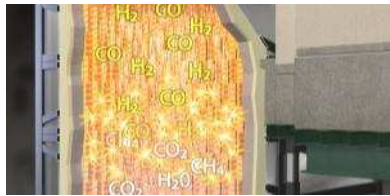




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## *Operating Experience with OPTIMELT™ Regenerative Thermo-Chemical Heat Recovery for Oxy-Fuel Glass Furnaces*

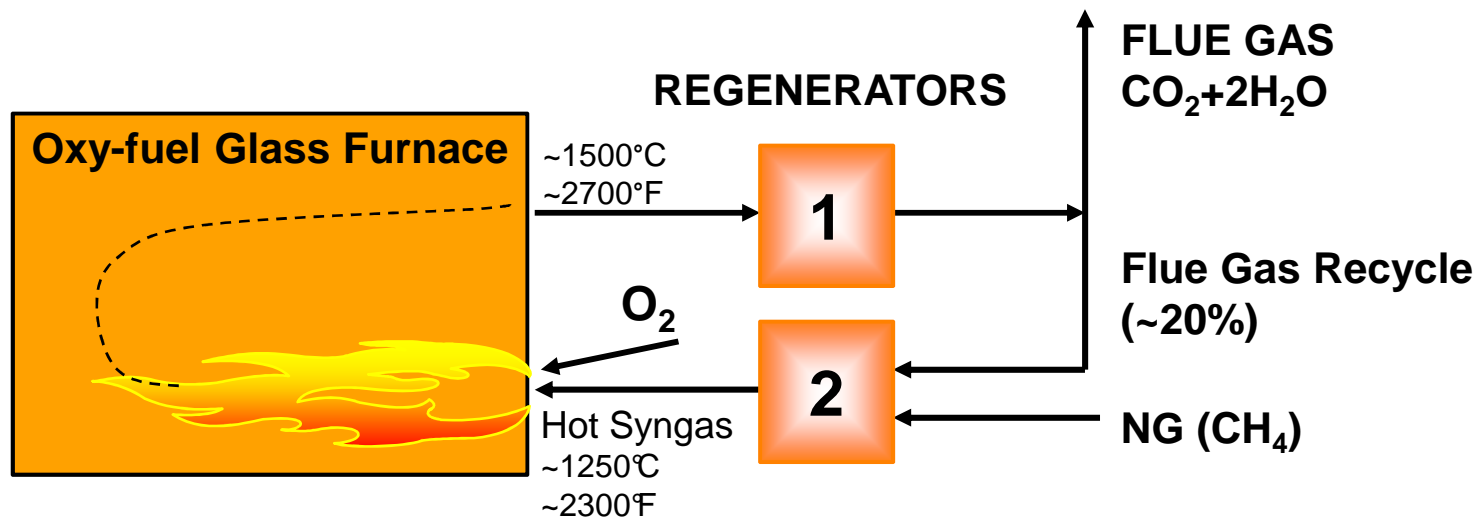
*A. Gonzalez and E. Solórzano, Grupo Pavis  
S. Laux, U. Iyoha, K.T. Wu, and H. Kobayashi,  
Praxair, Inc.*

**TC 09 Meeting Eindhoven,  
October 15, 2015**

# OPTIMELT™ Thermo-Chemical Regenerator



- High efficiency non-catalytic reforming process
- Recycled flue gas with CO<sub>2</sub> and water vapor is used for CH<sub>4</sub> reforming
- Regenerative system allows high operating temperatures/reforming rate
- Regenerators roughly 1/3 the size of air-fired regenerators

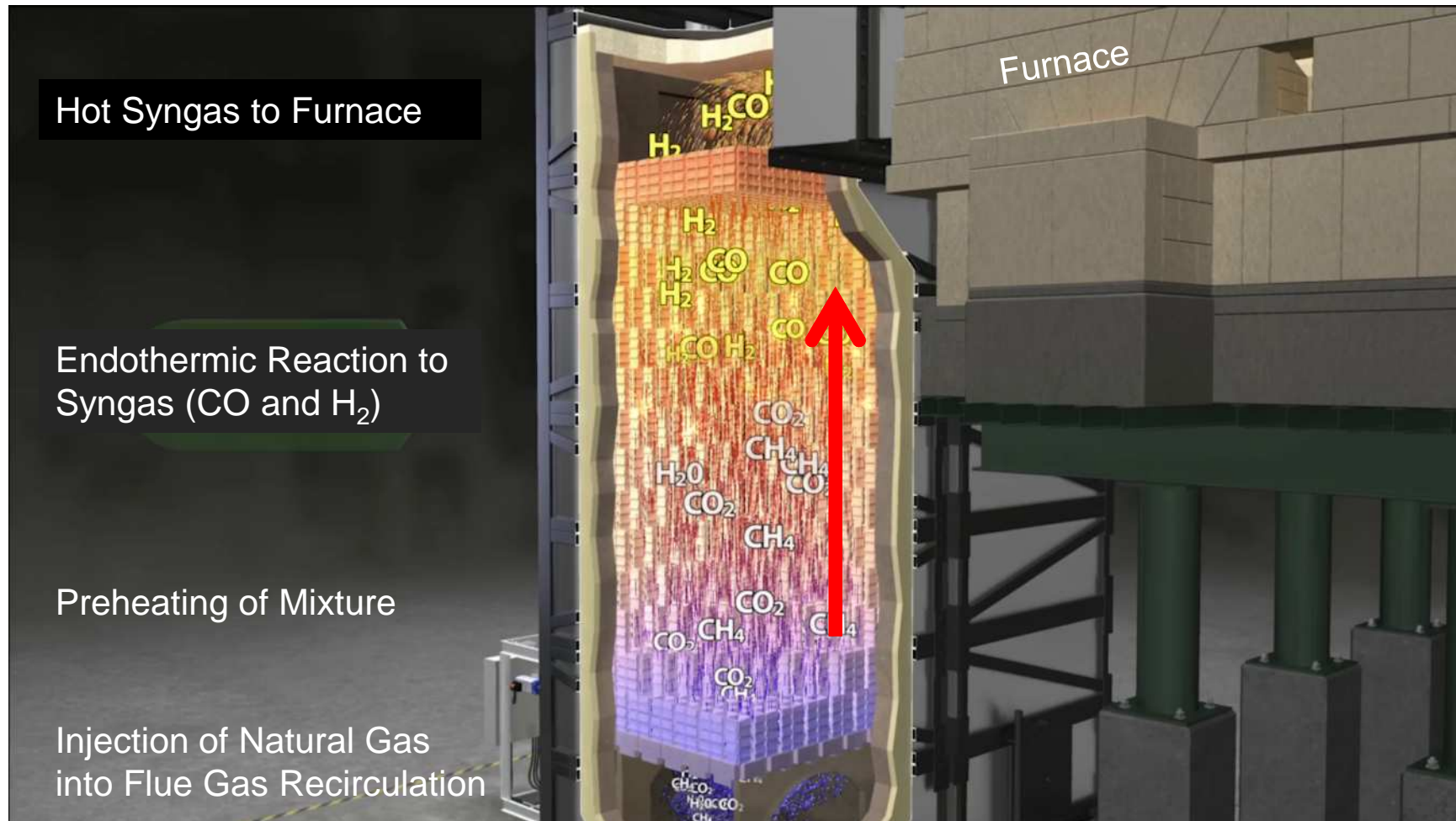


## Endothermic reforming reactions

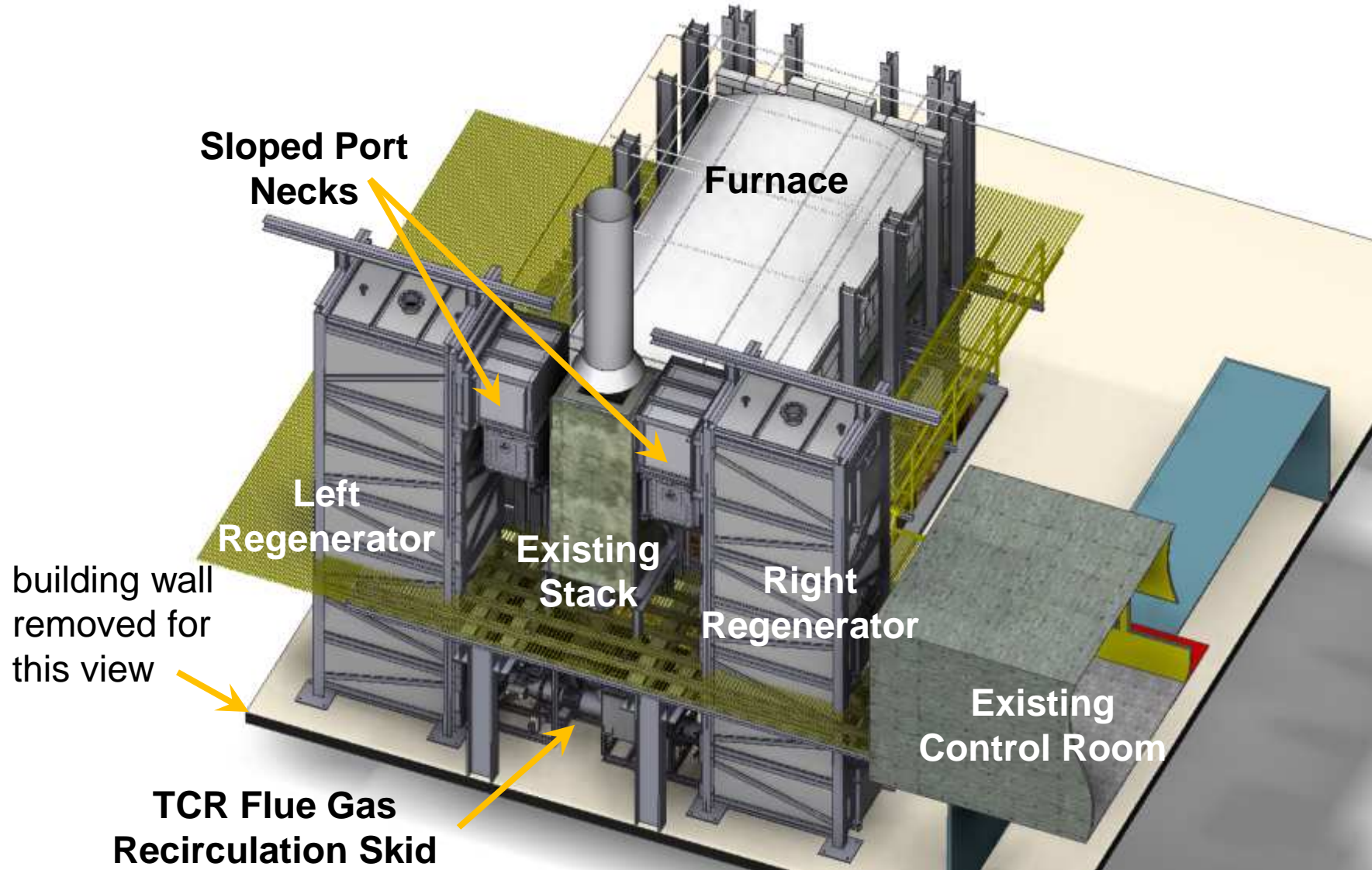


US Pat. 6,113,874

# OPTIMELT™ Process



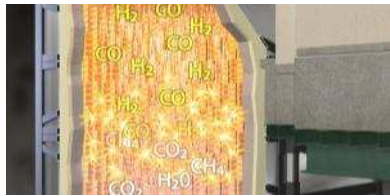
# TCR Installation on Furnace 13





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# Results



- Operation
  - Startup and process optimization completed 2014
  - Automatic and continuous operation
  - High availability achieved
  - No fundamental TCR technology issues identified
  - Switching between TCR and Oxy-fuel has become routine
  - Pavisa operates TCR
- Results
  - Glass pull rate and quality required achieved
    - No production was lost
    - Slight Increase in pull rate possible with TCR
    - Integration of TCR into furnace has overall positive effect on quality
  - Measured energy consumption at Pavisa 15 to 18% - in line with expectations

Very successful technology demonstration

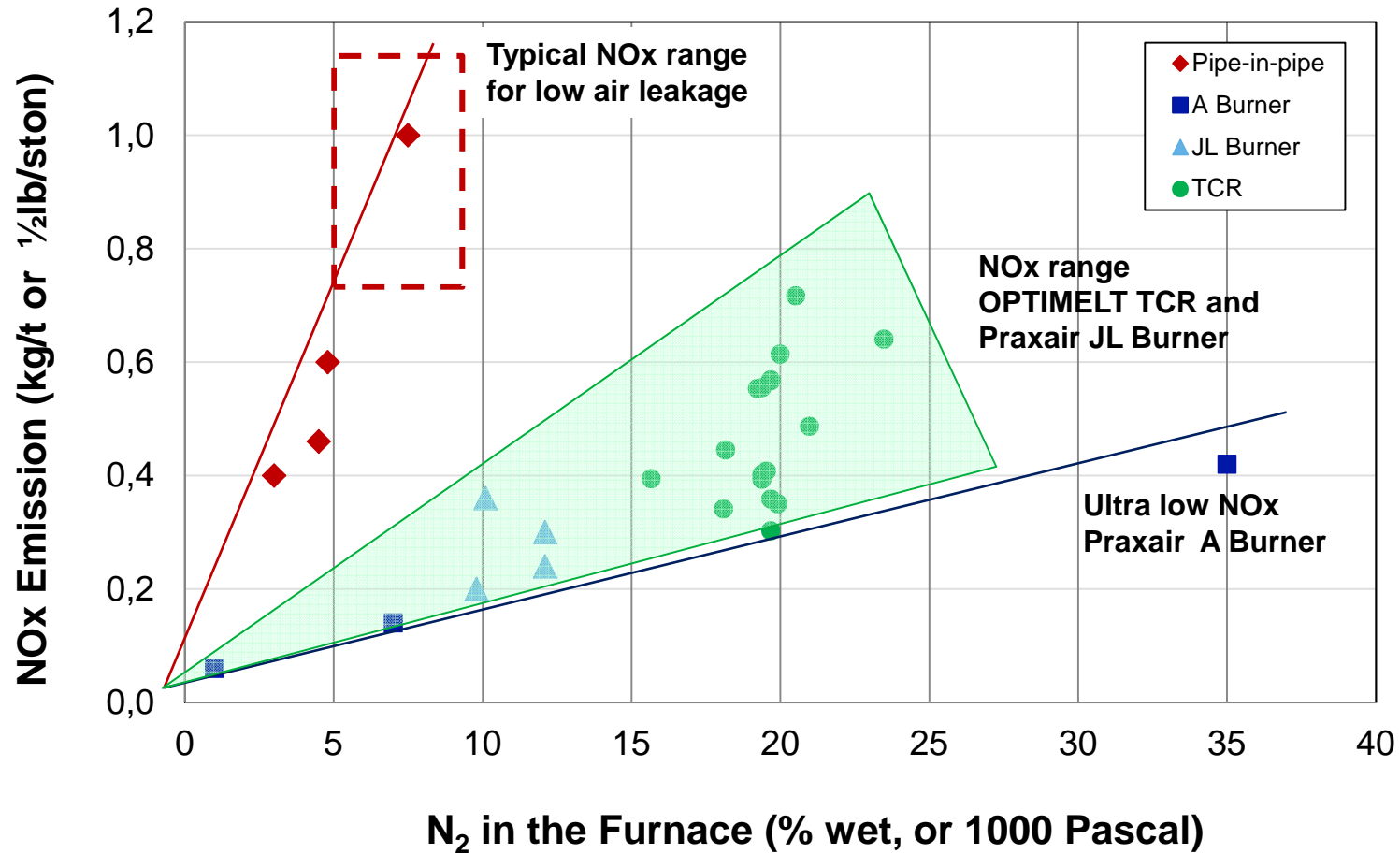
# Example: Clear Flint Production



Flint glass	Oxy-fuel firing	OPTIMELT firing
Averaged Evaluation Period	20-22 Jul 2015	6-8 Aug 2015
Pull Rate (t/d)	50.5	52.5 (+4%)
Cullet Rate (% of feed)	36	36
Furnace Wall Temperature (°C)	1529	1524 (-5)
Furnace Glass Temperature (°C)	1314	1312 (-2)
Excess Oxygen (% wet)	2.7	2.3
Total Fuel Average ( $m_N^3/hr$ )*	375	308
Fuel Savings (%)	base	-18%
Seed Count (1/oz)	23	33
Bottles with Stones (%)	1	1
Dominant Wavelength (nm)	571.6	568.9
Transmittance (%)	81.00	80.97
Fe <sup>2+</sup> /Fe <sup>3+</sup> redox ratio	0.278	0.285
Fraction of Fe <sub>2</sub> O <sub>3</sub> (%)	78.25	77.80

\* Notes: Fuel consumption of melter and forehearth.  
TCR fuel consumption corrected to lower pull rate of oxy-fuel baseline

# NOx Emission Oxy-fuel Container Furnaces



NOx emissions in line with Low NOx Burners used in Glass



- TCR emissions at Pavisa are in the range of the measured emissions for Low NOx glass oxy-fuel burners
- Emission trend of NOx versus Nitrogen in the furnace for TCR is similar to other oxy-fuel burners
- Pavisa F13 has relatively high nitrogen concentration due to air inleakage
  - Measured emissions at Pavisa had to be corrected for lower Nitrogen partial pressure due to elevation in Mexico City ( $\sim 0.76 \text{ bar}_{\text{abs}}$ )
- The typical nitrogen range for large commercial furnaces with low air leakage is 5 to 10% wet.
- Flue gas NOx concentrations for the technology are projected to be less than  $0.1 \text{ kg/GJ}_{\text{LHV}}$ , or about  $0.4 \text{ kg/t}$  at 10%  $\text{N}_2$  in the furnace.

Praxair is confident that OPTIMELT will meet  
future emission NOx requirements

- Praxair's OPTIMELT™ Thermochemical Regenerator (TCR)
  - Reduces energy consumption  
(~20% vs oxy-fuel, ~30% vs. air-regenerative)
  - Reduces CO<sub>2</sub> emissions
  - Reduces air pollutants to the level of oxy-fuel performance  
(NO<sub>x</sub>, SO<sub>x</sub>, CO, etc.)
- Successful commercial demonstration at Pavisa
  - System in automatic and continuous operation
  - Fuel savings well within expectations for size of installation and operating conditions
  - Glass quality on same level as oxy-fuel combustion
- 300 tpd size system is ready for commercial application

***Thank You for your Attention!***



***Stefan\_Laux@Praxair.com***