The utilization of renewable energy and the substitution of the fossil fuels by alternative sources is one of the priority points for a sustainable development. Fuels obtained from biomasses can become a valid alternative to displace fossil fuels, also in the light of stricter environmental constraints. In the outline of alternative liquid fuels, bio-lubricity can represent an interesting topic as concerns the “fluidification” of solid biomass to be used in power plants and, specially, in small scale energy systems for stationary applications.

**Focus:** Stable and efficient utilization of bio-lubricity in power plants and small scale energy systems

**Objective:** Fundamental combustion properties and behavior of droplets of bio-lubricity

- Coal/water slurry technology, a suspension of fine coal particles in water, was developed in the former Soviet Union in the ’50s of the last century to transport coal from mines to far power plants.
- Coal/Water Slurries (CWS) and Coal Oil Slurries (COS) were introduced in the ’70s of the last century, in connection to the petroleum crisis, to permit the utilization of coal in power plants designed for liquid fuels.
- Bio-lubricity represents the “green version” of CWS and COS: a fine suspension of biochar in bio-oil to form 100% bio-fuel or in fossil oil (light or heavy) for a mixed bio/fossil fuel.
- Bio-lubricity can represent a viable solution to convert efficiently the energy content of biochar if its utilization efficient and stable is assured. To this aim, the analysis of the combustion properties of bio-lubricity is the most critical point.

**Materials and Methods**

**Bio-lubricity**

Bio-lubricity = Bio (char + diesel)

**Biochar**

The biochar used to form the bio-lubricity was produced by multibatch catalytic pyrolysis of algae Spirulina A. platensis by multibatch catalytic pyrolysis of algae Spirulina A. platensis.

**Bioslurry**

Bioslurry produced: 20/80 wt/wt biochar/diesel

**Experimental set-up**

- A 75 μm wires bare thermocouple was used to hang and measure the temperature of the droplets
- A lateral thermocouple (75 μm wires) was used to sense droplet ignition and flames standing
- A CMOS high-speed camera (Photron Fastcam SA-X2, max acquisition rates of 1 Mfr/s, 1024x1024 pixels, 12-bit) was used to visualize the droplets before and after the ignition, as well as the variation of their size. The acquisition frequency was set at 1,000 frames/sec and full frame resolution
- All the signals were acquired by a LeCroy Waverunner 104MXI-A transient recorder
- The boiling of droplets was obtained by a resistive coil placed below the droplets (picture on the right)

**Method**

Thermo-optical investigation of the combustion behavior of droplets of bio-lubricity by high speed shadowgraphy

**Results**

Fundamental parameters of the combustion of droplets of bio-lubricity

**Activities**

- Combustion behavior of droplets of bio-lubricity formed by different biochar samples in biodiesel
- Thanks to a mechanical sieving based on sieve with 200 μm mesh, 125 μm and 50 μm, the sample was divided into four size classes
- Two bio-lubricity were formulated by using biochar particles belonging to the smaller granulometric classes
- A third bio-lubricity was formed for comparison by using algal biomass

**Results**

- All slurry droplets show significant swelling and sputtering.
- Ignition of bio-lubricity drops is governed by biodiesel fraction: Tign = 230-260 °C.
- The homogeneous combustion of bio-lubricity formed with biochar is dominated by the behavior of biodiesel. The slurry with algae exhibit a greater homogeneous burning time due to the contribution of the lipidic compounds.
- The three bio-lubricity examined show the formation of a solid carbonaceous residual at the end of the homogeneous combustion phase. It is generated by the thermo-chemical transformations that biochar and algae particles undergone during the homogeneous combustion phase.
- Considering the excellent ignition behavior and the homogeneous combustion of the analyzed bio-lubricity, the oxidation of the carbonaceous residual (heterogeneous combustion) remains the most critical aspect.
- The duration of heterogeneous combustion is almost invariant for algae slurry. For biochar slurry, it is double for the slurry formed with larger particles (50μm-125μm) with respect to the finer one (20-50μm). From this point of view, the bio-lubricity with algal biomass is very promising.
- However, smaller biochar requires supplementary energy costs due to the greater work for grinding finely the biochar, and greater problems of management and safety, in relation to storage, due to greater propensity to ignition.

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