



Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Institutionen för skogens
biomaterial och teknologi

Effect of sieve size and assortment on chipped woody biofuels qualities

Dan Bergström, Kalvis Kons, Fulvio Di Fulvio

Department of Forest Biomaterials and
Technology, SLU

dan.bergstrom@slu.se

- “The quality of fuel wood depends on several factors including its moisture content, ash content (AC), and particle size distribution (PSD).
 - ***For optimal combustion, the fuel should have a low content of fine particles.***”
- “With growing numbers of different wood fuel assortments entering the market, it is increasingly important to determine their quality in terms of their PSD and AC.
 - ***Information on these quantities facilitates the identification of shortcomings in supply chains, feeding systems and combustion processes....***”

Objectives

- “To analyze and compare the qualities of wood chips obtained from five different fuel wood assortments produced using two different chipper sieve settings.”

Study design

- Collection of different biomass assortments
- Time study of chipping work
- Sampling of chips
- Lab work
- Calculations...

Assortments

Bundled tree parts from thinnings (B)



Energy wood (EW)



Tree parts from marginal lands (TP)



Logging residues, fresh (LRF) & stored (LRS)



Chipping system

- Doppstadt DH910 drum chipper with a 450 kW engine, five 219 mm chipping knives having cutting lengths of 35 mm.
- Two different sieve sizes were used: “standard,” i.e. 100 × 100 mm; and “large,” i.e. 100 × 200 mm.
- The chipper was fed using a truck-mounted Epsilon Q170 crane and Hultdins SuperGrip II 360A grapple with a grabbing area of 0.36 m².



Time study

- Each assortment chipped with each sieve size
- Knife sharpness were controlled
- Each run took ca 1 hour of productive time
- Monitoring of main work elements
- Sampling of biomass from piles

Analysis

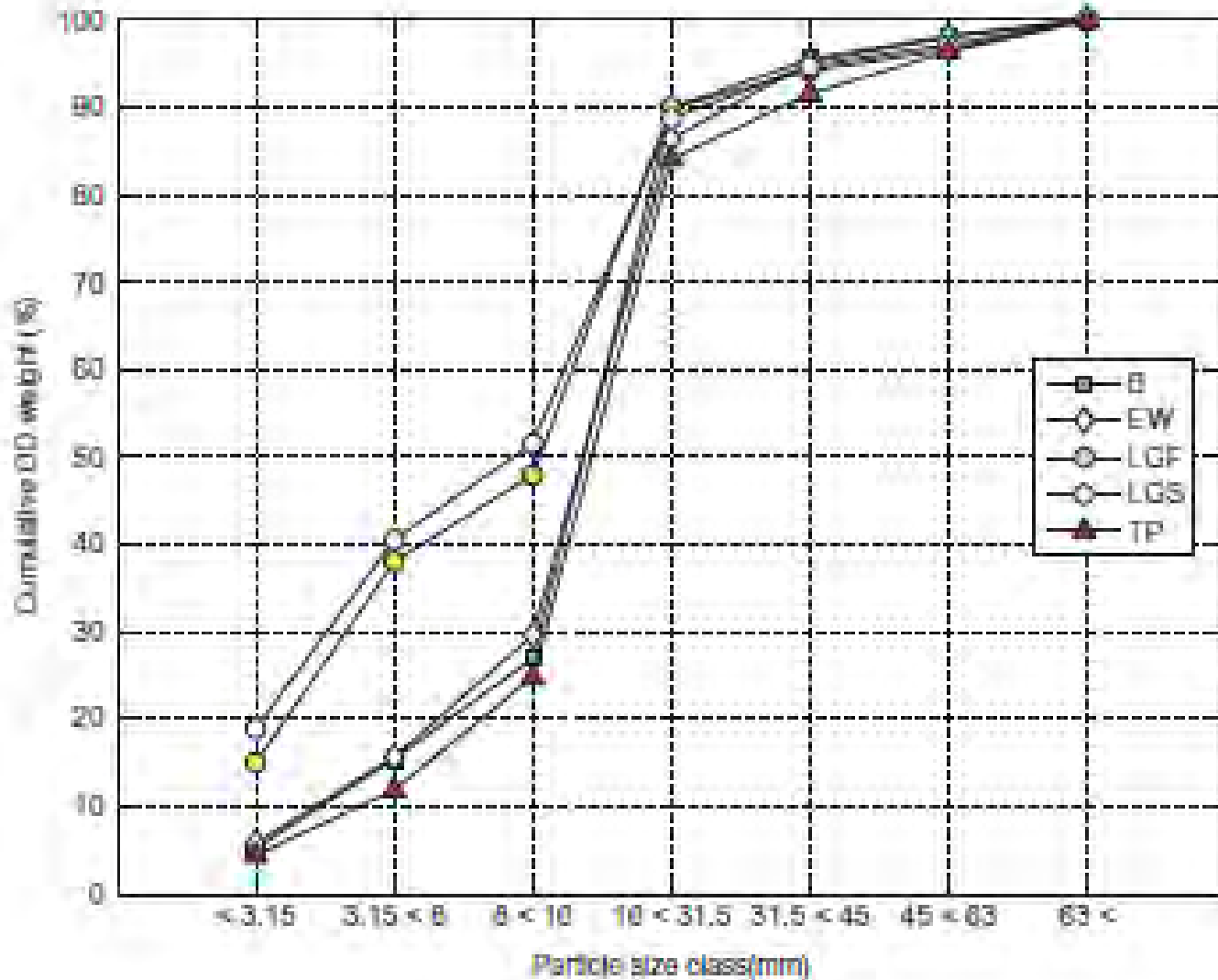
- Mass (weight bridge)
- MC
- AC
- PSD

Results

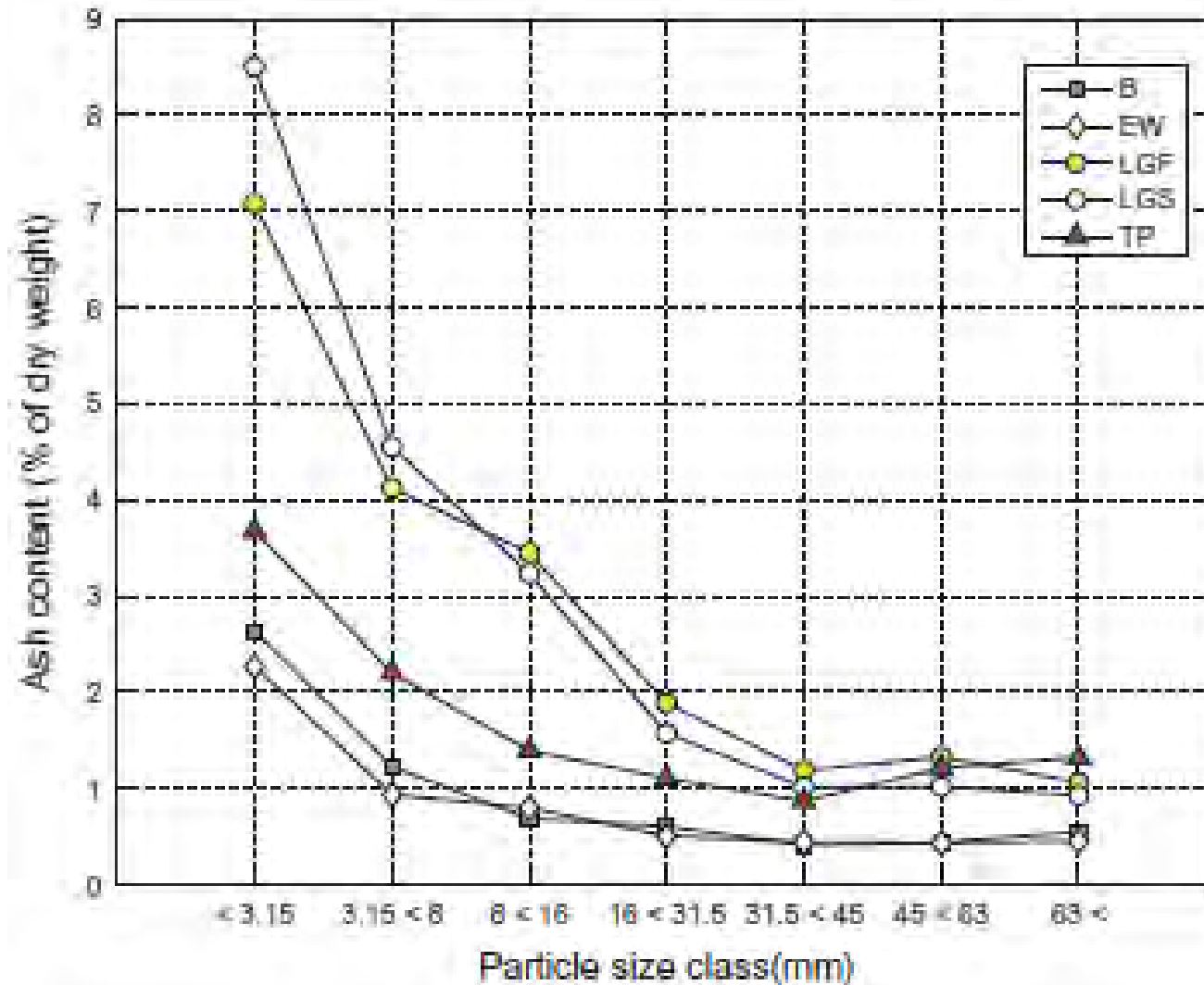
- Productivity & quality:
 - No differences between sieve sizes
 - >>Data were pooled!

| Production properties | Assortment | | | | | | | | | | AVG All |
|--|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|------------|
| | B | | EW | | LRF | | LRS | | TP | | |
| | L | N | L | N | L | N | L | N | L | N | |
| Productivity (t/PMH) | 58.1 | 59.7 | 39.3 | 41.4 | 25.9 | 31.1 | 23.7 | 29.7 | 27.4 | 27.4 | 36.4 |
| Productivity (OD t/PMH) | 32.0 | 32.2 | 14.5 | 16.6 | 13.0 | 15.6 | 12.4 | 11.6 | 11.2 | 9.3 | 15.7 |
| Average grapple load (t/crane cycle) | 0.51 | 0.51 | 0.38 | 0.41 | 0.29 | 0.33 | 0.22 | 0.27 | 0.28 | 0.29 | 0.35 |
| Chip bulk density (t/m ³) | 0.35 | 0.33 | 0.23 | 0.25 | 0.35 | 0.4 | 0.29 | 0.3 | 0.24 | 0.24 | 0.3 |
| Moisture content wet basis (%) | 45 (0.12) ^b | 46 (0.40) ^b | 63 (0.67) ^a | 60 (5.66) ^a | 50 (1.31) ^b | 50 (1.55) ^b | 62 (3.46) ^a | 61 (5.66) ^a | 59 (7.54) ^a | 66 (0.72) ^a | 57 |
| Fuel consumption (l/t biomass) | 1.47 | 1.54 | 2.21 | 2.16 | 1.65 | 1.57 | 1.79 | 1.9 | 2.97 | 2.94 | 2.02 |
| Fuel consumption (l/h) | 85 | 92 | 87 | 90 | 43 | 49 | 42 | 56 | 81 | 81 | 71 |
| Fuel consumption (l/OD t) | 2.67 | 2.85 | 5.97 | 5.40 | 3.30 | 3.14 | 4.71 | 4.87 | 7.24 | 8.65 | 4.70 |
| Chipping time/Work time (%) | 97 | 93 | 98 | 95 | 95 | 92 | 93 | 90 | 86 | 88 | 93 |

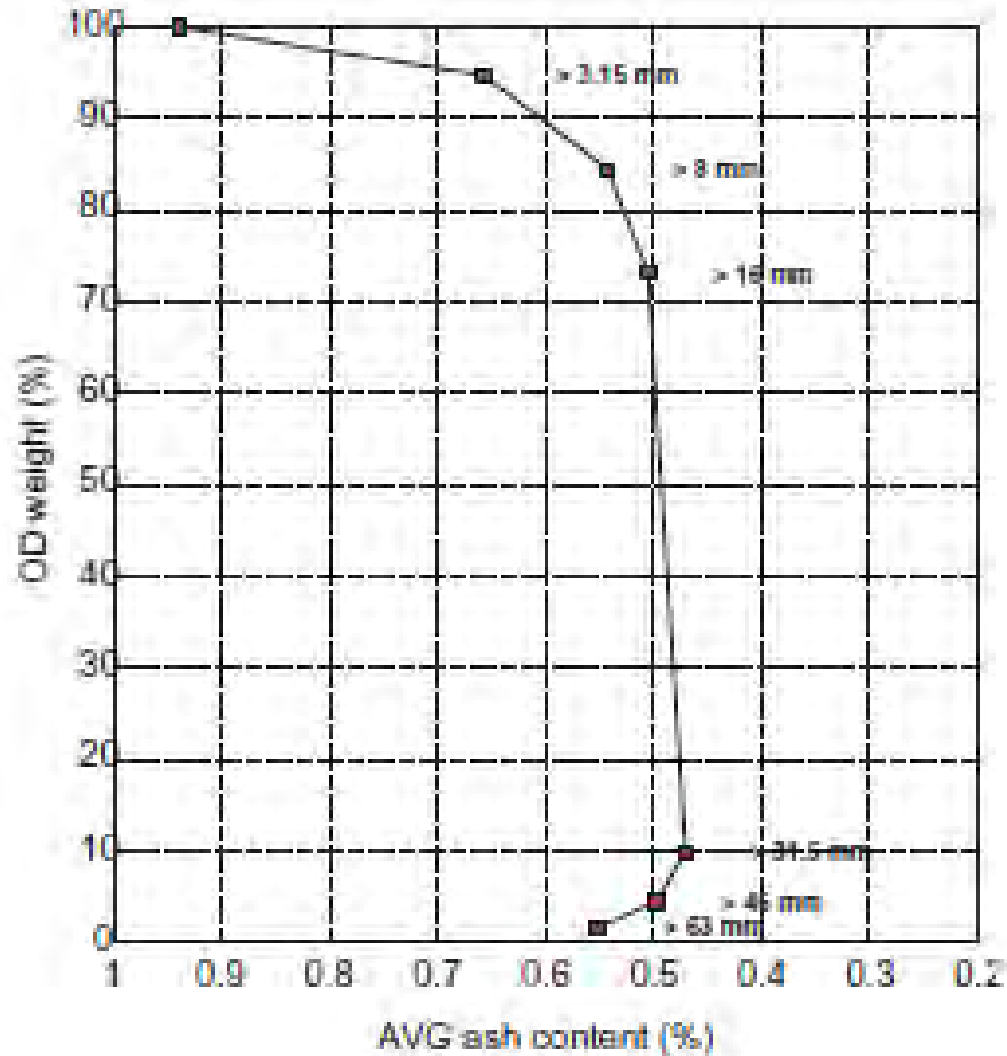
Mass vs. size distribution



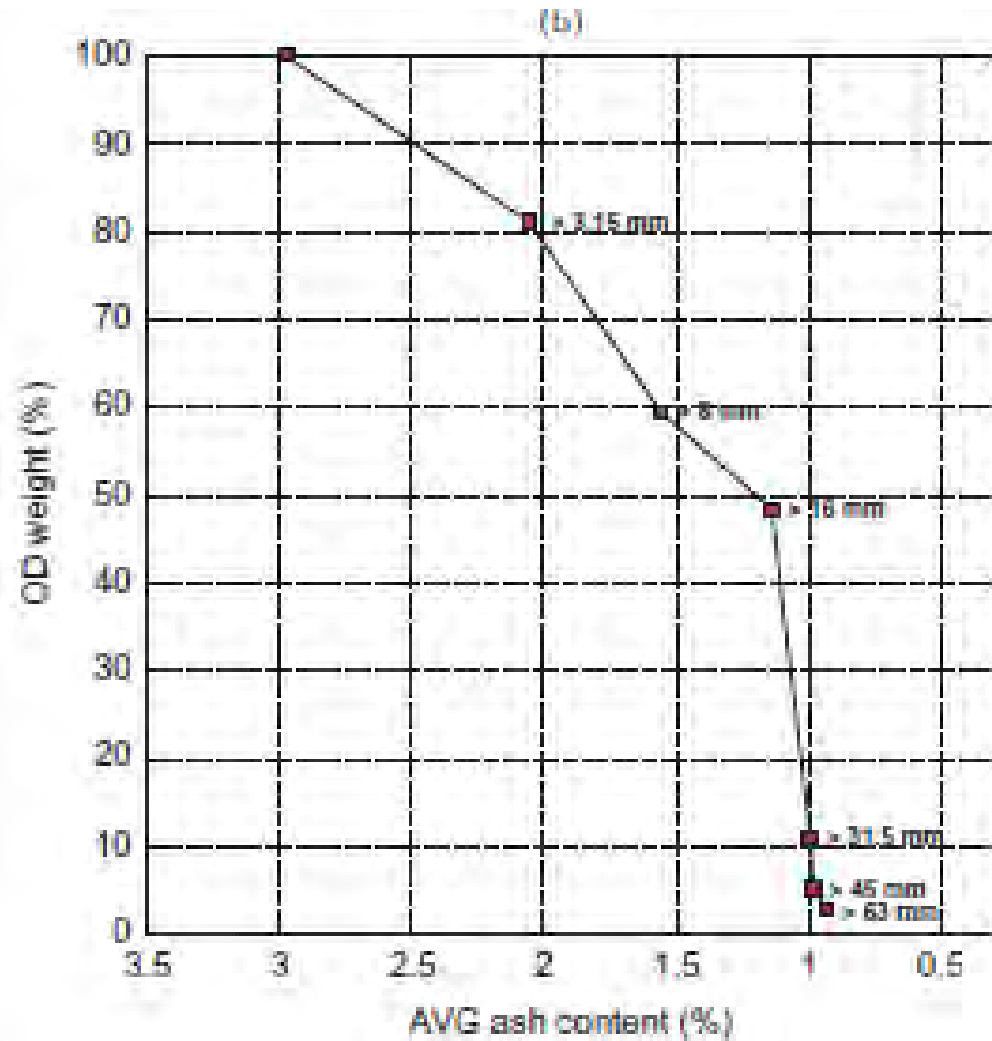
AC per size class



Effects of sieving (bundles)



Effects of sieving (stored LR)



Conclusions

- Sieve size:
 - sieve's main role in a large drum chipper is to recirculate oversized particles....
 - >> chip size is primarily determined by the knife configuration and settings.

Conclusions

- Key finding:
 - post-comminution screening could potentially significantly increase the fuel quality of the comminuted material.
 - >> beneficial when dealing with assortments such as logging residues for which the fines in the comminuted material are largely derived from needles, bark, twigs and soil.
- This nutrient-rich material could be gravimetrically separated from sand and used to produce valuable chemicals in biorefineries....

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- dan.bergstrom@slu.se