# Physical-mechanical fuel properties – Significance and standard determination methods

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# Quality characteristics in standardisation

**a) <u>Combustion related properties</u>**

| | |
|---|---|
| – moisture content | EN 14774 |
| – calorific value | EN 14918 |
| – volatile matter | EN 15148 |
| – ash content | EN 14775 |
| – ash melting behaviour | EN 15370 |

**b) <u>Mechanical properties</u>**

| | |
|---|---|
| – bulk density / particle density | EN 15103/15150 |
| – particle size distribution | EN 15149 |
| – durability (compressed fuels) | EN 15210 |

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# Moisture content

## Effects of moisture

- Calorific value (by mass) and energy content (by volume)
- Fuel losses (dry matter losses)
- Fungy growth and spores emissions (health hazards)
- Suitability for combustion (domestic furnaces)
- Risk of self-ignition
- Effect on bulk density

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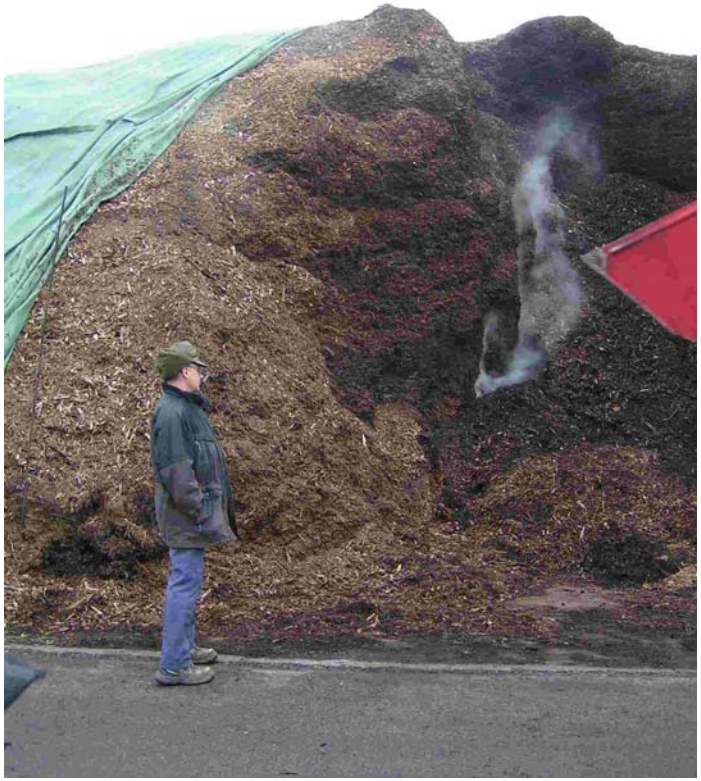
# Storage of "green" wood chips: Danger of self-ignition



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# Determination of moisture content

**Standard Method EN 14774:**

"Solid Biofuels – **Methods for the determination of moisture content** – Oven dry method„

- Part 1: Total moisture – Reference method
- Part 2: Total moisture – Simplified method
- Part 3: Moisture in general analysis sample

Method characteristics:

- Oven drying method
- Sample mass >300 g (part 1&2)
- Drying temperature: 105 ± 2 °C
- Drying time: until constant mass (16 – 24 h)
- Balance resolution: 0,1 g

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# Ash content

## Effects of ash content

- Ash disposal efforts
- Boiler design
- Particle emissions in flue gases
- Calorific value (d.b.)

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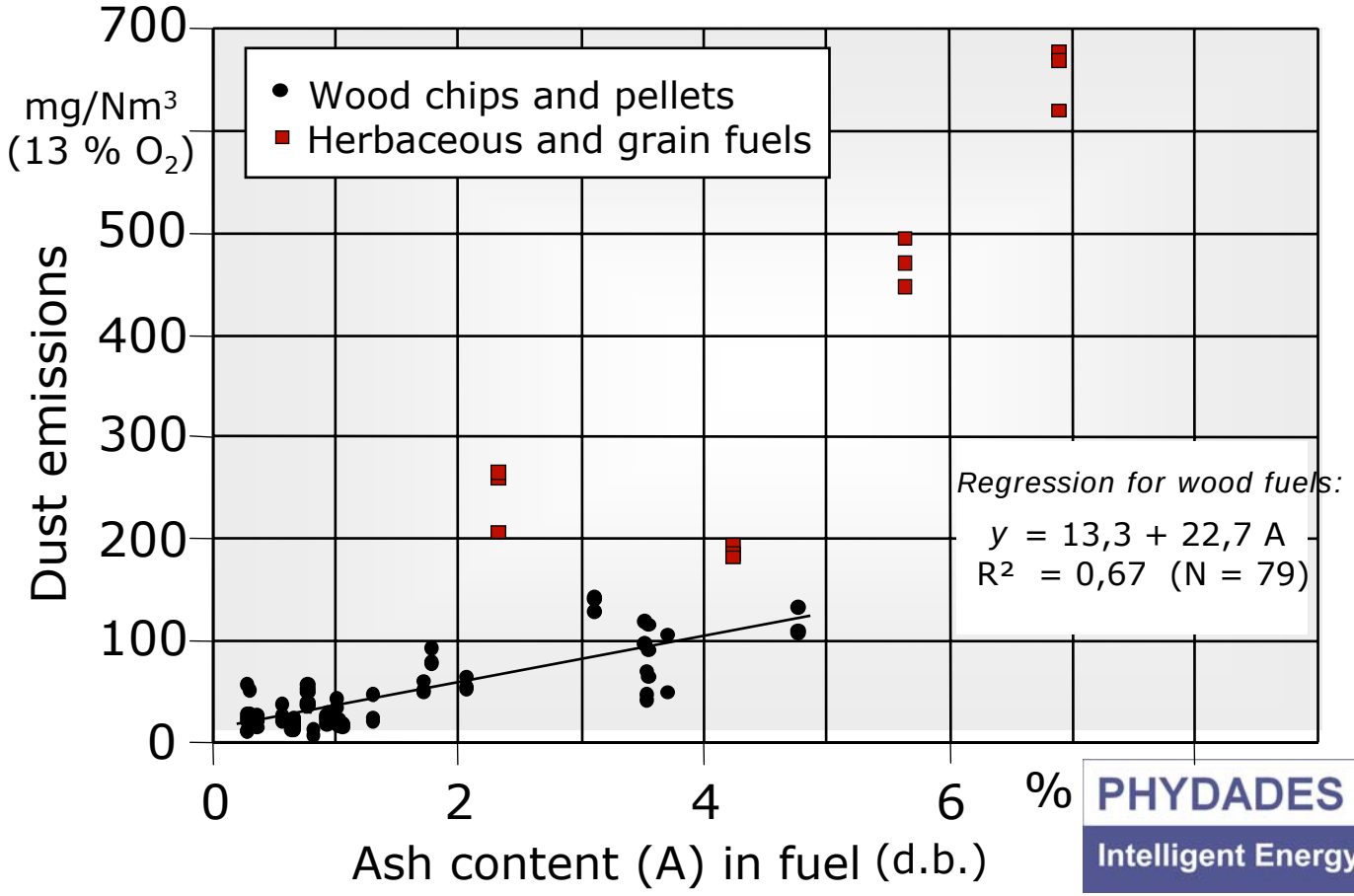
# Ash content

## Influence of the ash content on dust emissions (49 kW wood chip boiler)

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# Determination of ash content

**Standard Method EN 14775:**

"Solid Biofuels – **Methods for the determination of ash content„**

Method characteristics:

- Calculation from the mass of the residue remaining after the sample is heated.
- Sample mass > 1 g
- Defined temperature raise (5°/min)
  (RT -> 250 °C in 50 min, maintain for 60 min,
  250 °C -> 550°C in 60 min, maintain for 120 min)
- Furnace temperature: 550 ± 10 °C
- Cooling in desiccator
- Balance resolution: 0,1 mg = 0,0001 g

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# Determination of ash content

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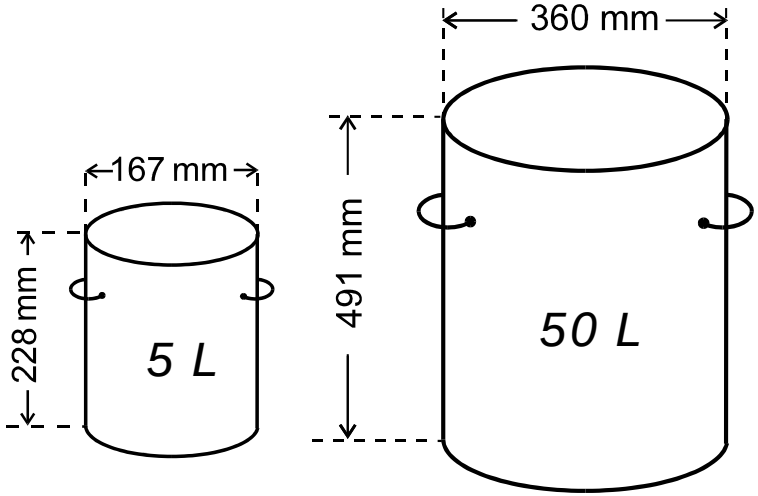
# Determination of bulk density

**Standard Method EN 15103:**

"Solid Biofuels – **Methods for the determination of bulk density**"




Method characteristics:

- The volume of the test sample is determined in defined round containers after shock impact
- Shock impact by dropping the container freely from 150 mm height onto a wooden board (3 times + refilling)
- Balance resolution: 1 g / 10 g

*Shock impact* *Levelling* *Weighing*

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# Durability of pellets & briquettes

## Effects of insufficient durability

- Release of fine particles or dust emissions during transport or storage (health hazard/consumer harassment)
- Risk of dust explosions (deflagrations)
- Disturbance of conveying process (broken pellets)

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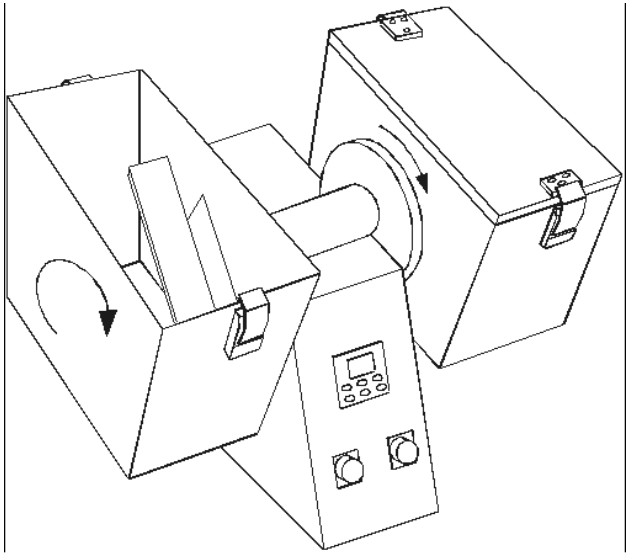
# Determination of durability of pellets & briquettes

**Standard Method EN 15210:**

"Solid Biofuels – **Method for determination of mechanical durability of pellets and briquettes**"
– Part1: Pellets – Part 2: Briquettes

Method characteristics (pellets):

- The test sample is tumbled in a defined rotating test chamber, the mass of abraded fine material is then determined
- Screening before tumbling: 3,15 mm
- Sample mass. 500 g
- Rotating time 10 min / 500 rotations
- Screening after tumbling: 3,15 mm round holes



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# Equipment for determining mechanical durability


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# Particle size & distribution

## Mechanical effects of unfavourable particle size distribution

- Clogging or system damages in conveying and transportation
- Disturb a continuous material flow
- Bridging in storage or conveying systems
- Increasing resistance to air flow in aeration or drying
- Inhibition of particle spreading on fire beds
- Dust formation during transportation

**Length is not determined by screening!**

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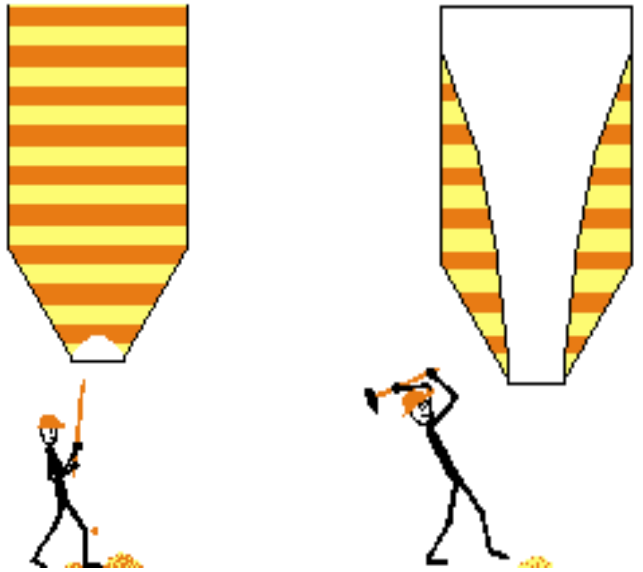
# Bridging

**Bridging summarizes several phenomenons**

- Building of a stabile bridge over an opening
- Inhomogeneous horizontal distribution or vertical flow
- Clogging hazards during conveying

**Influences on bridging properties**

- particle size distribution
- maximum particle length
- mean size/length ratio
- particle shape (sphericity)
- moisture
- density



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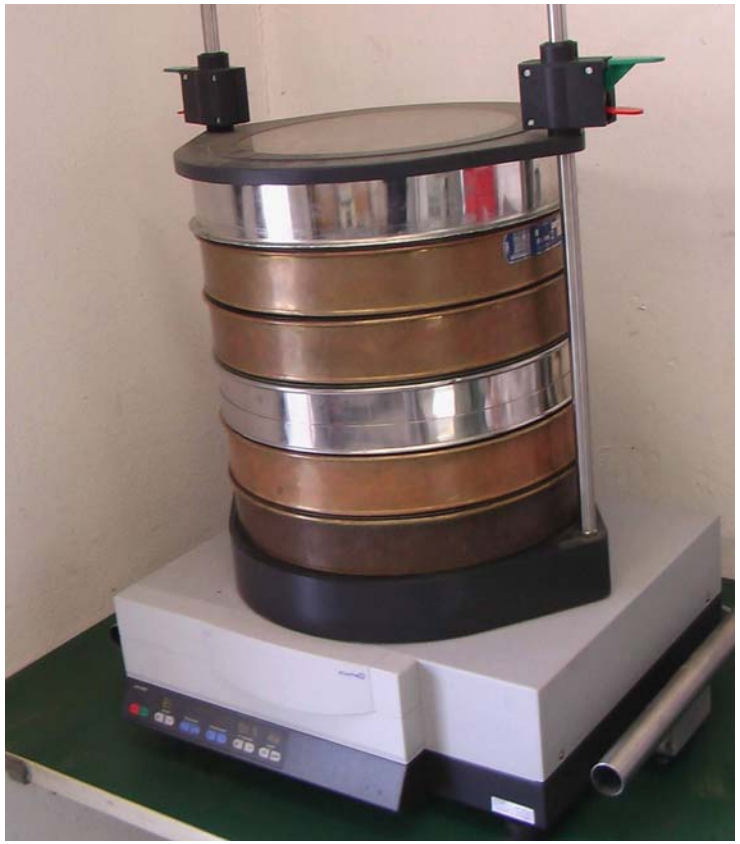
# Determination of particle size distribution

**Standard Method EN 15149:**

"Solid Biofuels – **Methods for the determination of particle size distribution„**

- Part 1: Horizontal screen method using sieve apertures between 1 and 63 mm
- Part 2: Horizontal screen method using sieve apertures of 3,15 mm and below



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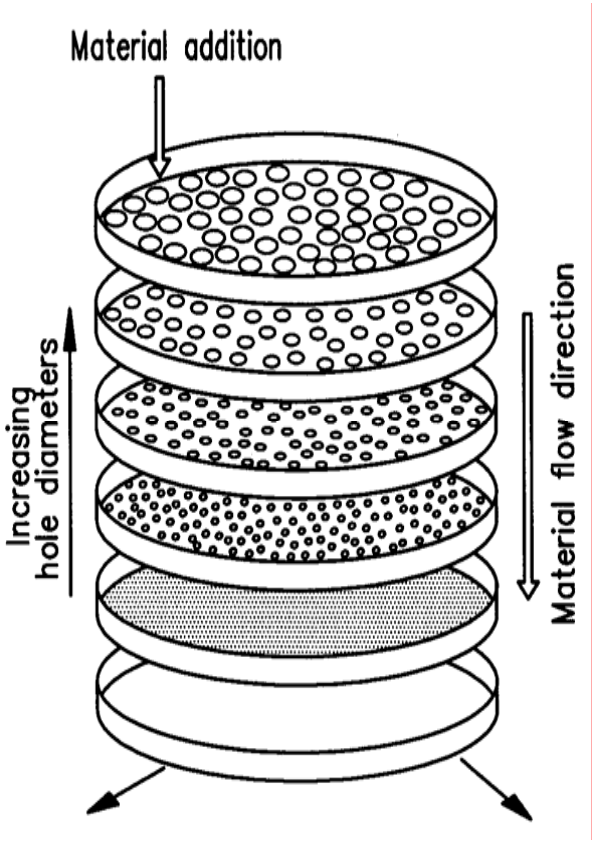
# Determination of particle size distribution

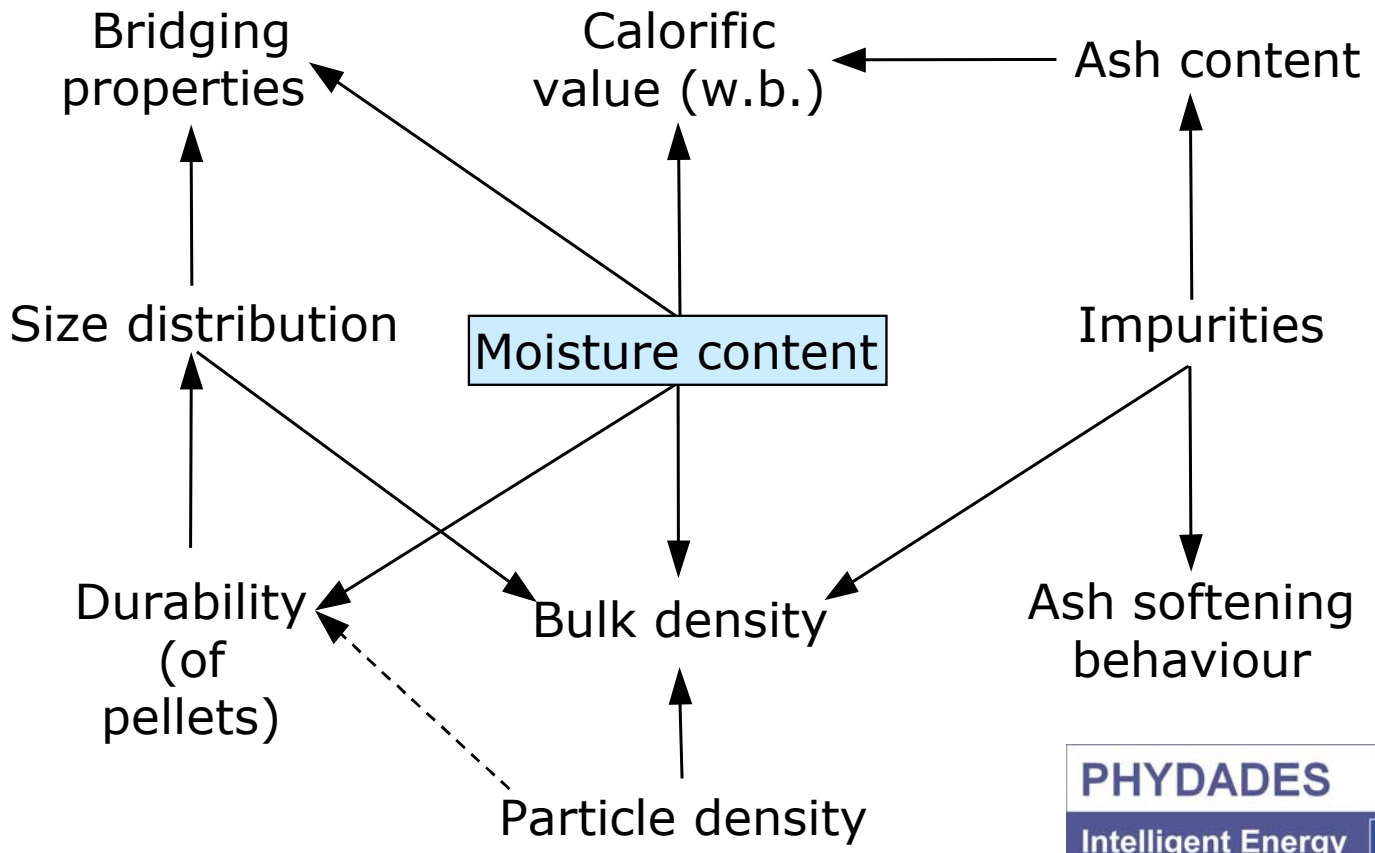
## Method characteristics (horiz. screening)

- Particle separation is achieved by screening, share of size class is determined by weight
- Min. sample size: 8 l (Part 1) or 50 g (Part 2)
- Sample moisture: < 20 %
- Min. screen sizes: 1200 cm² (Part 1) 250 cm² (Part 2)
- Hole geometry: round (Part 1) or square & round (Part 2)
- Hole sizes: 3,15/8/16/45/63 mm (Part 1); 0,25/0,5/1/1,4/2/2,8/3,15 mm (Part 2)
- Time: 15 min or to be tested in advance



# Summary and conclusions (1)

## Interdependency among physical / mechanical properties

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# Summary and conclusions (2)

- Moisture is the parameter with the largest influence on other physical properties.
- Measures which aim at manipulating a physical-mechanical property will always affect other parameters.
- Most of the required methods for physical fuel characterisation are standardised. Standards are currently under revision. But still there is only little experience with their application in general practice.
- The list of standardised test methods is still incomplete. Further fuel parameters should be introduced to gain information on fuel mechanical behaviour (e.g. particle shape factors).

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# *Thank you for your attention!*

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