

UBC INDEPENDENT TORREFACTION TESTS AND ANALYSIS

May 28th, 2013

Comparing torrefaction of bark and pine pulp chips
Biomass & Bioenergy Research Group

Bark samples (picture 1) and Wood pine chips (Picture 2) were subjected to torrefaction in the BTGA equipment available at University of British Columbia. Doctoral Candidate Bahman Ghiasi conducted the tests during the week of May 20-24, 2013. Bark sample was in pieces with lots of fine particles as Picture (1) shows. The sample was wet with a moisture content of around 65-66% (wb, wet mass basis). Pine chips (Picture 2) were clean without bark with moisture content 53-55% (wb)



Picture 1: Bark sample



Picture 2. Pine chips

Torrefaction test

Roughly 700 g of each of the samples (bark and pine chips) were torrefied. The torrefaction process consisted of two steps: drying followed by torrefying. For drying the reactor temperature was maintained at 150°C. Bark and pine chips were heated and maintained at 150 °C for 1 hour. Torrefaction started after one hour of drying, when the reactor temperature increased to a temperature of 280 °C for torrefaction. Torrefaction lasted for 30 minutes once the the sample reached to 280°C.

Test result and observations

Table 1 summarizes the results.

Figure 1 shows the temperature regime of the torrefaction reactor BTGA. The process is divided into four regions: heating to drying temperature, maintaining the temperature at 150°C to complete drying, heating the reactor to 280°C to initiate torrefaction, maintain the reactor temperature at 280°C to complete drying. The entire process took 212 minutes. It took slightly longer for bark temperature to rise to the drying temperature because of its higher moisture than pine chips. The bark also had a slight delay in heating up to the torrefaction temperature. But these differences were not significant.

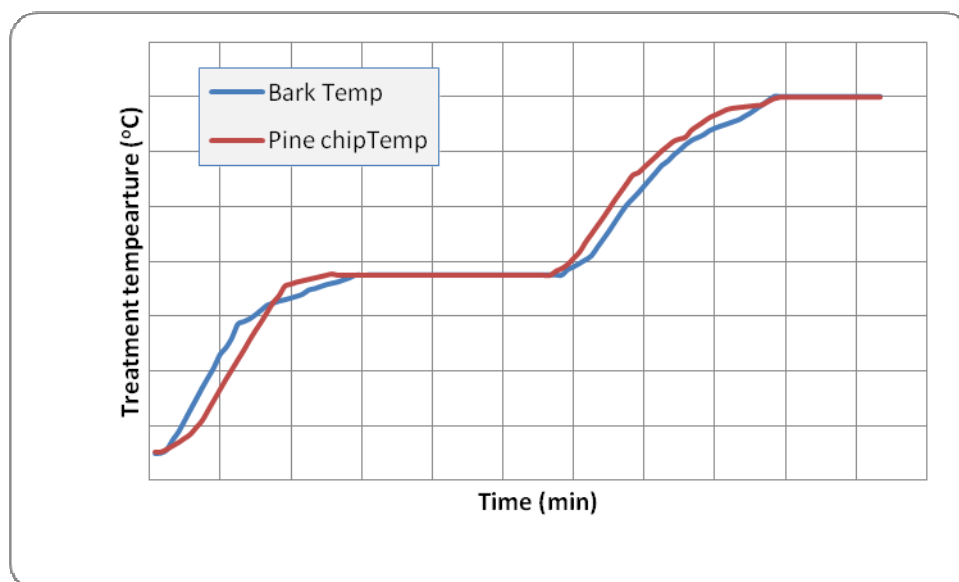
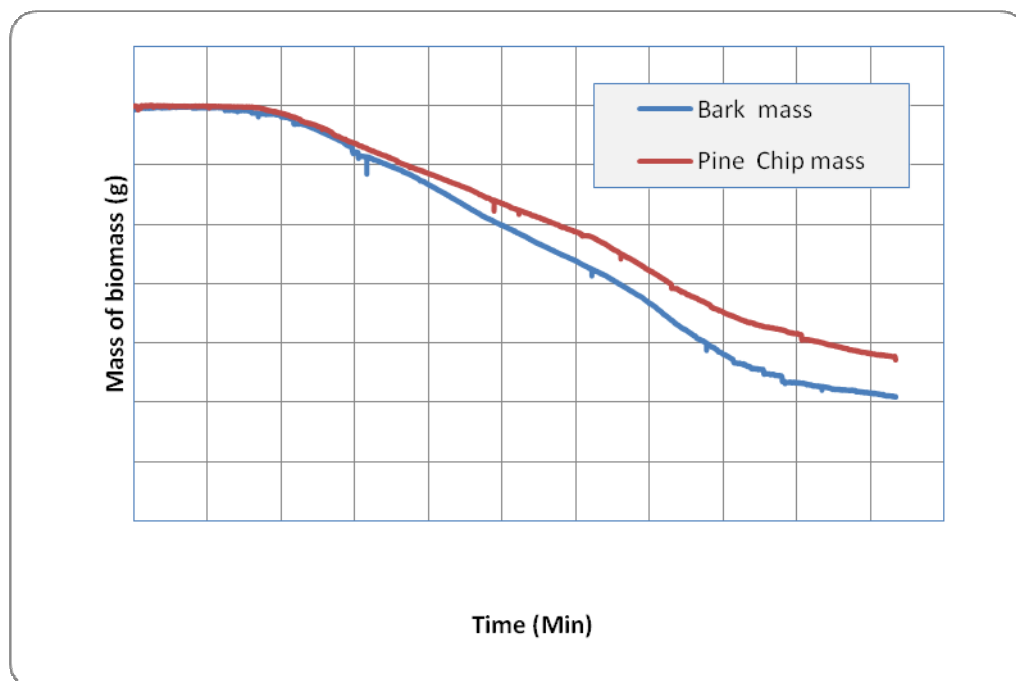


Figure 1 Treatment temperature for drying and torrefaction of bark. It took 40-60 minutes to heat the unit to drying temperature (150°C). The temperature was maintained at 150°C for next 6 minutes when the material was dry. The reactor was heated to 280°C to activate the torrefaction process. The temperature was maintained at 280°C for 30 minutes to complete torrefaction.

Figure 2 is the plot of mass loss vs. time. Although not very clear, the regions of heating when almost no mass loss took place (for about 40 minutes), decrease in moisture between 40 and 120 minutes, torrefaction past the 130-40 mark. Bark showed a larger mass loss than pine chips.

Sample	Bark	pine
initial weight	700g	700g
drying temperature	150 C	150 C
drying duration	1 hr	1 hr
torrefaction temperature	280 C	280 C
torrefaction duration	30 min	30 min
initial MC %	65-66	47-50
final MC%	1.5	1.45
final weight	210g	273g
HHV after torrefaction	21.6 GJ/ton	21.8 GJ/ton
ash content after torrefaction	2.10%	0.56%



Instantaneous mass of bark and pine chip during drying and torrefaction. Bark dried at a slightly faster rate than pine chip. Similarly, the bark showed a larger mass loss during torrefaction as is evident from its mass loss curve.

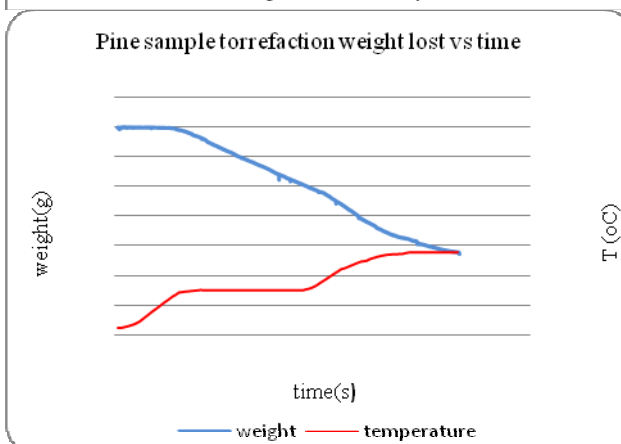
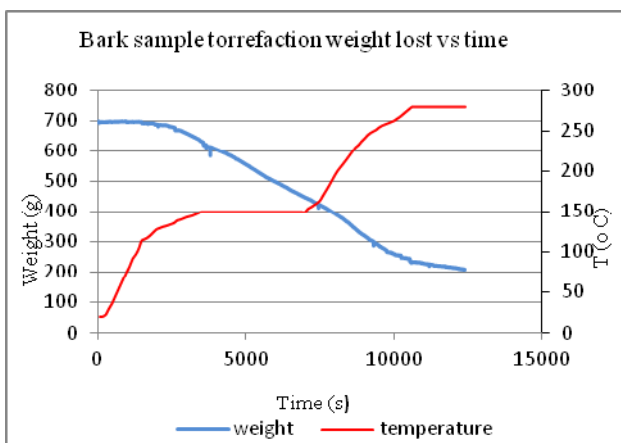
The result of calorific value measurement shows that even the bark has higher ash content but it has denser energy and through torrefaction it can have higher energy density compared to pine chips.



Picture 3: The shape and color of the torrefied bark



Picture 4: The shape and color of torrefied pine chip



NOTE: The adjacent tests are part of an on-going UBC program designed to ensure the torrefaction technology continues to maintain its state-of-the-art designation and to ensure that GBCE bio-coal is keeping pace with end-user technological advances.

Bark and pine sample torrefaction temperature and mass vs treatment time.