Fundamental drying experiments with processed residual municipal solid waste materials

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ABSTRACT: The EU's circular economy concept necessitates the increasing of the recycling ratio of municipal solid wastes. There are many existing mechanical – biological processing plants in Hungary for the preparation of residual municipal solid wastes (RMSW). The two most important products of these plants are the so called bio-fraction and the RDF (refuse derived fuel). Currently there are problems with both of these material streams in Hungary, namely most of the bio-fraction is still landfilled and the local thermal utilisation of the RDF is not solved yet. The high moisture content of the produced bio-fraction and RDF causes difficulties for the downstream operations; therefore drying of these materials has a recent engineering interest to improve. Authors have carried out a systematic drying experimental series where the effect of the material, material composition, mass (volume or surface) of material and particle size distribution on drying intensity were studied in a 1 m^3 oven. The initial slope of the relative moisture loss as function of time was determined. Process engineering design methods of convective hot air drying can be further developed taking into account the research results.

MATERIALS AND METHODS

BIO-fraction sub-samples

RDF sub-samples

Examined materials:

RDF (RDF as received by the Institute after sterilization)

BIO (bio-fraction as received by the Institute after sterilization)

Sorted BIO (bio-fraction metal-stone-glass-depleted sorted residue)

Sorted BIO-30mm (bio-fraction metal-stone-glass-depleted sorted residue after cutting milling with 30 mm screen)

Sorted BIO-20mm (bio-fraction metal-stone-glass-depleted sorted residue after cutting milling with 20 mm screen)

25%RDF-75%Sorted BIO-20mm (mixed material)

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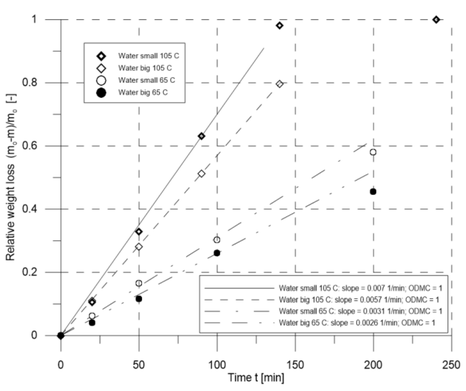

Figure 4. Tap water relative weight loss - time curves for calibration.

Sample	slope [1/min]	ODMC [-]
Sorted BIO big at 105 °C	0.0045	0.57
Sorted BIO small at 105 °C	0.0047	0.58
Sorted BIO -30mm big at 105 °C	0.0054	0.57
Sorted BIO -30mm small at 105 °C	0.0074	0.57
Sorted BIO -20mm big at 105 °C	0.0054	0.57
Sorted BIO -20mm small at 105 °C	0.0058	0.56
Sorted BIO big at 65 °C	0.0026	0.57
Sorted BIO small at 65 °C	0.0022	0.57
Sorted BIO -30mm big at 65 °C	0.0024	0.57
Sorted BIO -30mm small at 65 °C	0.0026	0.57
Sorted BIO -20mm big at 65 °C	0.0033	0.57
Sorted BIO -20mm small at 65 °C	0.003	0.57

Sample	slope [1/min]	ODMC [-]
25%RDF-75% Sorted BIO -20mm big at 105 °C	0.0069	0.44
25%RDF-75% Sorted BIO -20mm small at 105 °C	0.01	0.41
50%RDF-50% Sorted BIO -20mm big at 105 °C	0.004	0.46
50%RDF-50% Sorted BIO -20mm small at 105 °C	0.006	0.46
25%RDF-75% Sorted BIO -20mm big at 65 °C	0.0038	0.44
25%RDF-75% Sorted BIO -20mm small at 65 °C	0.0048	0.41
50%RDF-50% Sorted BIO -20mm big at 65 °C	0.0028	0.46
50%RDF-50% Sorted BIO -20mm small at 65 °C	0.0034	0.46

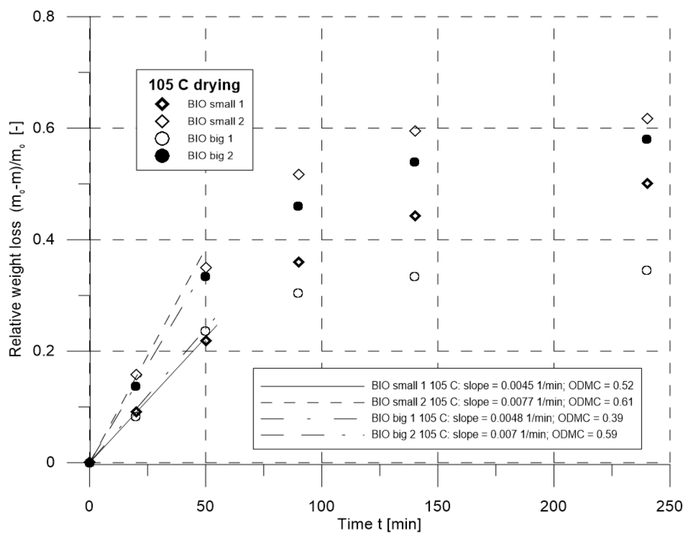

Figure 5. Drying curves of bio-fraction at 105 ° C.

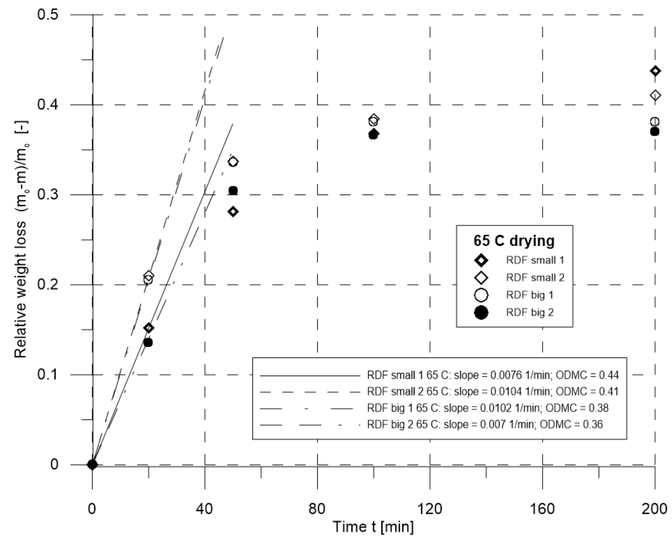

Figure 6. Drying curves of bio-fraction at 65 ° C.

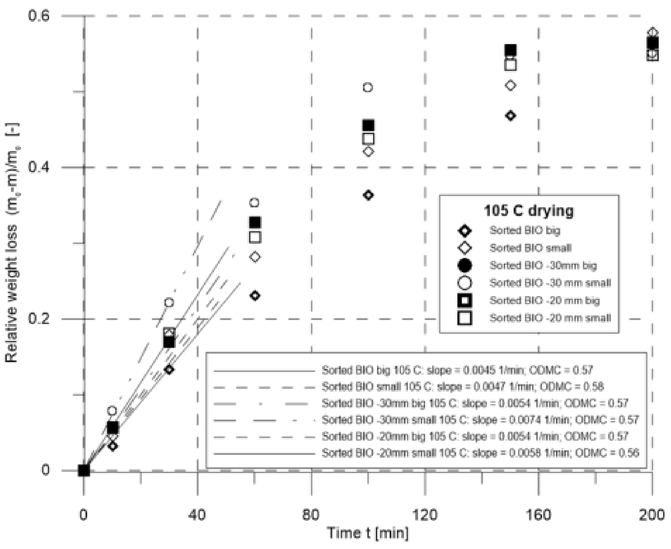

Figure 7. Drying curves of sorted and cut bio-fraction at 105 ° C.

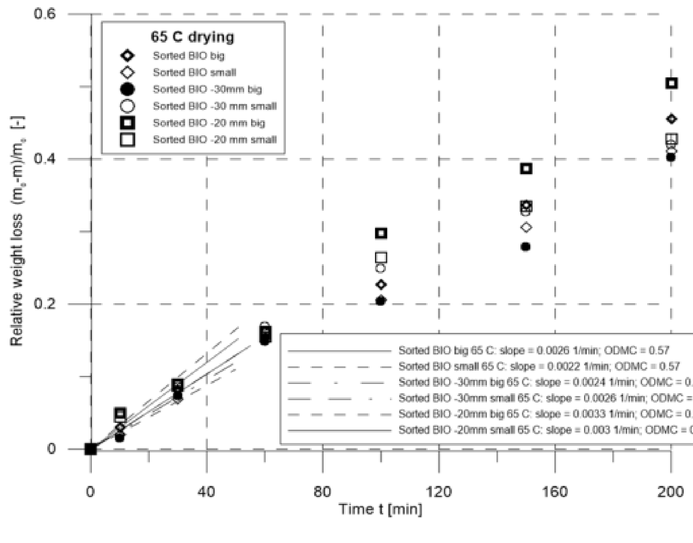

Figure 8. Drying curves of sorted and cut bio-fraction at 65 ° C.

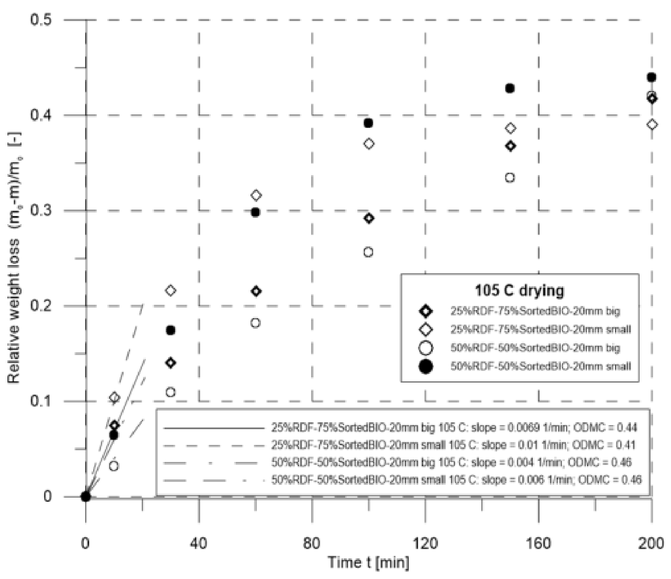

Figure 9. Drying curves of bio-fraction and RDF mixtures at 105 ° C.

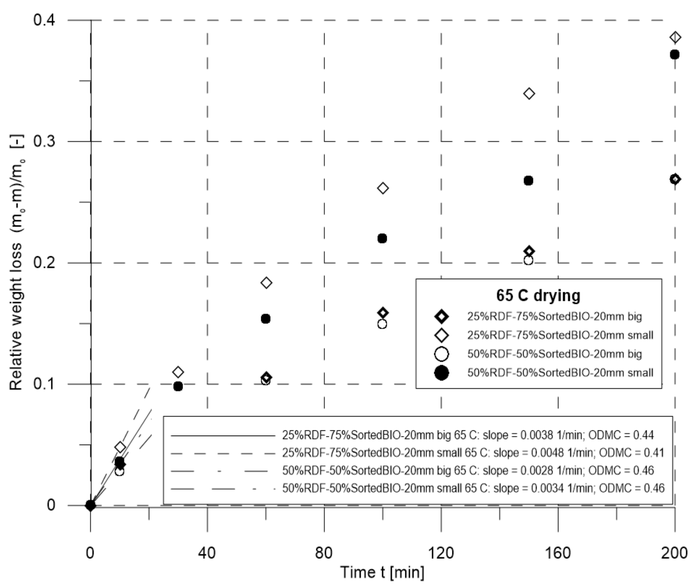

Figure 10. Drying curves of bio-fraction and RDF mixtures at 65 ° C.

CONCLUSION

- Drying at 105 Celsius results in about twice the initial drying rate compared to drying at 65 Celsius.
- If drying of RDF and bio-fraction separately in similar equipment with the same capacity, the initial drying rate of RDF is approx. three times the one of the bio-fraction.
- Samples of 50 to 80 grams had an initial drying rate of approx. 5% larger than samples of 100 to 120 grams under otherwise identical conditions. It validates the known fact, that the width of the material bed on the drying belt strongly affects drying.
- The initial drying rate of the -20mm cutting mill cut stone-metal-glass-depleted bio-fraction is approx. 25% bigger than if we didn't shred it.
- The average moisture content of RDF and bio-fraction mixtures can be easily calculated from the mixing ratio. The initial drying rate of the mixture is between the initial drying rates of the two components separately and is a function of the mixing ratio. This function relationship could not be determined from this measurement.
- The process engineering design method of convective hot air drying is shortly described in Chapter 1. The shown research results validate and fine tune this method especially focusing on the retention time in the drier. So far some actual process design has been made.

LITERATURE

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