Upstream Torrefaction/Densification Integration on Physical and Mechanical Properties of Woody and Non-woody Bio-pellets

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Abstract. By combining torrefaction with pelletization, solid biomass materials can be converted into a high-energy-density commodity energy carrier with additional properties comparable to fossil fuel. The objective of the present work was to evaluate the Volumetric Energy Density (VED), Compressive Strength and Hygroscopic Behavior (EMC) of torrefied pellets of five tropical woody and non-woody biomasses from Thailand (Acacia, Leucaena, Rubber tree, Eucalyptus Bark, and Empty Fruit Bunch) by applying torrefaction as a downstream operation. Torrefaction was performed at 300°C with selected holding times in order to obtain a 22% mass loss. After grinding, the raw and torrefied feedstocks were densified. The results showed the torrefaction enhanced high heating value of biomass while the densification enhanced bulk density. The black pellet density dropped off except for EFB. The VED of torrefied chips is almost equal to that of the original material, whereas the step of compression creates the advantage difference. The VED increased for all biomass samples from a minimum of 6% to a maximum of 34%. The hardness defines as the resistance to deformation has been reduced from 25% to 56% except for EFB equal that of the normal pellets of wood. The compressive strength and density of a single pellet showed positive correlation. The EMC of pellets was performed under controlled exposure to Relative Humidity (31.6 %, 74.7 %, and 82.3 %). White pellets absorbed 13 to 17% more moisture than black pellets at 31.6% and 82.3% respectively. Unless for EFB, all torrefied pellets had a significantly difference in moisture uptake at high RH (from 8 to 11%) and became closer (5.5 to 6%) at low RH. An inverted phenomenon has been observed for white pellets. This study showed an upstream integration of torrefaction process can potentially produce highly dense

and durable torrefied pellets which make them more competitive in terms of energy content and density to some fossil product fuels.

Keywords: Bio-pellets, Upstream torrefaction, Energy