CASCADED USE OF THERMALLY MODIFIED WOOD WASTE

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1. Keywords

Thermally modified wood, pellets, cascaded use, biogenic carbon, life cycle assessment

2. Highlights

- Thermally modified wood waste (TMW) is a high value feedstock for the bioeconomy
- TMW is an excellent feedstock for densification in supplying downstream processes
- The cascade use principle for TMW has real potential to sequester biogenic carbon

3. Purpose

Wood is a natural carbon sink and its cascaded use helps to extend its lifetime in the bioeconomy. Thermally modified wood (TMW) building products (e.g. flooring, deck and façade planking etc.) are increasingly utilised in modern construction and have extended lifetimes due to their enhanced durability and resistance to weathering and degradation. TMW is manufactured using only heat and steam, and no chemicals, and this simplifies its recycling and reuse potential. In this study, the cascaded use of thermally modified wood waste was investigated as feedstock for downstream biorefining applications.

4. Materials and methods

Sixteen-year-old TMW (Pinus Sylvestris) plank waste was recovered, pre-processed and densified for downstream applications using systematic methods for pelleting [1]. Pelleting was done with a 15 kW ring-die pellet press. Two stationary Ø8 mm ring dies, with press channel lengths of 37.5 and 45 mm, were employed with two rollers operating at 50 Hz within the die. The feedstock moisture content was adjusted to 11.3 % (wet basis) and eight batches of pellets were produced and sampled. The temperature of the ring die (°C), instantaneous press power (kW) and extruded pellet temperature (°C) were recorded every second using a data logger. Feedstock was analysed for calorific value and ash content. Pellets samples were analysed using standard methods for quality. Using the production data, scenarios for the cascaded use of TMW waste were modelled using life cycle assessment (LCA).

5. Results and discussion

Analysis of produced pellets showed that they had high durability (97-98 %), high bulk density (685-715 kg m^{-3}), low production fines (0.7-1.0 %), low moisture content (4.8-7.6 %) and low ash content (0.13-0.24 %). Based on higher heating value determination the pellets exhibited a high volumetric energy density (13.4-14.0 GJ m^{-3}) indicating that the sequestered carbon in the material was well conserved. LCA results indicated a significant reduction in environmental impacts and specific emission footprint for a thermal conversion scenario compared to conventional wood pellets, even with the absence of a cascade.

6. Conclusions and perspectives

The results are strong evidence that the cascading use principle has real potential for TMW products in the bioeconomy and is a valid strategy for further extending the lifetime of wood products and sequestering biogenic carbon.

7. References

[1] Agar D , Rudolfsson M, Kalén G, Campargue M, Da Silva Perez D, Larsson SH. A systematic study of ring-die pellet production of forest and agricultural biomass. Fuel Processing Technology 180; 45-55 (2018).