
Presenter: Mr Peter Warren. Co-author: Mr Dave Fisher
Date: 13/09/2016
Timeline

2010: Tata mothballs Teesside Cast Products following collapse of consortium who purchased the slabs. Coke oven operation continues

2011: SSI of Thailand purchases Teesside Cast Products for $469m
SSI UK invests a further $290m ($125m partial reline)

2012: April 15\(^{th}\): Blast furnace blown in after partial reline. > 50% new staff

2013: July: PCI (Siemens-VAI) commissioned ($62m)

Cash constrained from start

2015: September 19\(^{th}\): Blast Furnace blown down. No cash for supplies
2015: October 2\(^{nd}\): SSI UK liquidated. Government official takes over
2 weeks later: Last coke oven pushed

No salamander tap. No stoves controlled cooling
# Redcar Blast Furnace Campaigns

<table>
<thead>
<tr>
<th>Campaign</th>
<th>Dates</th>
<th>Million tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1979 to 1986</td>
<td>15.1</td>
</tr>
<tr>
<td>2</td>
<td>1986 to 2000</td>
<td>43.8</td>
</tr>
<tr>
<td>3</td>
<td>2000 to 2010</td>
<td>28.5 (*)</td>
</tr>
<tr>
<td>4</td>
<td>2012 to 2015</td>
<td>9.2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>96.6</td>
</tr>
</tbody>
</table>

* Mothballed
14m hearth diameter
4220m$^3$ Working Volume

- 2 Rows 1st generation Staves
  - 32 x
  - 32 x

- 3 Rows modified 1st generation Staves
  - 52 x
  - 56 x
  - 60 x

- 4 Rows Copper Staves
  - 72 x
  - 72 x
  - 72 x

- 6 Rows 1st generation Staves
  - 60 x
  - 36 x
  - 60 x
  - 66 x
  - 60 x
  - 60 x

- Under hearth cooling by water pipes

- Shotcrete
- Silicon Carbide Bricks
- Micropore Carbon Blocks
- Supermicropore Carbon Blocks
- Semi-Graphite Layer
- Sillimanite Bricks

New wall
1 layer pad

Replaced staves
Partial Reline: Row 6 cast iron
Row 7 to 10 copper

Row 7: Copper
67% original width

Row 6: Cast Iron
Partial Reline: Hearth

Pad: 2 rows removed, 1 replaced – deeper sump
Partial Reline: Ancillaries
New investment: PCI plant

1 * 120 tonnes/hour mill
2 streams – total 112 tonnes/hour

Commissioned July 2013
Lump ore stickiness test
Slag basicity limit - $K_2O$ loading & slag volume

![Graph showing the relationship between basicity B3, $K_2O$ loading (kg/thm), and slag volume (kg/thm) for different temperatures (240, 260, 280, 300, 320°C).](image-url)
Sinter alumina / silica ratio and RDI

Sinter Al₂O₃:SiO₂ Ratio Vs Sinter RDI

R² = 0.6505

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Sinter strength - ISO

- Multiple tuyere failures
- Low heat flux
- High % coke at wall

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Sinter size specification

- Comparison with heat loss and stability led to change

<table>
<thead>
<tr>
<th>Old</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;50mm: 5% max</td>
<td>&gt; 40mm: 10% max</td>
</tr>
<tr>
<td>Mean Size: 18mm min</td>
<td>5 to 16mm: 45% min</td>
</tr>
<tr>
<td>&lt;5mm: 4.5% max</td>
<td>&lt;5mm: 4.5% max</td>
</tr>
</tbody>
</table>
Coal blend

COAL BLEND BY LOCATION

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Coke strength – Micum 40

Coke oven output reduced by 10%
# Target PCI rate and coke quality for stability

<table>
<thead>
<tr>
<th>M10 (%)</th>
<th>&gt;6.3</th>
<th>6 - 6.3</th>
<th>&lt;6</th>
</tr>
</thead>
<tbody>
<tr>
<td>M40 (%)</td>
<td>&lt;84</td>
<td>&gt;84</td>
<td>&lt;85</td>
</tr>
<tr>
<td>PCI rate (kg/thm)</td>
<td>80</td>
<td>100</td>
<td>110</td>
</tr>
</tbody>
</table>

Increasing coke strength

Adjusted for
- Low size
- Low CSR
- Higher % sinter + pellets
Summary of 2 best periods of operation with strong coke

<table>
<thead>
<tr>
<th></th>
<th>15 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>M10 (%)</td>
<td>5.5</td>
</tr>
<tr>
<td>M40 (%)</td>
<td>88.1</td>
</tr>
<tr>
<td>CSR (%)</td>
<td>69.7</td>
</tr>
<tr>
<td>BF Screenings %</td>
<td>3</td>
</tr>
<tr>
<td>Sinter + pellets %</td>
<td>75</td>
</tr>
<tr>
<td>PCI rate (kg/thm)</td>
<td>177</td>
</tr>
<tr>
<td>Coke rate (kg/thm)</td>
<td>271</td>
</tr>
<tr>
<td>Nut coke rate (kg/thm)</td>
<td>50</td>
</tr>
<tr>
<td>Equivalent coke rate (kg/thm)</td>
<td>471</td>
</tr>
<tr>
<td>Productivity (t/m3/24h)</td>
<td>2.1</td>
</tr>
</tbody>
</table>
Effect of lump proportion on fuel rate

Equivalent coke rate corrected (kg/thm)

- To end Nov 2014
- End Nov 2014 to May 2015 (high coke strength)

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Summary benefits of improved coke

• 5% improvement in big coke yield

• 30 kg/thm increase in PCI rate

• 15 kg/thm reduction in equivalent coke rate

• Enabled usage of lump ore with little or no penalty
  • Productivity 2.1 to 2.2 t/m³/24h
PCI injection lines blocked

- Soft fine cohesive coal from US
- Standard Russian coals used most of the time
- The US coal did not block lines when blended with Russian coal
Poor Operation

- 3 events of severe instability
- All followed very poor coke
- Sudden big reduction in casting rate
- Poor response – teams had not seen it before
- Briefed all of the teams at training days

- 1200°C top gas temperature
- Multiple bleeder lifts
- 1380°C metal temperature
Summary and Conclusions

• SSI UK was a case of ‘The Corner Shop buys The Supermarket’
• Cash constrained from the start
• Killed by the 2015 crisis - high losses - banks withdrew support
• Kept going for 3.5 years
  • Testament to the flexibility and ingenuity of the workforce
  • Goodwill of the many suppliers (and banks)
• High coke quality pays for itself on profit and loss
  • If you have the cash
  • Recent increase in coking coal costs - to be tested again?
• Do not ignore the sinter: poor strength - tuyere failures
• A robust operating strategy was developed for low cost operation at modest productivity
  • No chance to test this over the long term
Current state – still standing

Photo courtesy of Dave Cocks – technology manager to 2010
Thank You

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