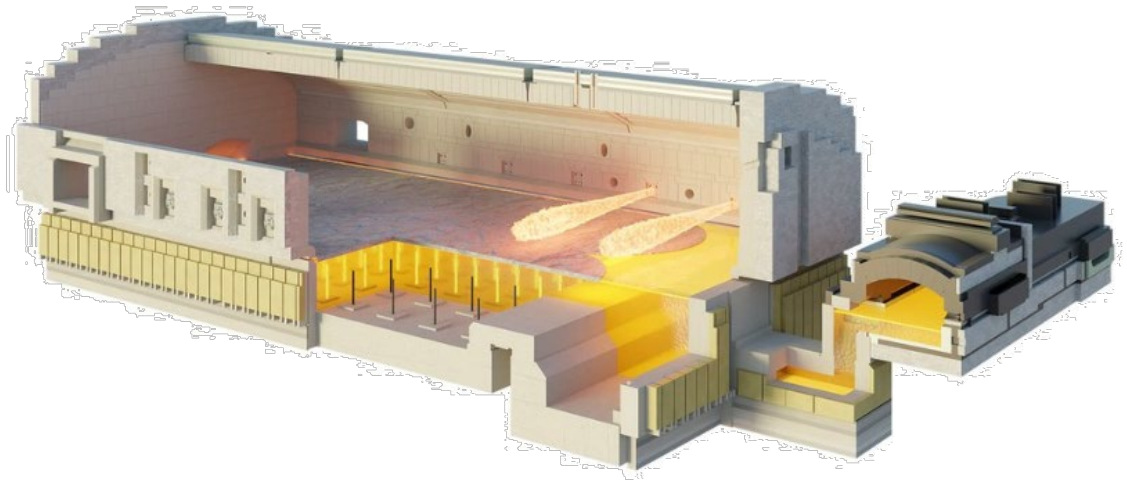
- Electric power share 20% up to 40% @ EFF
  up to 50% @ OXY / RECU
- Low specific energy consumption (< 3 GJ)
  Low carbon footprint



FURNACES

SUPER HYBRID FURNACES – 50 - 80% ELECTRICAL SHARE

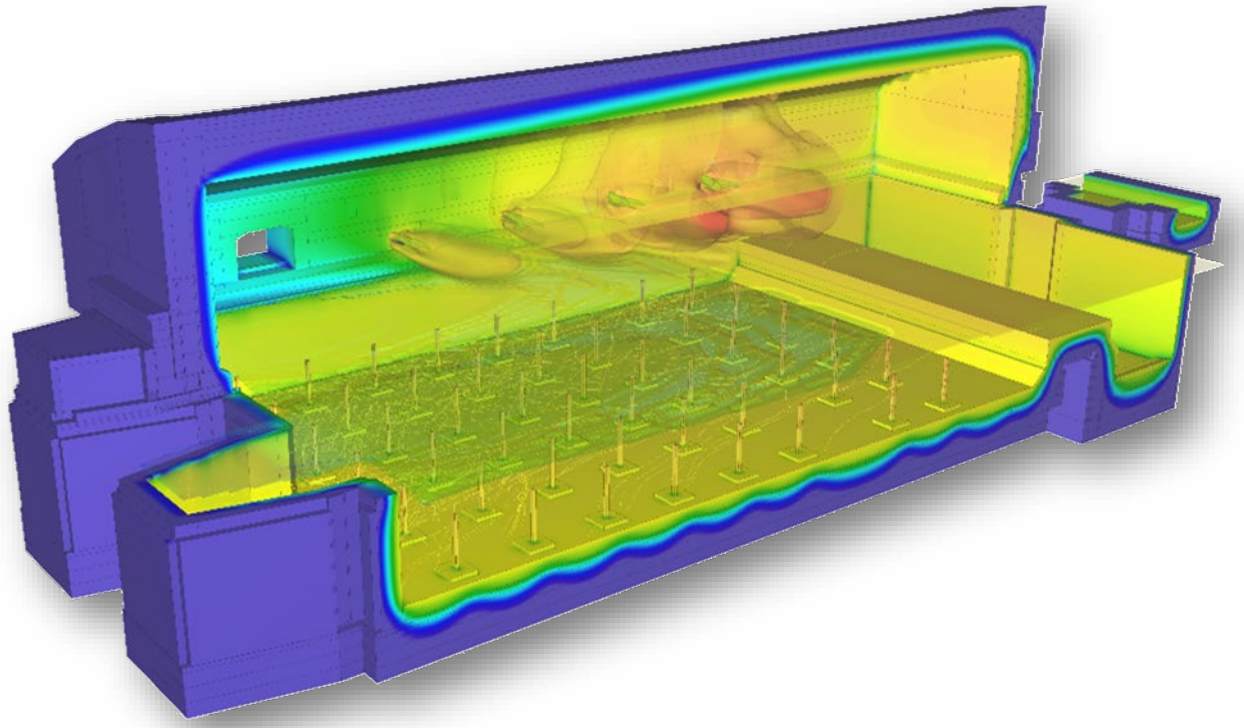
- Cross fired Gas-Oxy-Furnace
- Electrical share: 50% <> 80%



FURNACES

SUPER HYBRID FURNACES – 50 - 80% ELECTRICAL SHARE

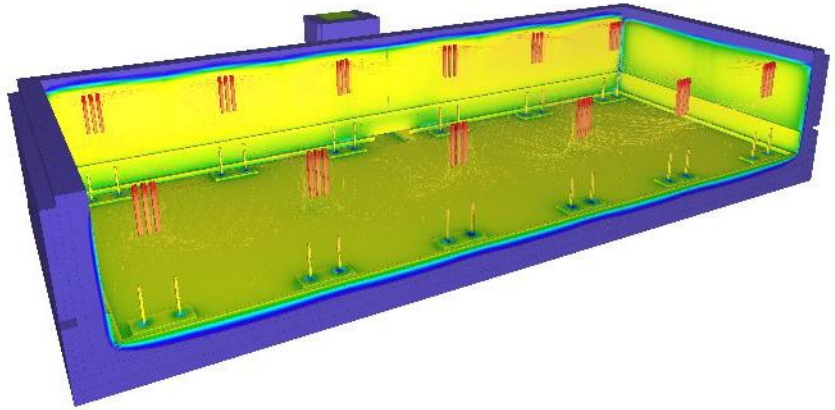
- Cross fired Gas-Oxy-Furnace
- Electrical share: 50% <> 80%
- Deep refining section: > 2,5 m glass bath
- No lime Silica crown or Jargal



FURNACES

ALL ELECTRIC FURNACES – 100% ELECTRICAL SHARE

- Top electrode technology in combination with bottom electrodes
- Rectangular furnace:
  > even distribution of glass convection below the batch layer
  > higher temperature gradient bottom-top
  > more stable melting conditions (compared to round furnaces)



FURNACES

ALL ELECTRIC FURNACES – 100% ELECTRICAL SHARE

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- Rectangular furnace:
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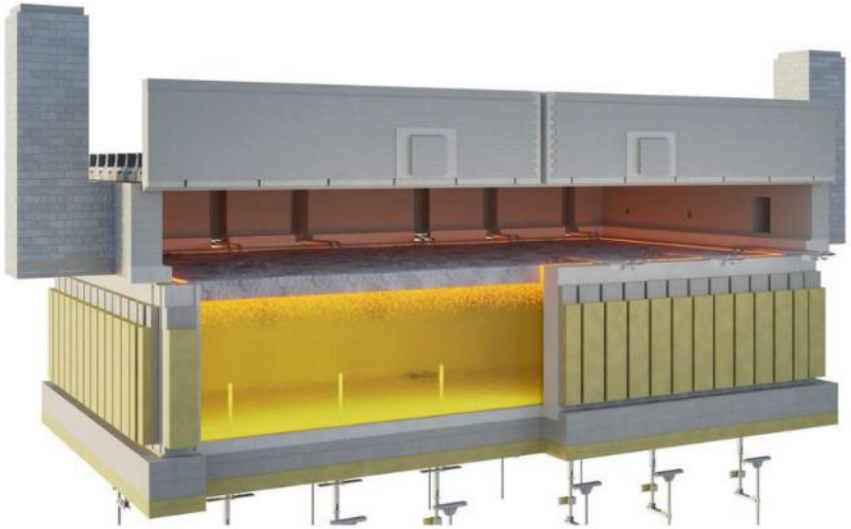
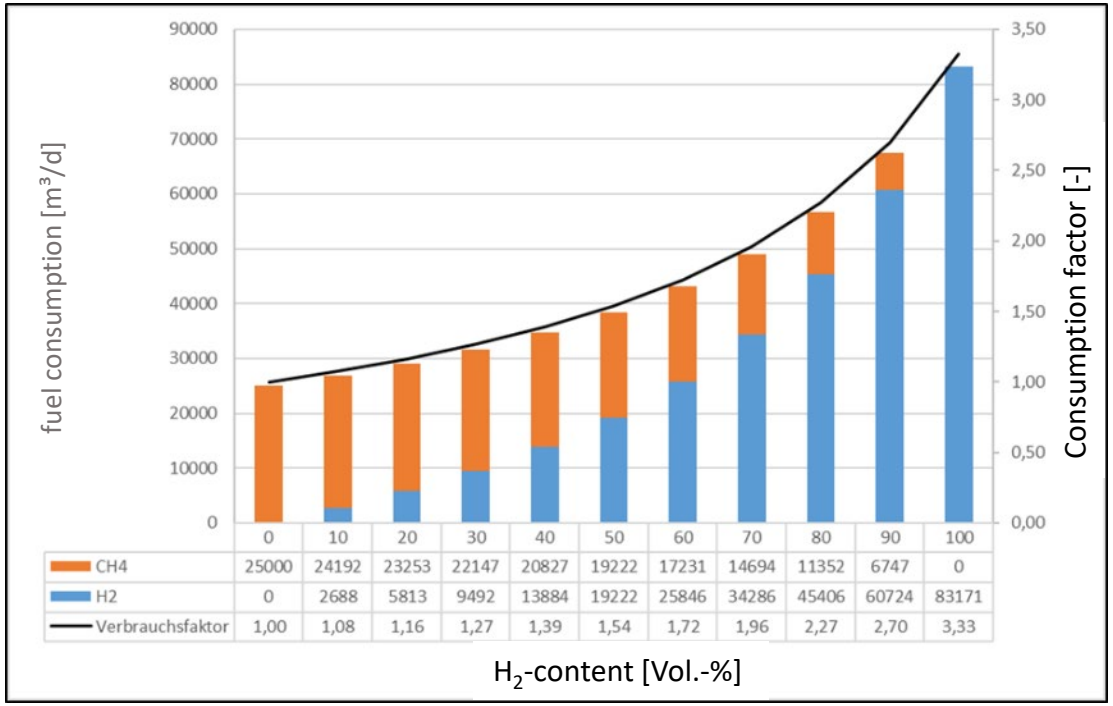
  > higher temperature gradient bottom-top
- Easy paving of metal line
- Simple furnace expansion to the sides



HYDROGEN-FIRING

BASICS :

- Lower heat value of the Hydrogen
  - > higher volume flow of the mixture required
  - > 1 m³ Methane = 3,33 m³ Hydrogen



H2-content [Vol.-%]	0	10	20	30	40	50	60	70	80	90	100
CH4	25000	24192	23253	22147	20827	19222	17231	14694	11352	6747	0
H2	0	2688	5813	9492	13884	19222	25846	34286	45406	60724	83171
Verbrauchsfaktor	1,00	1,08	1,16	1,27	1,39	1,54	1,72	1,96	2,27	2,70	3,33

HYDROGEN-FIRING

BASICS :

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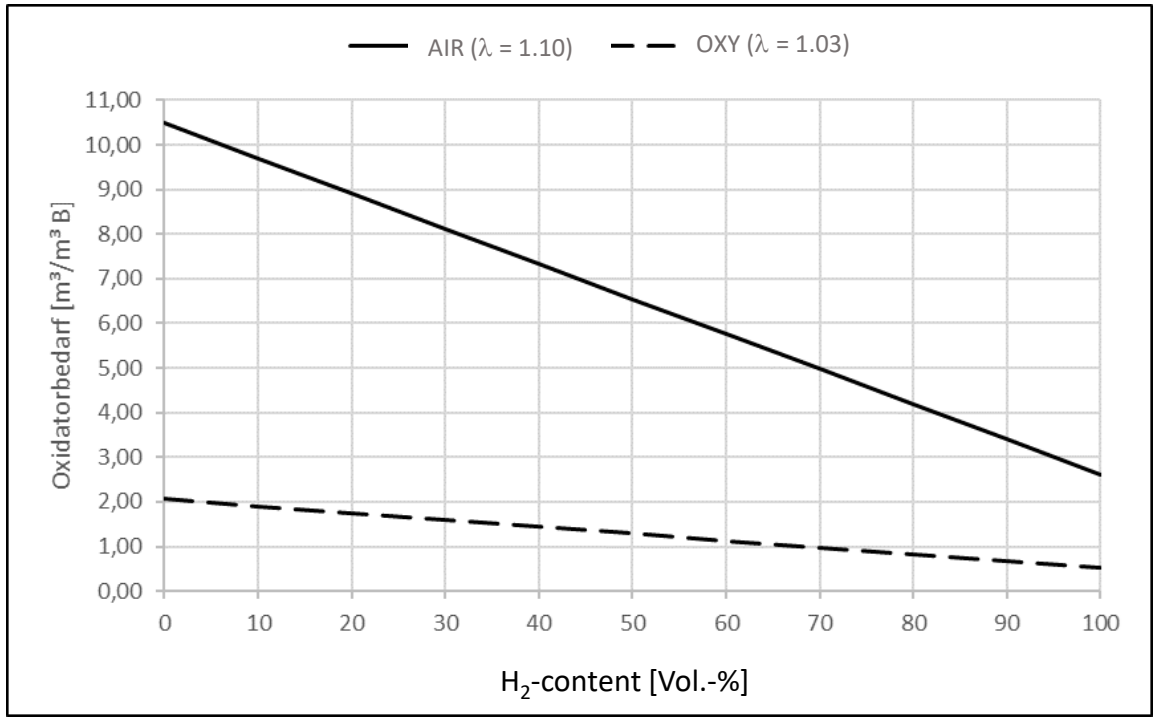
- Lower oxidant requirement of Hydrogen

	Methane	Hydrogen	
Air	10	2.4	m^3/m^3
Oxygen	2	0.5	m^3/m^3

> less volume flow **per m³** mixture required



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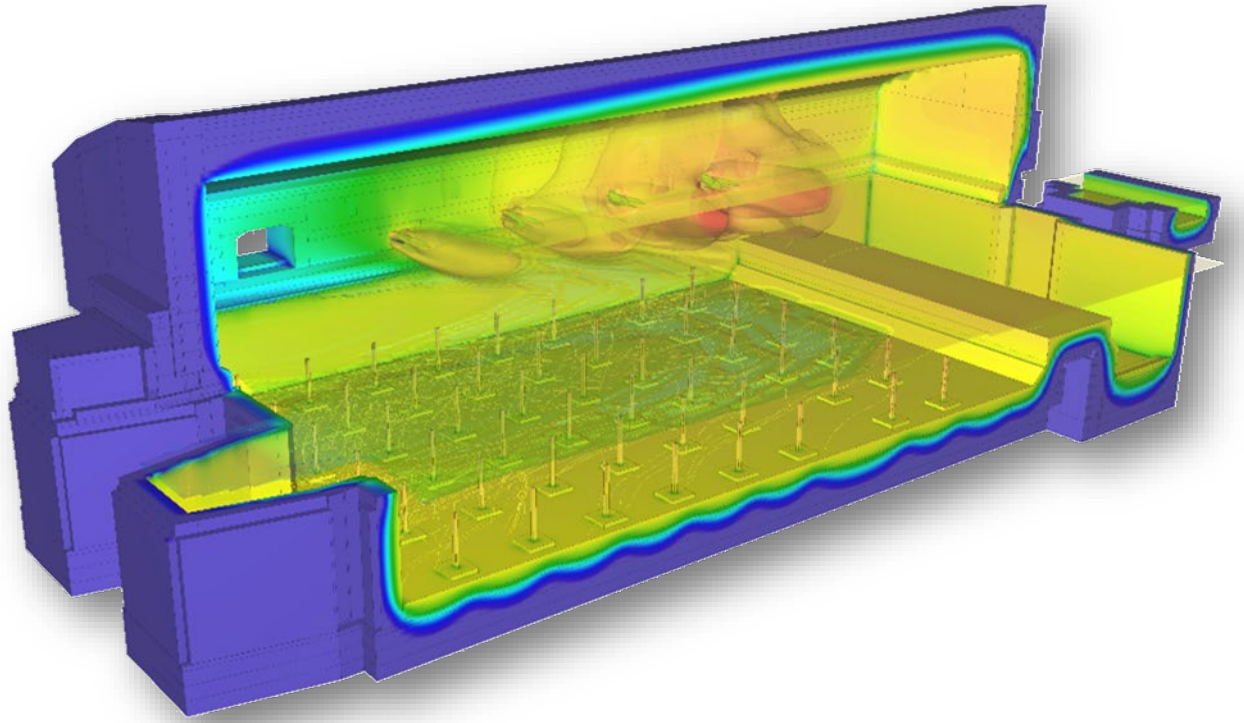
- Impact of higher water content in furnace atmosphere
  - refractory corrosion, foam formation, water content in the melt



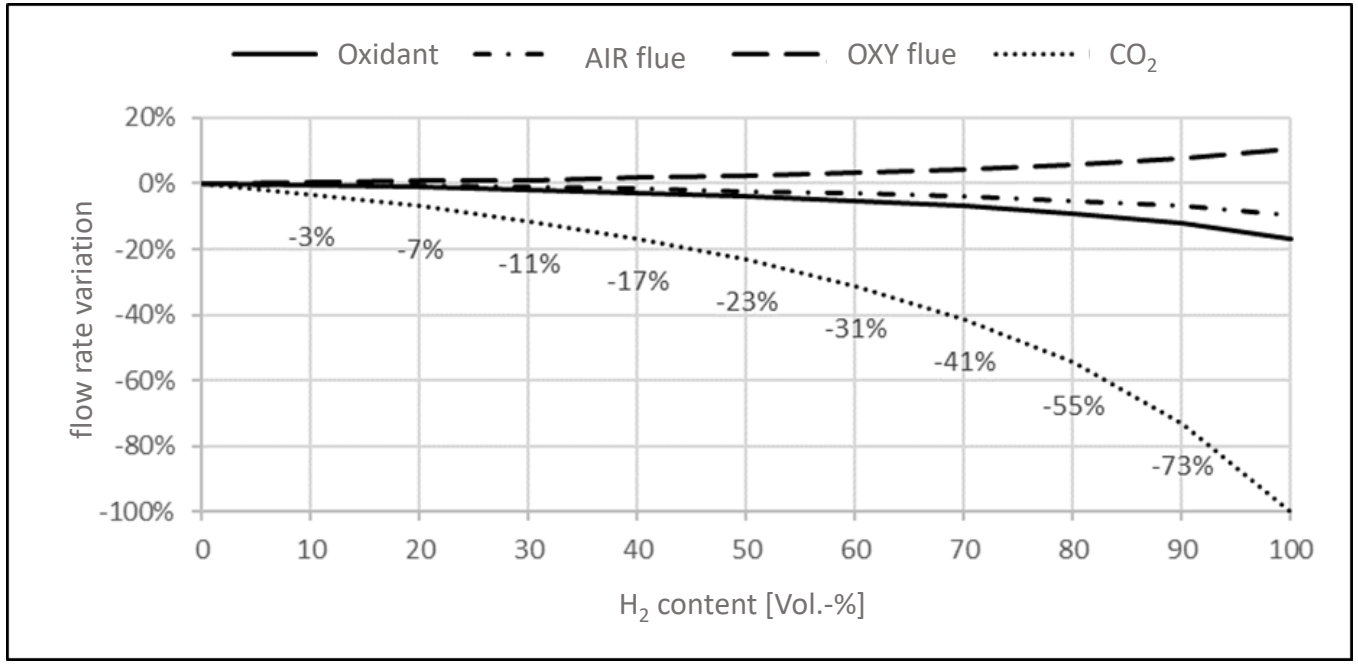
HYDROGEN-FIRING

CO_2-REDUCTION

- @ 20 % H_2 = 7 % reduced CO2
  > possible with normal heating equipment

- @ 50 % H_2 = 23 % reduced CO2
  > requires special H2-equipment

- Significant reduction of CO_2 from combustion only at high hydrogen content (> 80% H2)

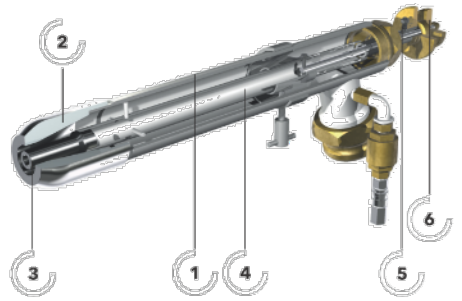


HYDROGEN-FIRING

HORN® DUALFLAME GAS BURNER

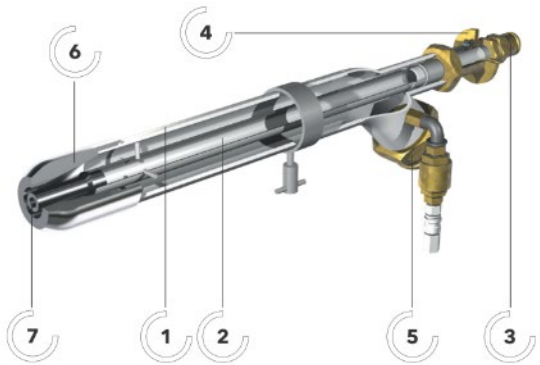
- Underport installation
- For all types of gases, including LPG/air-mixtures and hydrogen
- Two different adjustment possibilities: the manual controlled burner, DUALFLAME MC, and the automatic controlled burner, DUALFLAME AC
- Velocity control and mixing impulse from outside without nozzle replacement
- Low NOx formation at DUALFLAME AC

HORN ® DUALFLAME MC burner



1. Casing pipe
2. Gas nozzle – outside
3. Gas nozzle – inside
4. Inner gas pipe
5. Control wheel – inner nozzle position
6. Control wheel – outer nozzle gas stream

HORN ® DUALFLAME AC burner



1. Casing pipe
2. Inner gas pipe
3. Gas connection – inside nozzle
4. Control wheel – inner nozzle position
5. Gas connection – outer nozzle
6. Gas nozzle – outer
7. Gas nozzle – inside

HYDROGEN-FIRING

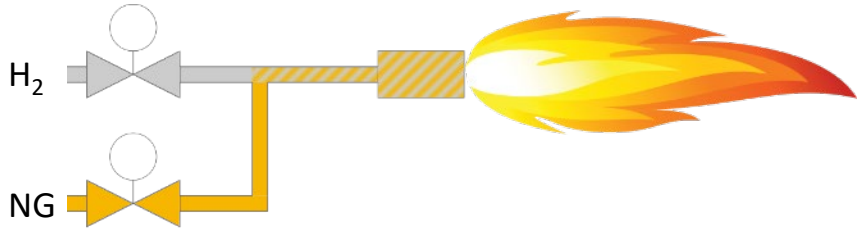
PRE-MIXED OR SEPARATE INLETS

- Two ways to supply the burners with fuel are possible

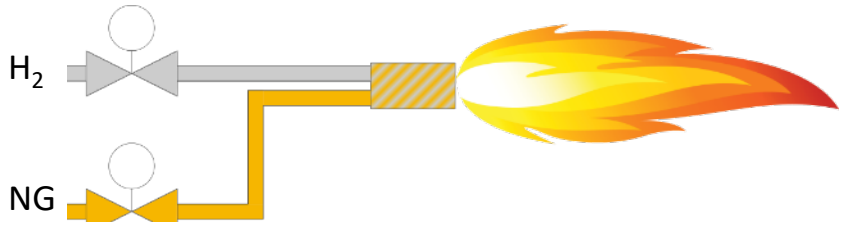
- Mixing natural gas and hydrogen before distribution to the burners
  - Mixing station currently in development by a Horn sub-supplier

- Mixing directly at the burner tip
  - Applicable with HORN® DUALFLAME AC burner
  - two separate gas inlets for inner and outer nozzle

pre-mixed



separate inlets with HORN® DUALFLAME AC burner



HYDROGEN-FIRING

CURRENT STATUS

- Mixing with NG up to 20+Vol-% possible
- Higher share requires special H2-Gas – Equipment
- No significant issues with Air-Gas-furnaces up to 50% (Furnaces are operating)
  > similar flame length and energy transmission
- Significant reduction of CO_2 from combustion only at high hydrogen content (> 80% H2)
- Intensive scientific study by practical tests on combustion technology, glass chemistry, refining mechanism and refractories
- Modelling studies required to simulate the heat transfer in regenerators

THANK YOU FOR YOUR ATTENTION.

HORN
GLASS INDUSTRIES