Solid biomass fuels - is there a need for emissions profiling?

Greg Forbes, Chris Johnston, Joanna Relf
Background;

- Combustion of solid biomass fuels
- Wood and herbaceous
- Flue gas emission tests
- Principally;
  - NOx gases
  - PM 10
Environment and Renewable Energy Centre, Hillsborough, Northern Ireland
Experimental facilities

120 kW multi-fuel boiler

320 kW woodchip boiler
**Flue-gas analysis equipment**

- Flue-gas sampler with heated (180 ºC) draw line
  (Average flue gas temperature ~180 ºC)
- Gas analyser (Horiba PG 250) with real time data collation
Flue-gas particulates collector

Isokinetic particulates collector (Dekati PM10)

Heat Blanket (180 ºC)

Impactor

Heat controller

Draw line

Impactor suction pump (Zambelli ZB20)
Fuel types tested

- SRC willow (2, 3 & 4 yr old)
- Stem, chip and bale harvested
- Riddled SRC willow (fines removed)
- Short rotation forest Poplar (15 yr old)
- Coniferous log wood (40 yr old) & Brash
- Miscanthus (chop harvested)
- Commercial wood pellets
- Herbaceous matter pellets
Fuel quality standards

- Fuels purchased for use must meet EU standards CEN/TC 335 (G30* & G50*)
- British Standards BS EN ISO 17225-4 (2014)
- Normative properties (compulsory); fuel origin, particle size*, ash and moisture content
- Informative properties (voluntary); bulk density, net energy, Nitrogen and Chlorine content

No fuel emissions information
Examples of differences in particle size distributions (% weight) found in a range of fuels combusted at AFBI Hillsborough.
Woodchip - most common particle distributions
RHI boiler emissions criteria

- Emission limit for boilers up to 300 kW;
  - NOx (maximum) 150 g/GJ
  - PM10 (maximum) 30 g/GJ
    (Boiler test standard EN 3035)

- For boilers over 300 kW standards for tests to meet 30/150 criteria apply;
  - NOx : EN 14792:2005
  - PM10 : EN 13284-1:2009
    (ISO 9096:200310)
NOx gas results

- Large differences found between fuels

- Overall average:

  \[ 142.6 \pm sd 48.2 \text{ g/GJ} \]

  (Based on data from boiler operating at full capacity)

  (average %MC = 14.9 \pm sd 4.4\%)

(g/GJ calculation by AEA methodology)
Particulates (PM10) results

- Large differences found between fuels
- Two wood and Miscanthus fuels averaged 167.4 ± (sd) 73.5 g/GJ
- All fuels ranged 65.4 to 389.8 g/GJ

(g/GJ calculation by AEA methodology)
Emission reduction strategies

- IEA Good Practice Guidelines for Biomass – Bio-energy development
- Recognise potential biomass fuel emissions contributions to;
  - Atmospheric pollution
  - Adverse effects on Human health
- Advise mitigation technologies
Predictive methodology NOx

Linear relationship between fuel N content and NOx emissions (ppm)
Predictive methodology - PM10

- Poplar - 15 yr old short rotation forestry
- Willow - 3 yr old short rotation coppice
- Miscanthus - annual chop harvested (not densified)
## Particle sizes: PM gravimetric (µg)

### Correlations

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<th>12.5 mm</th>
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Summary;

- Solid biomass fuel combustion can contribute to air pollution
- There is no requirement for fuel emissions information
- Could fuel emission profiles aid emission control strategies?
Acknowledgements;

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The Department of Agriculture and Rural Development, Northern Ireland

The Department of the Environment, Northern Ireland

The Agri-Food and Biosciences Institute, Northern Ireland
AFBI- Renewable energy centre equipment

- 120 kW Multi-fuel boiler
- 100 kW Biogas boiler
- 110 kW CHP
- Oil back-up boiler
- Thermal expansion tank
- 9,000L Hot water tank
- 320 kW woodchip boiler