
PILOT SHAFT KILN EVALUATION OF GREEN COKE

PREPARATION AND TEST METHODS

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1 Introduction

R&D Carbon (RDC) has developed a special pilot shaft kiln for the evaluation of green cokes. The full pilot shaft kiln evaluation described in this document includes the determination of the green coke quality, the calcinability of the coke and the final calcined coke quality that can be achieved.

The green coke quality will be determined by the measurement of its typical properties.

The calcinability of the material will be firstly evaluated by static calcinations made with different calcined coke additions in order to see the agglomeration propensity of the coke, and then by calcining it in the PRO 203 pilot shaft kiln.

The calcination of the material will be made in two steps. The first one will be the calcination up to 1'000°C in the pilot shaft kiln in order to remove the volatiles present in the green coke. The second one will be the static calcination of the pre-calcined material in order to reach a typical real density.

The final calcined coke quality will then be determined by measuring all typical properties after shaft kiln and static calcination.

3 Green Coke Testing

4 x 55 gallons (minimum of 400 kg) of a representative green coke is needed for a complete evaluation. This sample will be firstly divided to produce a 5 kg sample which will be tested in the R&D Carbon laboratory. The properties shown in the table below will be performed.

Pos	Properties	Unit	Method	Method RDC
1	Water Content Coke	%	ISO 11412	M204
2	Volatile Matter	%	ISO 9406	M175
3	Hardgrove Grindability Index	-	ISO 5074	M196
4	Sieving Analysis	%	ISO 12984	M111
5	Elements XRF	%, ppm	ISO 12980	M103-1
6	Ash Content	%	ISO 8005	M169-1

Figure 1: Properties of Green Coke

4 Sample Preparation

The sample will be firstly dried at 200°C in order to prepare the coke fraction < 16 mm that will be used for the evaluation. After sieving, the material > 16 mm will be crushed and sieved again until all the material is < 16 mm. The crushed fractions will be added to the natural ones and the sample will be homogenized.

5 Agglomeration Test using Static Calcination

An agglomeration test will be performed before the shaft kiln calcination in order to see if a calcined coke addition will be necessary due to clogging propensity of the green coke.

For this purpose, pilot static calcinations of 5 kg samples (< 16 mm fraction) will be made, in the BF12 static calcining furnace, to evaluate the agglomeration behavior of the coke. Three calcinations will be made respectively with 0%, 10% and 20% addition of calcined coke. The calcined coke for the addition will be the one used for the 0% addition test. The following calcination program will be applied:

- RT to 200°C: 200°C/h
- 200°C to 800°C: 100°C/h
- 800°C to 1'100°C: 50°C/h
- Soaking Time at 1'100°C: 20 hours

The agglomeration behavior of the coke will be evaluated by sieving before and after calcination. Based on the difference in grain size between the green and calcined product, an optimum calcined coke addition for shaft kiln calcination will be estimated.

The calcination yield of the green coke will be determined from the static calcination.



Figure 2: RDC 164 Calcining Furnace BF12 C

6 Pilot Shaft Kiln Calcination

6.1 Kiln Description

R&D Carbon has developed a continuous pilot shaft kiln unit using green coke sized at < 16 mm. This kiln simulated the condensation and coking of the volatiles on the descending semi-calcined coke bed. The 90 cm tall furnace is electrically heated at 1'000°C and has an internal cylindrical tube of 30 cm. The off-gases are removed from the tube top where a draft is applied to the kiln. The throughput regulated by the frequency of the volumetric discharge

end is 15 kg/h and the total residence time of the coke material is about 7 hours. Cooling is made indirectly by water circulation at the bottom side of the unit.



Figure 3: PRO 203 Pilot Shaft Kiln

6.2 Calcination of Green Coke

100 kg of the prepared fraction < 16 mm of green coke will be calcined in the PRO 203 Pilot Shaft Kiln described above. The green coke will be calcined with an addition of calcined coke previously estimated from the agglomeration test. The calcined coke used for the addition will be static calcined green coke to evaluate.

7 Static Calcination

The shaft kiln calcined coke, where the volatiles have been removed, will be calcined at a finishing temperature of 1'125°C in order to reach the final real density. The final calcination will be made in the BF24 baking furnace with the following program:

- RT to 200°C: 200°C/h
- 200°C to 800°C: 100°C/h
- 800°C to 1'125°C: 50°C/h
- Soaking Time at 1'125°C: 20 hours



Figure 4: RDC 167 Pilot Baking Furnace BF24

8 Calcined Coke Testing

The calcined coke after final static calcination will be divided in order to obtain the 5 kg sample needed for laboratory testing. The following properties will be determined:

Pos	Properties	Unit	Method	Method RDC
1	Sieving Analysis	%	ISO 12984	M111
2	Tapped Bulk Density	kg/dm ³	ISO 10236	M153
3	Grain Stability	%	ISO 10142	M156
4	Pulverizing Factor	-	-	M168
5	Real Density Xylene	kg/dm ³	ISO 8004	M152-1
6	Crystallite Size	Å	ISO 20203	M104
7	Specific Electrical Resistance	μΩm	ISO 10143	M147
8	Air Reactivity Coke 525°C	%/min	ISO 12982-1	M142-1
9	CO ₂ Reactivity Coke	%	ISO 12981-1	M141
10	Elements XRF	%, ppm	ISO 12980	M103-1
11	Ash Content	%	ISO 8005	M169-1
12	Pore Distribution Hg 2000 bar	-	-	M105

Figure 5: Properties of Calcined Coke