Splitvane Engineers

Cokeless Foundry Technology
Overview

- Urgent need to reduce greenhouse gases globally
- Air quality standards are growing tighter both in the US and globally
- Many "traditional" heavy industry processes have not changed substantially for decades
- Industrial processes are needed that are inherently cleaner and more efficient
- Opportunity in the casting industry
Casting industry

- Metal castings are utilized in the manufacture of many durable goods
- Example users include the automotive industry, construction equipment, railway equipment, piping
- Global casting production (in 2013), approx 80 million metric tons, with a revenue of $104 billion
The casting process

- Metal is melted into liquid in a furnace
- Cast into shapes by pouring the metal in a mold
- Removing the mold material after the metal has cooled
- Heat source typically metallurgical coke (from coal or petroleum coke)
What is coke?

- The fuel traditionally used in metal casting
- *Metallurgical coke* a special kind of purified coal
- *Petroleum coke* is the residue remaining after crude oil is processed into gasoline
- Typically preferred due to its ability to burn at a high stable burning temperature with minimal smoke
Challenges of using coke

- Burning coke generates cancer causing pollutants and greenhouse gases
- Contributor to have heavy smog countries in countries such as China
- Production of coke significantly reduced in the USA, Canada and Europe
Benefits of natural gas

• Dramatically reduces emissions of carbon monoxide, carbon footprint
• Meets recent more stringent EPA rules
• No building required to store coke
• Reduces capital cost of casting foundry
• Better overall energy efficiency, lower energy cost
Competing Cold Blast Cupola
## Competing Cold Blast Cupola

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very mature technology and can be built anywhere</td>
<td>Production regime is not flexible and cupola must be run continuously once heated</td>
</tr>
<tr>
<td>Different kind of cheap scrap can be used due to cleaning and carburization operations</td>
<td>Difficult production management due to slowness of the system</td>
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<td>Acceptable in areas where electricity costs are too high for electric melting</td>
<td>Expensive Charge with pig iron and very little steel scrap</td>
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<td></td>
<td>No quick alloy change possible</td>
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<td></td>
<td>Sulfur pick up in the cupola</td>
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<td></td>
<td>High environmental impact with lots of slag, dust and refractory lining wear</td>
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<td></td>
<td>Very high flue gas rates require big de-dusting installations</td>
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</tbody>
</table>
Competing Hot Blast Cupola

a) Coke; cold blast; 2 rows of tuyeres

b) Coke; hot blast with additional electrical heating (750 °C)

c) Natural gas; oxygen addition; induction superheating of iron
Competing Hot Blast Cupola

The graph shows the thermal efficiency (%) of blast cupolas with different coke charge (%). The efficiency is plotted against the coke charge. The graph compares the performance of cold blast, blast preheated to 520 °C (separately-fired heater, 70 % efficiency), and blast preheated to 520 °C (fully recuperative system).
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<td>Reduced coke consumption by comparison with the Cold Blast Cupola (CBC)</td>
<td>Very expensive investment with additional environmental measure for flexible use</td>
</tr>
<tr>
<td>High Tap Temperatures</td>
<td>Difficult production management due to slowness of the system</td>
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<tr>
<td>High Melting Capacity</td>
<td>Limited to iron No quick alloy change possible</td>
</tr>
<tr>
<td>Less Sulfur pick up in the cupola</td>
<td>High environmental impact with lots of slag, dust and refractory lining wear</td>
</tr>
<tr>
<td>Can use different and cheap grades of ferrous scrap</td>
<td>Very high flue gas rates require big deducting installations</td>
</tr>
<tr>
<td>More scrap steel can be used than the cold blast cupola because of the higher pick up of carbon</td>
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Competing Cokeless Technologies

- In the 1970’s TAFT an English engineer started to modify coke fired cupolas to natural gas
- To replace coke as a supporting media for iron – he added a water cooled grate
- Gas Fired burners were placed under the water cooled grate
- Ceramic balls were installed above the water cooled grate to act as heat exchangers
- Since the flame must be cooled to avoid melting the water cooled grate, casting is done at or very close to the Eutectic temperature
• The melt must then be poured into a second electric superheating furnace
Splitvane Cokeless Technology

- Proprietary natural gas fired foundry process
- Based on a two chamber horizontal configuration and heat recuperator
- Overcomes challenges of Taft/KGT design
  - Fully expandable to virtually any capacity
  - Alloying is readily performed in the second chamber
  - No temperature limit, allowing virtually any alloy to be produced
  - Refractory spheres are not required
Splitvane Twin Chamber Cokeless Furnace
Side Ports for Alloying & Oxygen Lancing
Heat is recuperated from flue gas to pre-heat combustion air.
Advantages in Terms of Tacit Efficiency

- There are 2 ways to measure efficiency
- Melt Efficiency at the furnace
- Tacit Efficiency to include the efficiency for delivering the fuel or coke to the cupola and

![Table (2) Melting Energy Efficiency from J.F. Schiffo – J.T. Radia – 2004](image)
Merits of Splitvane Cokeless Technology for Tacit Efficiency

• The use of natural gas improves the tacit efficiency and eliminates the costly use of conveyors, storage facilities for coke

• The use of natural gas improves the tacit efficiency over electric melting when electricity is produced by fossil fuel
Overall Flue emissions

• Overall flue emissions are reduced by 70%
• If clean natural gas is used – sulfur free the furnace melt does not need de-sulfurization
• The Splitvane Twin Chamber Cokeless Furnace can be used straight to cast ductile iron for the automotive industry
Merits of Splitvane Cokeless Technology for low CO emissions

- An exothermic reaction occurs in the recuperator as for hot blast cupolas and reduces carbon monoxide emissions below the level of TAFT cokeless cupolas.
Impact on Green House Gas Emissions

• The design proposes that by converting 0.6 to 1% of the world production of ferrous castings from coke to natural gas, an important reduction of green house gases and emissions from 306,000 to half a million metric tons would result.
Further Research

Patent 9617610 was issued on April 11, 2017 by the US Patent Office

Splitvane has applied for research funds from the US National Science Foundation to measure emissions during operation over a period of 6 months.
Splitvane is looking for strategic partners to develop further the technology of the Twin Chamber Cokeless Furnace into a range of alloys such as Thin Wall Ductile Iron for the automotive industry that can yield higher strength to weight ratio than aluminium castings.

The technology is available for licensing to build furnaces for casting from 2 to 20 tons per hour. Larger furnaces will require strategic partners to be developed.