Executive Committee Meeting of the All India Glass Manufacturers Federation

15 DECEMBER 2012
FIROZABAD – INDIA
FT BURNERS

PRACTICAL APPLICATION
RESULTS OF NEW GAS BURNER IN FLOAT, CONTAINER AND TABLEWARE GLASS INDUSTRY
Contents of Presentation

● Introduction and history
● FT burner design and operating principles
● FT burner design and simulation
● Installation
● Production results
● Benefits
Optimized natural gas combustion process

- Furnace design
- Regenerator design
- Technology level
- Control system level
- Batch composition
- Combustion system design especially burner design
The new situation in the world reflecting the economy and strong ecological request

- Increasing price of combustion oil
- Very strong ecological limits and higher penalties
- Growing interest in use of natural gas in glass furnaces
- NOx production
- Conversion from oil combustion to gas firing
- New and advanced burner system FLAMMATEC™ FLEX
History of Dual Gas Injector Burners

- Dual gas injector burners are not a new technology and have been known since at least the 1960’s.
- This concept was used by Corning and had two (2) concentric pipes with two (2) separate gas streams.
- Dual gas injector burner was broadly used in eastern Europe since 1970. The construction was simple without any optimization. The burner required two (2) gas inlets with different pressure.
- 1968 GAZ de France published their Twin Gas burner.
- A similar burner was used by Tokyo Gas in 2008.
- Other burner manufacturers introduced additional burners in the late 1990’s. These burners had only one (1) gas inlet with the two (2) gas streams separated inside the burner.
History of Dual Gas Injector Burners

- The common feature of all of these burners is that the gas enters the burner by only one (1) pipe with the second gas stream separated inside the burner.
- Advantages of a new burner concept were developed for the FlammaTec burner in 2006/2007.
- FlammaTec utilizes a complete two (2) gas stream concept with new advanced features such as:
  - Two (2) fully separate gas flows and control and measurement
  - Adjustable burner nozzle
  - Optimized burner tip
- Practical results confirm the newly advanced burner concept with a technical advantage.
BURNER SCHEME
BURNER SCHEME
FT BURNER DESIGN AND OPERATING PRINCIPLES

Underport burner
FT Design Optimized by Computer Modeling
Turbulence optimization
FT Design Optimized by Computer Modeling
Flame temperature

FlammaTec burner

Conventional burner
FT Design Optimized by Computer Modeling
Flame velocity

FlammaTec burner

Conventional burner
FT Design Optimized by Computer Modeling

Optimum burner block location
FT Design Optimized by Computer Modeling
Optimum burner block location
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace type</td>
<td>tableware</td>
</tr>
<tr>
<td>Glass type</td>
<td>SODA – LIME Glass</td>
</tr>
<tr>
<td>Pull</td>
<td>100 MTPD</td>
</tr>
<tr>
<td>Cullet</td>
<td>23 %</td>
</tr>
<tr>
<td>Total gas consumption</td>
<td>648 Nm³/h</td>
</tr>
<tr>
<td>Heat value of gas</td>
<td>10390 kcal/kg</td>
</tr>
<tr>
<td>Combustion heat</td>
<td>6029 KW</td>
</tr>
<tr>
<td>Melter area</td>
<td>34.2 m²</td>
</tr>
<tr>
<td>Glass depth melter</td>
<td>1245 mm</td>
</tr>
<tr>
<td>Spec. pull</td>
<td>2.92 MTPD/m²</td>
</tr>
<tr>
<td>Spec. energy consumption</td>
<td>5.209 MJ/kg</td>
</tr>
</tbody>
</table>
**Furnace type:** tableware
**Glass type:** SODA – LIME Glass
**Pull:** 100 MTPD
**Cullet:** 23 %

**Total gas consumption:** 612.3 Nm³/h  
**Heat value of gas:** 10390 kcal/kg  
**Combustion heat:** 5697 KW

**Melter area:** 34.2 m²  
**Glass depth melter:** 1245 mm  
**Spec. pull:** 2.92 MTPD/m²  
**Spec. energy:** 4.922 MJ/kg
Furnace type: container
Glass type: green
Pull: 251 MTPD
Cullet: 53 %

Total gas consumption: 1005 Nm3/h
Heat value of gas: 11192 kcal/kg
Combustion heat: 9550 kW
Electric boosting: 1082 kW
NOx: 920 mg/Nm3 (8% O2)

Melter area: 82.8 m2
Glass depth melter: 1150 mm
Spec. pull: 3.03 MTPD/m2
Spec. energy consumption: 3.66 MJ/kg
**Furnace type:** container  
**Glass type:** green  
**Pull:** 251 MTPD  
**Cullet:** 53%  

**Total gas consumption:** 968 Nm3/h  
**Heat value of gas:** 11192 kcal/kg  
**Combustion heat:** 9201 kW  
**Electric boosting:** 1082 kW  
**NOx:** 650 mg/Nm3 (8% O2)  

**Melter area:** 82.8 m2  
**Glass depth melter:** 1150 mm  
**Spec. pull:** 3.03 MTPD/m2  
**Spec. energy consumption:** 3.54 MJ/kg
**Furnace type:** Float  
**Glass type:** white  
**Pull:** 700 MTPD  
**Cullet:** 30%

**Total gas consumption:** 4300 Nm3/h  
**Heat value of gas:** 10910 kcal/kg  
**Combustion heat:** 41939 kW  
**NOx:** < 1500 mg/Nm3 (8% O2)

**Melter area:** 522 m2  
**Glass depth melter:** 1325 mm  
**Spec. pull:** 1.34 MTPD/m2  
**Spec. energy consumption:** 5.18 MJ/kg
Furnace type: Float
Glass type: white
Pull: 650 MTPD
Cullet: 25%

Melter area: 520 m²
Glass depth melter: 1250 mm
Spec. pull: 1.25 MTPD/m²
Spec. energy consumption: 5.64 MJ/kg

Total gas consumption: 4744 Nm³/h
Heat value of gas: 10455 kcal/kg
Combustion heat: 44342 kW
NOx: 1950 mg/Nm³ (8% O2)
Furnace type: tableware
Glass type: white
Pull: 85 MTPD
Cullet: 15%

Total gas consumption: 543 Nm3/h
Heat value of gas: 10390 kcal/kg
Combustion heat: 5052 kW
NOx: 2375 mg/m³ (8%O2)

Melter area: 53 m²
Glass depth melter: 1150 mm
Spec. pull: 1.6 MTPD/m²
Spec. energy consumption: 5135 MJ/kg
<table>
<thead>
<tr>
<th><strong>Furnace type</strong></th>
<th>tableware</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Glass type</strong></td>
<td>white</td>
</tr>
<tr>
<td><strong>Pull</strong></td>
<td>85 MTPD</td>
</tr>
<tr>
<td><strong>Cullet</strong></td>
<td>15 %</td>
</tr>
</tbody>
</table>

**Flammatec burners**

- **Total gas consumption**: 514 Nm³/h
- **Heat value of gas**: 8000 kcal/kg
- **Combustion heat**: 4782 kW
- **Nox**: 1625 mg/m³ (8%O₂)

**Melter area**: 53 m²

**Glass depth melter**: 1150 mm

**Spec. pull**: 1.6 MTPD/m²

**Spec. energy consumption**: 4861 MJ/kg
**Furnace type:** Float
**Glass type:** white
**Pull:** 600 MTPD
**Cullet:** 25%

**Melter area:** 465 m²
**Glass depth melter:** 1280 mm
**Spec. pull:** 1.29 MTPD/m²
**Spec. energy consumption:** 5.62 MJ/kg

**Total oil consumption:** 3704 Kg/h
**Heat value of oil:** 10525 kcal/kg
Furnace type: Float
Glass type: white
Pull: 600 MTPD
Cullet: 25%

Total gas consumption: 4810 Nm³/h
Heat value of gas: 9070 kcal/kg
NOx: 1840 mg/Nm³ (8% O2)

Melter area: 465 m²
Glass depth melter: 1280 mm
Spec. pull: 1.29 MTPD/m²
Spec. energy consumption: 5.62 MJ/kg
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace type</td>
<td>tableware</td>
</tr>
<tr>
<td>Glass type</td>
<td>soda-lime</td>
</tr>
<tr>
<td>Pull</td>
<td>160 MTPD</td>
</tr>
<tr>
<td>Cullet</td>
<td>28 %</td>
</tr>
</tbody>
</table>

**Old burners**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total gas consumption</td>
<td>1096 Nm3/h</td>
</tr>
<tr>
<td>Heat value of gas</td>
<td>11645 kcal/kg</td>
</tr>
<tr>
<td>Combustion heat</td>
<td>10372 kW</td>
</tr>
</tbody>
</table>

**Melter area** : 86,9 m²
**Glass depth melter** : 1448 mm
**Spec. pull** : 1,84 MTPD/m²
**Spec. energy consumption** : 5597 MJ/kg
Furnace type: tableware
Glass type: soda-lime
Pull: 160 MTPD
Cullet: 28%

Total gas consumption: 1061 Nm3/h
Heat value of gas: 11645 kcal/kg
Combustion heat: 10050 kW

Melter area: 86.9 m2
Glass depth melter: 1448 mm
Spec. pull: 1.84 MTPD/m2
Spec. energy consumption: 5135 MJ/kg
## FT Burner Installation - Comparison

<table>
<thead>
<tr>
<th></th>
<th>Previous Burners</th>
<th>FT Burners</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>End fired furnace - tableware</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total energy consumption Nm3/hr</td>
<td>648</td>
<td>612,3</td>
<td>5,51</td>
</tr>
<tr>
<td>Specific energy consumption MJ/T</td>
<td>5209</td>
<td>4922</td>
<td>5,51</td>
</tr>
<tr>
<td><strong>End fired furnace - container</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total energy consumption Nm3/hr</td>
<td>1005</td>
<td>963</td>
<td>4,18</td>
</tr>
<tr>
<td>Specific energy consumption MJ/T</td>
<td>3,66</td>
<td>3,54</td>
<td>3,28</td>
</tr>
<tr>
<td><strong>End fired furnace - tableware</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total energy consumption Nm3/hr</td>
<td>543</td>
<td>514</td>
<td>5,34</td>
</tr>
<tr>
<td>Specific energy consumption MJ/T</td>
<td>5135</td>
<td>4861</td>
<td>5,34</td>
</tr>
<tr>
<td><strong>Cross fired furnace – tableware</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total energy consumption Nm3/hr</td>
<td>1096</td>
<td>1061</td>
<td>3,2</td>
</tr>
<tr>
<td>Specific energy consumption MJ/T</td>
<td>5597</td>
<td>5135</td>
<td>3,2</td>
</tr>
</tbody>
</table>
The practical results fully confirmed the expected benefits

- Flame is easy to tune from short turbulent shape up to a long low turbulent shape and highly luminous flame.
- Highly luminous stable flame is achieved.
- Batch melting was enhanced after a change to FLAMMATEC burner creating shorter batch piles.
- Bottom temperatures were visibly increased, allowing glass quality improvements and a fuel reduction.
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