Data Article

Experimental data on morphological characterization of chars from coal and bagasse blends

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Abstract

Morphological characterization of chars from coal and bagasse plays an important role in both the burning efficiency and intrinsic reactivity of chars, during a combustion process [1], [2]. In this work, abundant data on the morphology of chars produced from coal and bagasse blends are presented. Char synthesis was performed varying the temperature (900, 1000 and 1100 °C) and bagasse proportion feeding (0, 25, 50, 75 and 100% w/w) in the pyrolysis reaction. Proximate, ultimate, petrographic and vitrinite reflectance of raw coal and bagasse are presented. Char morphology is classified into three groups – thin walls, thick walls, and solid particles –, and results are exhibited. The data set is a comprehensive source for advancing in a further understanding of char’s morphology from coal-bagasse blends.

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Data description

Data presented in this work describes the production and characterization of chars derived from coal of three Colombian regions (Cundinamarca, Antioquia and Valle States) and bagasse obtained from a sugar refinery mill located at the South West Colombian region. The data corresponds to the synthesis of char at different values of temperature (900, 1000 and 1100 °C) and three blend proportions (0, 25, 50, 75 and 100% w/w) in the pyrolysis reaction.

Table 1 presents the proximate and ultimate analysis of coals and bagasse. Table 2 shows the petrography and vitrinite reflectance analysis. Char’s morphology of coals, bagasse and blends were characterized according to the thick and thin network morphologies, thick and thin spheres, pore mix, dense mixture, inert, solids and filaments.

Table 3 displays the char morphological classification of coals and bagasse. Table 4 shows the char’s morphology according to each morphology type. The data are relevant for researchers seeking for a classification system to characterize chars from coal-bagasse blends. The data can be used for further experiments such as thermogravimetric analysis (TGA), which can correlate char morphology vs. characteristic reactivity temperatures. The data of changes in chars morphology from coal-bagasse blends impact thermochemical conversion.

1. Data description

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Table 1 presents the proximate and ultimate analysis of coals and bagasse. Table 2 shows the petrography and vitrinite reflectance analysis. Char’s morphology of coals and bagasse were obtained in an entrainment reactor using nitrogen at three pyrolysis temperatures (900, 1000 and 1100 ºC) and three blend proportions (0, 25, 50, 75 and 100% w/w).

Table 3 displays the char morphological classification of coals and bagasse [4]. Table 4 shows the char’s morphology according to each type of char, where the used nomenclature is the following: the first letter C: Char; followed by the letter A, C, V or B indicating the origin of the material, Antioquia, Valles, Cundinamarca or Bagasse. The following character 9, 10, 11 stands for the pyrolysis temperature of 900, 1000 and 1100 ºC. The numbers 00, 25, 50, 75, 100, indicates the percentage of bagasse in the blend. For example, C-V-9-25 represents a char from Valles coal, obtained at 900 ºC with 25% w/w of bagasse.

Regarding the included figures, Fig. 1 shows the morphology frequency of chars from the original coals and bagasse as a function of temperatures 900, 1000 and 1100 ºC. Figs. 2–4 show the morphology frequency of chars from coals and bagasse blends (25, 50 and 75% w/w) at temperatures 900, 1000 and

Specifications Table

| Subject                  | Chemical Engineering::Chemical Engineering (General) |
|-------------------------|---------------------------------------------------|
| Specific subject area   | Figures and tables                                 |
| Type of data            | Data were obtained by proximate analysis (LECO TGA-601), ultimate analysis (LECO TruSpec CHN), petrography analysis (Olympus BX-51), morphological microscopy (Nikon LV-100), SEM microscopy (Jeol JSM6490LV). Chars from coal and bagasse blends were obtained in an entrainment reactor using nitrogen at three pyrolysis temperatures (900, 1000 and 1100 ºC) and three blend proportions (0, 25, 50, 75 and 100% w/w). |
| How data were acquired  | Data were obtained by proximate analysis (LECO TGA-601), ultimate analysis (LECO TruSpec CHN), petrography analysis (Olympus BX-51), morphological microscopy (Nikon LV-100), SEM microscopy (Jeol JSM6490LV). Chars from coal and bagasse blends were obtained in an entrainment reactor using nitrogen at three pyrolysis temperatures (900, 1000 and 1100 ºC) and three blend proportions (0, 25, 50, 75 and 100% w/w). |
| Data format             | Raw and analyzed data                              |
| Parameters for data collection | Original coals and bagasse samples for char’s synthesis were characterized by proximate, Heat High Value (HHV), ultimate, petrography and vitrinite reflectance analysis. Char’s morphology of coals, bagasse and blends were characterized according to the thick and thin network morphologies, thick and thin spheres, pore mix, dense mixture, inert, solids and filaments. |
| Description of data collection | Raw data of proximate, HHV, ultimate and sulphur analysis (Table 1) were made according to ASTM D 7582-10, ASTM D5865-11a, ASTM D5378-08, ASTM D4239 – 12 methods respectively. Raw data of petrography and vitrinite reflectance (Table 2) according to ASTM D2799–1 and ASTM D2798–11a. Raw data of char’s morphological classification (Table 3), Char’s morphology according to each morphology type (Table 4). Analyzed data of chars morphology frequency from original coal and bagasse as a function of the temperature (Fig. 1) and analyzed data of chars morphology frequency from coal-bagasse blend as a function of the temperature (Figs. 2–4). |
| Data source location    | Char’s production and its morphological characterization were done in the Chemical Engineering School of the Universidad del Valle, (Cali, Colombia). |
| Data accessibility      | Data are provided in this article.                |

Value of the Data

- The chars morphology raw data is useful to estimate coal-bagasse blends reactivity at larger scales processes, such as combustion and gasification. It is also a novelty data concerning the morphological characterization of chars from coal-bagasse blends. The raw data of proximate, ultimate, petrographic and SEM analyses can be used to evaluate the quality of coal-bagasse blends.
- The data are relevant for researchers seeking for a classification system to characterize chars from coal-bagasse blends.
- The data can be used for further experiments such as thermogravimetric analysis (TGA), which can correlate chars morphology vs. characteristic reactivity temperatures.
- The data of changes in chars morphology from coal-bagasse blends impact thermochemical conversion.
1100 °C. Finally, Fig. 5 portrays the morphology of the original and char samples of the three coals and bagasse through the SEM technique.

### 2. Experimental design, materials, and methods

#### 2.1. Synthesis of Chars

Fig. 6 shows a process diagram for obtaining chars. This system consists of a vertical tubular entrainment reactor [6] with an isothermal zone of 180 mm. The quartz tube has a length of 900 mm and an external diameter of 60 mm, with a wall thickness of 1 mm. The reactor is heated with a Carbolite STF 18 tubular oven. The reactor uses an inert atmosphere controlled with nitrogen and oxygen flows, with a total flow of 88 ml/s containing 5% v/v oxygen, to avoid the tars condensation. The system for obtaining chars is composed of a temperature controller [5], a feed system for displacement screw-type samples [3-4], a char and gas separator (7), and a feed system for N₂ and O₂ gases [1] with their respective flow meters [2].

#### 2.2. Experimental design

A randomized complete experimental block design was used for obtaining char samples, taking into account three factors: coal origin, the percentage of bagasse in the coal-bagasse blends and pyrolysis temperatures. Coal origin: in this investigation, three carbons from different regions of Colombia (Cundinamarca, Antioquia and Valle States) were analyzed since the morphology of chars is related to the range and composition of the original sample. The percentage of bagasse: blends of coal-bagasse were made in proportions of 0, 25, 50, 75 and 100% w/w of bagasse. Pyrolysis temperatures: three temperatures were used, 900, 1000 and 1100 °C. The particle size of 250 μm was used for all samples. The samples were fed employing a feeding system consisting of a hopper equipped with an endless screw driven by an electric motor with speed variation. In total 50 g were pyrolyzed per run over a
Table 3
Char’s morphological classification of coals and bagasse.

| Reactivity | Group     | Morphology type | Characteristics                                                                 | Optical texture |
|------------|-----------|-----------------|--------------------------------------------------------------------------------|-----------------|
|             | Thin wall | Filaments       | Particles with walls smaller than 3μm, which has not a geometric shape.         |                 |
|             |           | Bagasse cenosphere | Spherical particles with porosity greater than 70%. More than 50% of the wall is less than 3μm. |                 |
|             |           | Bagasse network | Particles with walls smaller than 3μm and elongated shapes. It is the union of several filaments. |                 |
|             |           | Coal cenosphere | Shapes from spherical to subspherical, a simple main chamber; It presents some secondary and tertiary porosity within the walls of the char, porosity, 75% of the wall thickness. |                 |
| Resistent Particles |           | Coal network | Particles with porosity greater than 70%. More than 50% of the wall is less than 3μm. |                 |
|             | Thin wall | Bagasse cenosphere | Spherical particles with porosity greater than 40%. More than 50% of the wall is greater than 3μm. |                 |
|             |           | Bagasse network | Particles with walls smaller than 3μm showing elongated shapes, the union of several filaments. |                 |
|             |           | Coal cenosphere | Shapes from spherical to subspherical, a simple main chamber, presents pronounced secondary and/or tertiary porosity within the walls of the char, porosity, 75% of the wall thickness. |                 |
|             |           | Coal network | Particles with porosity greater than 40%. More than 50% of the wall is greater than 3μm. |                 |
period of 2 hours. The combinations of the different levels of the three factors and the replicas gave a total of 90 pyrolysis experiments, which were carried out randomly. The obtained chars were stored hermetically for later analysis.

2.3. Characterization of coals, bagasse, and chars

2.3.1. Proximate analysis

The contents of volatile matter, ash, fixed carbon, and moisture were determined by recording the weight loss when the temperature increases under a controlled atmosphere, using a LECO TGA-601 thermogravimetric balance. All analyses were performed by duplicate with an error rate of less than 1%, following the methodology proposed by ASTM D 7582-10. The calorific value was obtained by burning a gram of sample in a LECO AC600 calorimeter following the procedure of ASTM D5865-11a.

2.3.2. Ultimate analysis

For the determination of Carbon (C), Hydrogen (H) and Nitrogen (N), combustion at 950 °C was carried out in an oxygen atmosphere of 1 g of sample. The oxidation reactions of these elements produce CO₂, H₂O and NOx gases. The last gas was reduced to elementary N, detected by thermal conductivity, while C and H were analyzed by infrared absorption. This procedure was performed in a TruSpec CHN LECO analyzer, using ASTM D5378-08. To determine the total sulphur content, a LECO S-144 Sulphur analyzer was used, following ASTM D4239-12. A sample of 1 g was introduced into a tubular furnace that was subsequently heated to 1350 °C under an atmosphere oxidizing, producing the SO₂ gas, which was measured in an infrared absorption detector. The oxygen was calculated by difference.

2.3.3. Petrography analysis

For the determination of the coal maceral composition, specimens were made by embedding a sample of approximately 0.4 g in epoxy resin powder, mixed with Buehler brand liquid hardener. The sample was hardened, by a curing process for 24 hours. The specimens were roughened with 400, 600 and 1200 grains of sands and then polished with metallographic cloths, using alumina suspensions of 1.0, 0.3 and 0.05 μm at 200 rpm in a Struers Labopol-5 brand polishing machine until the specimens with their surface were obtained without any scratches. The prepared samples were analyzed in a Nikon LV100 metallographic microscope using a 50X air objective to determine the maceral
Table 4
Char’s morphology according to each morphology type.

| Sample | Item     | Bagasse | Coal |
|--------|----------|---------|------|
|        |          | Filaments | Thick spheres | Thin network | Thick spheres | Thin network | Mix porous | Mix dense | Inertoid | Solids |
|        |          |          |          |          |          |          |            |            |          |        |
| CA900  | Total    | 0        | 0        | 0        | 0        | 0        | 3          | 23.5       | 8.5      | 106.5   | 101    |
| %      |          | 0.00     | 0.00     | 0.00     | 0.00     | 0.00     | 0.3        | 2.10       | 0.21     | 19.68   | 13.12  |
| CA925  | Total    | 2.5      | 3        | 0        | 6.5      | 3        | 4.5        | 13.5       | 3.5      | 90.5    | 70.5   |
| %      |          | 0.57     | 0.68     | 0.00     | 1.48     | 0.68     | 1.03       | 3.08       | 0.80     | 20.64   | 16.08  |
| CA950  | Total    | 2.5      | 0.5      | 2        | 11       | 16       | 2          | 16.5       | 0.5      | 64.5    | 63     |
| %      |          | 0.60     | 0.12     | 0.48     | 2.62     | 3.81     | 0.48       | 3.93       | 0.12     | 15.38   | 15.02  |
| CA975  | Total    | 28       | 6        | 8.5      | 41.5     | 73       | 1          | 26         | 3        | 79      | 75     |
| %      |          | 0.90     | 1.48     | 2.09     | 10.22    | 17.98    | 0.25       | 6.40       | 0.74     | 19.46   | 18.47  |
| CC900  | Total    | 0        | 0        | 0        | 0        | 0        | 53         | 61         | 68       | 134     | 26     |
| %      |          | 0.00     | 0.00     | 0.00     | 0.00     | 0.00     | 13.25      | 15.25      | 17.00    | 33.50   | 6.50   |
| CC925  | Total    | 2        | 5        | 0        | 46       | 21       | 30         | 68         | 52       | 86      | 25     |
| %      |          | 0.50     | 1.24     | 0.00     | 11.41    | 5.21     | 7.44       | 16.87      | 12.90    | 21.34   | 6.20   |
| CC950  | Total    | 3        | 6        | 2        | 60       | 36       | 23         | 45         | 20       | 76      | 20     |
| %      |          | 0.74     | 1.48     | 0.49     | 14.78    | 8.87     | 5.67       | 11.08      | 4.93     | 18.72   | 4.93   |
| CC975  | Total    | 0        | 12       | 14       | 163      | 62       | 2          | 37         | 2        | 33      | 20     |
| %      |          | 0.00     | 2.98     | 3.47     | 40.45    | 15.38    | 0.50       | 9.18       | 0.50     | 8.19    | 1.49   |
| CV950  | Total    | 50.5     | 19.5     | 3.5      | 66.5     | 26.5     | 22         | 36         | 31.5     | 58.5    | 31.5   |
| %      |          | 0.12     | 5        | 1        | 16       | 6        | 5          | 9          | 8        | 14      | 8      |
| CV975  | Total    | 58       | 53       | 9.5      | 199      | 17.5     | 4.5        | 3          | 4        | 7       | 7.5    |
| %      |          | 0.15     | 13       | 2        | 50       | 4        | 1          | 1          | 2        | 2       | 5      |
| CB9100 | Total    | 42       | 15       | 7        | 275      | 54       | 0          | 0          | 0        | 134     | 26     |
| %      |          | 0.60     | 3.82     | 1.78     | 69.97    | 13.74    | 0.00       | 0.00       | 0.00     | 0.00    | 0.00   |
| CA1000 | Total    | 0        | 0        | 0        | 0        | 0        | 19         | 12         | 105      | 60      | 48     |
| %      |          | 0.00     | 0.00     | 0.00     | 0.00     | 0.00     | 4.75       | 3.00       | 26.25    | 15.00   | 12.00  |
| CA1025 | Total    | 3        | 2        | 0        | 50       | 6        | 12         | 15         | 44       | 58      | 58     |
| %      |          | 0.75     | 0.50     | 0.00     | 12.50    | 1.50     | 3.00       | 3.75       | 11.00    | 14.50   | 14.50  |
| CA1050 | Total    | 3        | 3        | 0        | 79       | 7        | 15         | 12         | 52       | 60      | 67     |
| %      |          | 0.75     | 0.75     | 0.00     | 19.75    | 1.75     | 3.75       | 3.00       | 13.00    | 15.00   | 16.75  |
| CA1075 | Total    | 21       | 5        | 0        | 211      | 15       | 6          | 7          | 38       | 29      | 23     |
| %      |          | 0.52     | 1.25     | 0.00     | 52.75    | 3.75     | 1.50       | 1.75       | 9.50     | 7.25    | 5.75   |
| CC1000 | Total    | 0        | 0        | 0        | 0        | 0        | 29         | 74         | 98       | 110     | 24     |
| %      |          | 0.00     | 0.00     | 0.00     | 0.00     | 0.00     | 7.23       | 18.45      | 24.44    | 27.43   | 9.99   |
| CC1025 | Total    | 0        | 0        | 0        | 0        | 29       | 16         | 35         | 81       | 37      | 104    |
| %      |          | 0.00     | 0.00     | 0.00     | 0.00     | 0.00     | 7.23       | 18.45      | 24.44    | 27.43   | 9.99   |
| CC1050 | Total    | 2        | 5        | 3        | 149      | 15       | 18         | 76         | 30       | 43      | 21     |
| %      |          | 0.50     | 1.25     | 0.75     | 37.25    | 3.75     | 4.50       | 19.00      | 7.50     | 10.75   | 5.25   |
| CC1075 | Total    | 8        | 3        | 1        | 206      | 15       | 14         | 38         | 31       | 42      | 16     |
| %      |          | 2.00     | 0.75     | 0.25     | 51.50    | 3.75     | 3.50       | 9.50       | 7.75     | 10.50   | 4.00   |
|        |          |          |          |          |          |          |            |            |         |         | 0.75   |
| Source: Authors– Raw data. |
|---------------------------|
| **CV1000** Total | 0 | 0 | 0 | 0 | 0 | 18 | 67 | 148 | 127 | 20 | 6 | 6 |
| % | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.50 | 16.75 | 37.00 | 31.75 | 5.00 | 1.50 | 1.50 |
| **CV1025** Total | 3 | 0 | 0 | 26 | 10 | 12 | 66 | 115 | 105 | 30 | 11 | 6 |
| % | 0.75 | 0.00 | 0.00 | 6.47 | 2.49 | 2.99 | 16.42 | 28.61 | 26.12 | 7.46 | 2.74 | 1.49 |
| **CV1050** Total | 5 | 3 | 0 | 60 | 14 | 22 | 62 | 71 | 102 | 20 | 14 | 8 |
| % | 1.25 | 0.75 | 0.00 | 15.00 | 3.50 | 5.50 | 15.50 | 17.75 | 25.50 | 5.00 | 3.50 | 2.00 |
| **CV1075** Total | 9 | 11 | 5 | 169 | 19 | 27 | 48 | 38 | 40 | 26 | 4 | 8 |
| % | 2.21 | 2.70 | 1.23 | 41.42 | 4.66 | 6.62 | 11.76 | 9.31 | 9.80 | 6.37 | 0.98 | 1.96 |
| **CB10100** Total | 42 | 15 | 7 | 275 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % | 10.50 | 3.75 | 1.75 | 68.75 | 13.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CA1100** Total | 0 | 0 | 0 | 0 | 0 | 11 | 19 | 97 | 73 | 83 | 58 | 19 |
| % | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.75 | 4.75 | 24.25 | 18.25 | 20.75 | 14.50 | 10.00 |
| **CA1125** Total | 2 | 3 | 0 | 36 | 10 | 10 | 69 | 63 | 69 | 77 | 51 | 3 |
| % | 0.50 | 0.74 | 0.00 | 8.93 | 2.48 | 2.48 | 17.12 | 15.63 | 17.12 | 19.11 | 12.66 | 0.74 |
| **CA1150** Total | 3 | 11 | 4 | 110 | 7 | 17 | 30 | 52 | 61 | 47 | 48 | 8 |
| % | 0.74 | 2.73 | 0.99 | 27.30 | 1.74 | 1.74 | 4.22 | 7.44 | 12.90 | 15.14 | 11.66 | 1.99 |
| **CA1175** Total | 15 | 13 | 8 | 149 | 28 | 9 | 19 | 36 | 42 | 46 | 24 | 4 |
| % | 3.72 | 3.23 | 1.99 | 36.97 | 6.95 | 2.23 | 1.74 | 4.71 | 8.93 | 10.42 | 11.41 | 0.99 |
| **CC1100** Total | 0 | 0 | 0 | 0 | 0 | 37 | 69 | 61 | 61 | 61 | 23 | 2 |
| % | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.25 | 17.25 | 15.25 | 15.25 | 15.25 | 40.25 | 5.00 |
| **CC1125** Total | 11 | 1 | 0 | 41 | 32 | 25 | 50 | 61 | 81 | 24 | 16 | 26 |
| % | 2.84 | 0.26 | 0.00 | 10.59 | 8.27 | 6.46 | 12.92 | 15.76 | 20.93 | 6.20 | 4.13 | 6.72 |
| **CC1150** Total | 11 | 6 | 3 | 80 | 27 | 23 | 34 | 58 | 78 | 23 | 15 | 29 |
| % | 2.61 | 1.43 | 0.71 | 19.00 | 6.41 | 5.46 | 8.08 | 13.78 | 18.53 | 5.46 | 3.56 | 6.89 |
| **CC1175** Total | 15 | 3 | 2 | 88 | 33 | 1 | 11 | 27 | 58 | 24 | 11 | 12 |
| % | 5.00 | 1.00 | 0.67 | 29.33 | 11.00 | 0.33 | 3.67 | 9.00 | 19.33 | 8.00 | 3.67 | 4.00 |
| **CV1000** Total | 0 | 0 | 0 | 0 | 0 | 20 | 116 | 62 | 138 | 28 | 18 | 10 |
| % | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.95 | 28.71 | 15.35 | 34.16 | 6.93 | 4.46 | 2.48 |
| **CV1125** Total | 7 | 4 | 4 | 38 | 22 | 11 | 80 | 55 | 92 | 30 | 22 | 17 |
| % | 1.73 | 0.99 | 0.99 | 9.38 | 5.43 | 2.72 | 19.75 | 13.58 | 22.72 | 7.41 | 7.90 | 4.20 |
| **CV1150** Total | 20 | 10 | 1 | 92 | 16 | 3 | 10 | 20 | 69 | 34 | 37 | 14 |
| % | 4.95 | 2.48 | 0.25 | 22.77 | 3.96 | 0.74 | 2.48 | 4.95 | 17.08 | 8.42 | 9.16 | 3.47 |
| **CV1175** Total | 21 | 13 | 1 | 144 | 44 | 4 | 11 | 28 | 30 | 27 | 43 | 3 |
| % | 5.24 | 3.24 | 0.25 | 35.91 | 10.97 | 1.00 | 2.74 | 6.98 | 7.48 | 6.73 | 10.72 | 0.75 |
| **CB11100** Total | 34 | 24 | 7 | 279 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % | 8.44 | 5.96 | 1.74 | 69.23 | 13.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
Fig. 1. Char’s morphology frequency from original coal and bagasse as a function of the temperature, a) 900 °C, b) 1000 °C, c) 1100 °C. Source: Authors—analyzed data.
Fig. 2. Char's morphology frequency from coal-bagasse blend at 900 °C. a) 25%, b) 50%, c) 75%. Source: Authors—analyzed data.
Fig. 3. Char’s morphology frequency from coal-bagasse blend at 1000 °C. a) 25%, b) 50%, c) 75%. Source: Authors—analyzed data.
Fig. 4. Char’s morphology frequency from coal-bagasse blend at 1100 °C. a) 25%, b) 50%, c) 75%. Source: Authors—analyzed data.
Fig. 5. SEM morphology of original and char samples produced at 900 °C. Source: Authors—Raw data.
composition by ASTM D2799-1. The 3 most important microscopic components of coal were identified as inertinite, liptinite, and vitrinite; and from this analysis, the maceral volume percentage was obtained.

2.2.4. Vitrinite reflectance analysis

The vitrinite reflectance was performed on an Olympus BX-51 microscope coupled to a J&M MSP 200 spectrophotometer, using reflected light, polarized monochromatic, with a 50X oil objective. Initially, the system was calibrated using 5 standard patterns of known reflectance. The average reflectance was determined following the procedure of the ASTM D2798-11a.

2.2.5. Morphology analysis

For this purpose, specimens were made by mixing 0.2 g of carbonized with LECO brand epoxy resin in a one-inch diameter mould. The mixture was cured for 24 hours, then extracted from the mould and subjected to a sanding and polishing process in the Struers Labopol-5 brand polishing machine, at 200 rpm, using 400, 600 and 1200 grain of sands; and for polishing, alumina suspensions of 1.0, 0.3, 0.05 μm. The polishing times exerted varied at each stage depending on the proportion of bagasse in the sample. This is because biomass is a soft material and easy to erode, and therefore imperfections occur on its surface. The sanded and polished specimens were analyzed with a Nikon LV-100 metallographic microscope using reflected white light, with a 50X air objective. In this analysis, at least 400 particles were identified for each test. Each carbonized particle was classified according to Avila et al. [3], Lester et al. [4], and Sanabria and Castro [5]. Morphologies were identified according to their origin, coal or bagasse, with thick and thin network morphologies, thick and thin spheres, pore mix, dense mixture, inert, solids and filaments that are exclusive structures of bagasse particles. To evaluate the reactivity, morphologies were gathered into three groups [6], in thin walls, thick walls and solid particles, where the first 2 are porous mixtures, and the last consists of mixtures dense, solid and inert.

2.2.6. SEM analysis

A scanning electron microscope (Jeol JSM6490LV) was used, with a probe for chemical micro-analysis (INCAPenta FETx3), with sample coating systems (gold and carbon) and with heating and cooling plates.
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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dib.2020.105358.

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