Cheaper Coke to Reduce Aluminium Production Cost?

Group Discussion II

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Alternative coke A properties (50 $/t cheaper)

Property	Unit	1/3 Coke A + 2/3 Coke E	100% Coke E
Apparent density	Kg/dm^3	1.588	1.598
Specific electrical resistance	µΩm	54.2	53.6
Flexural strength	MPa	12.2	11.1
Thermal conductivity	W/mK	3.63	3.83
Real density in xylene	Kg/dm^3	2.074	2.083
Air permeability	nPm	0.62	0.51
CO_2 reactivity: residue dust loss	% % %	87.0 5.3 7.7	89.5 3.0 7.5
Air reactivity: residue dust loss	% % %	74.4 12.6 13.0	85.8 3.0 11.2
Elements (XRF): S V Na Ca	% ppm ppm ppm	2.05 233 228 182	2.12 216 211 175

Net Carbon Consumption

$$NC = C + \frac{334}{CE} + 1.2\,(BT - 960) - 1.7\,CRR + 9.3\,AP + 8TC - 1.5ARR$$

$$\Delta NC = -1.7\,\overbrace{(87.0 - 89.5)}^{\Delta CRR} + 9.3\,\overbrace{(0.62 - 0.51)}^{\Delta AP} + 8\,\overbrace{(3.63 - 3.83)}^{\Delta TC} - 1.5\overbrace{(74.4 - 85.8)}^{\Delta ARR}$$

$$\Delta NC = \quad +4.3 + 1.0 - 1.6 + 17.1 = 20.8\ kg/tAl$$

For 5’000 tonnes of coke A

- To produce 1’000 kg of Al, 360 kg of calcined coke is needed
  (240 kg of coke E and 120 kg of coke A)
- With 5’000 tonnes of coke → $\frac{5000}{0.12} \cong 41'500\ tonnes\ of\ Al$
- Anode cost: 600 $/t or 0.6 $/kg
- Lost: $Al\ amount \cdot \Delta NC \cdot Anode\ price = 41'666 \cdot 20.8 \cdot 0.6 \cong 500'000\ \$$
- Gain: $5'000 \cdot 50 \cong 250'000\ \$$

Remedies to improve NC

- Better covering (sizing)
- Increase of the cycle fire time (at cost of production)
- Increase of the baking temperature (at cost of energy and refractory)

Baking temperature increased case

	ΔCRR	ΔAP	ΔTC	ΔARR	ΔNC
Base case	-2.5	0.09	-0.2	-11.4	20.8
+ 50°C	0	0.09	-0.2	7	**10**

- Lost: $Al\ amount \cdot \Delta NC \cdot Anode\ price = 41'666 \cdot 10 \cdot 0.6 \cong 250'000\ \$$
- Gain: $5'000 \cdot 50 \cong 250'000\ \$$
- Cost of heat-up estimate at 180’000 $

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- 1$/Nm^3 → 10$ /MWh = 3.6 GJ
- + 50°C ≅ $3.3\ GJ$ (10% more of 3 GJ)
- $\frac{3.3\ GJ \cdot 10\$}{3.6\ GJ} = 9\ \$\ per\ tonnes\ of\ anode$
- Or 4.5 $ per tonne of Aluminium (1 t of Anodes can produce 1 t of Al)
- Cost: $4.5 \cdot 41'666 \cong 180'000\ \$$