Biocarbon for industrial applications

What is the difference between biocarbon and biochar?

Biocarbon and biochar are both solid, carbon-rich material obtained from the pyrolysis of biomass. Both are similar to charcoal but vary in their ultimate fate (energy or carbon storage). The familiar barbeque "charcoal" is a form of biocarbon.

- Biochar and biocarbon production via pyrolysis hold considerable promise for co-production of industrial heating, electricity generation, and as solid, liquid and gaseous feedstocks for many industries:
    - biocarbon as a reductant where fossil fuel carbon such as coal is currently used
    - biocarbon as a coal replacement for industries requiring high carbon and energy content feedstocks
    - biochar as a soil amendment (see TNSB05 -Biochar)
    - biochar for carbon sequestration applications (see TNSB05 -Biochar)
    - as activated carbon (after steam treatment)
- Among the industrial applications, the metallurgical sector is the most promising market for biocarbon.

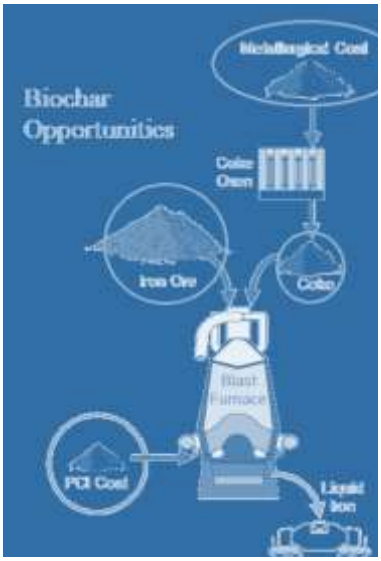
Biocarbon industrial opportunities

While use of biochar in agriculture has lots of land use benefits the biocarbon market is most likely to be driven by the industrial uses because of volume and ability to pay.

Millions of tonnes of biomass/biocarbon will be needed to replace fossil fuel carbon.

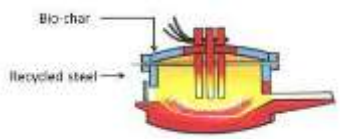
Transitioning industry to produce low levels of greenhouse gas emissions requires replacement of coal for which biocarbon is ideal. Industrial applications are:

- Up to 100% replacement of pulverized coal injection (PCI) in blast furnace ironmaking
- Up to 100% replacement of coke breeze for the induration of iron ore pellets
- 5-10% substitution of metallurgical coal in coke making (slot ovens)
- Replacement of coke briquettes by biocarbon briquettes
- Up to 100% replacement of injection carbon (for slag foaming) and charge carbon (heat) in electric arc furnace (EAF) steelmaking.



The biocarbon is mainly used as a reductant,

for example: $2Fe_2O_3 + 3C \longrightarrow 4Fe + 3CO_2$



Making biocarbon

Making biocarbon and biochar is easy

Both is produced by heating biomass in an oxygen-free or air-limited environment

Making "applications-specific" biocarbon and biochar is difficult

Various applications (industries) require biocarbon with specific properties to meet process requirements. The raw biomass type, moisture, density and composition as well as pyrolysis conditions (slow vs fast pyrolysis) and temperature greatly influence properties. The original biomass carbon content will have some effect but pyrolysis conditions play a very significant role in the final product.

With an increase of pyrolysis temperature or residence time, the carbon content, energy content, grindability, porosity and surface area are higher with a lower bulk density

Coal equivalent properties for iron and steel industry

Table 1 shows some typical coal properties which biocarbon would need to meet to be suitable for direct injection in blast furnace ironmaking:

- Analysis is based on ASTM D05 and ISO/TC27 procedures
- Typical levels of these and other properties for biocarbon are likely to be different to those that are measured for coal
- There is no consensus as to which test methods to use for biocarbon
  - Many are based on procedures used for coal
  - No harmonised methods for biocarbon
  - No testing protocols or specifications for various applications

Table 1 Equivalent coal properties

	Typical values	Procedure
%volatile	33.55	ISO 562
%Ash	6.28	ASTM D7582
%Carbon	80.39	ASTM D5373
%Hydrgen	5.17	ASTM D5373
%Nitrogen	1.60	ASTM D5373
%Sulpur	0.85	ASTM D5373
HHV (MJ/kg)	33.3	ISO 1928
HGI	59	ASTM D409

International standards

The ISO committee ISO/TC238 has established a Working Group to:

- Establish specifications for key properties of biocarbon applicable to the iron and steel sector
- Develop and validate testing methods and protocols for measuring these properties by expanding the scope of existing standards or developing new ones; ensure that specifications are based on these protocols
  - addition of new protocols for sampling, sample preparation, calibration, etc..
  - new guidelines may also be needed for handling, storage, and transportation, and for health and safety measures

Some of this work is underway at NRCan/CanmetENERGY