Gasification of low-value feedstock (paper rejects, RDF and MBM) at laboratory (5 kWth) and commercial (80 MWth) scale

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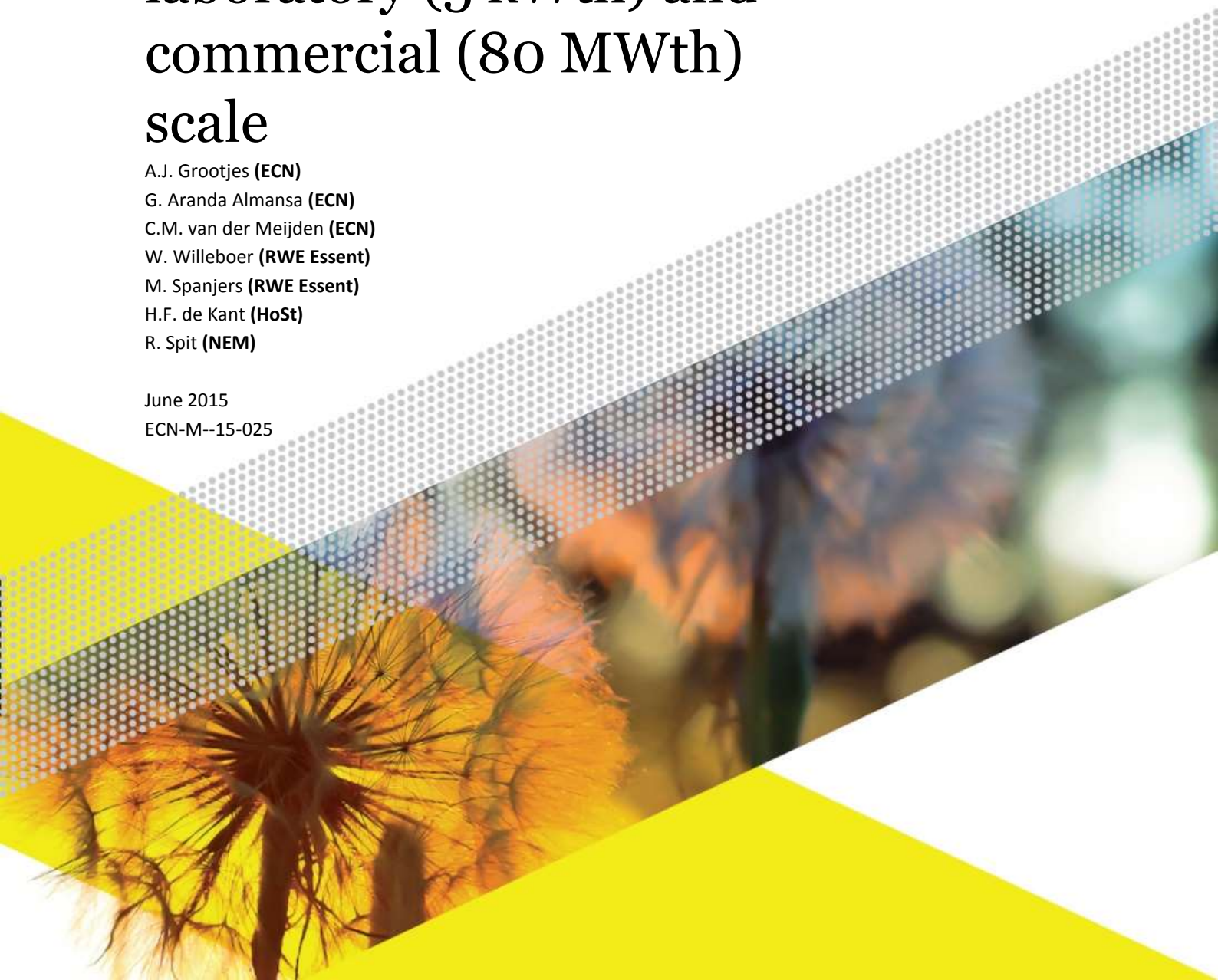

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Background

- Increasing obligations for replacement of fossil fuel consumption in power plants with biomass and waste for reduction of CO_2 emissions.
- Aim: reduction of production cost of renewable electricity → Expected decrease of future governmental subsidies → Need for cheaper (yet troublesome) fuels.
- Main technical challenges: fouling, deposition and corrosion issues.
- Combination of gasification + boiler (indirect co-firing) for conversion of difficult feedstock into heat and/or power (gasification as fuel pre-treatment).
- Adaptation and optimization of the operating conditions of gasifier and boiler for operation with low-value feedstock → Reduction of costs → Market widening.

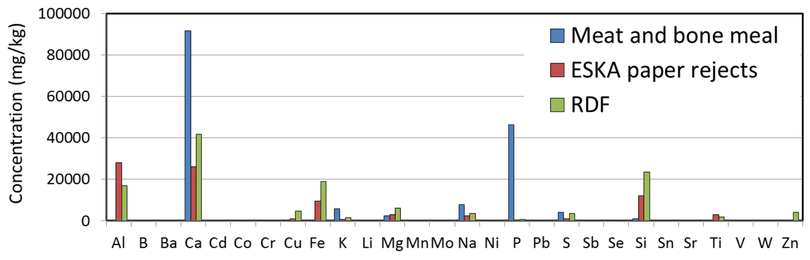
Research objectives

- Gasification of low-value fuels (paper rejects, meat and bone meal, and RDF) at laboratory (5 kW_{th}) and commercial scale (80 MW_{th}).
- Focus on fate and distribution of contaminants and deposition/fouling/ corrosion issues.
- SPA tar analysis, dust measurement, ICP-OES analysis of gas phase, cyclone ash and filter dust, SEM/EDX analysis of deposition probe.

Low-value feedstock tested

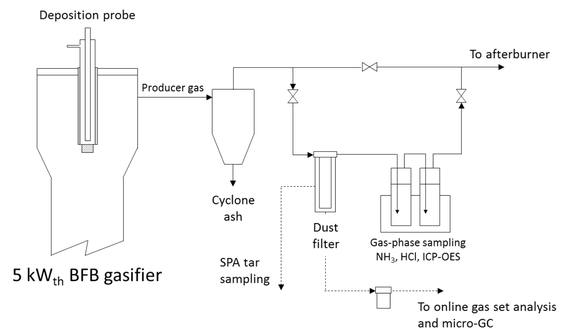
Meat and bone meal (MBM), paper rejects, refuse-derived fuel (RDF).

	Ash 550°C	Volatile matter	HHV	C	H	N	O	S	Cl
	% wt. dry	% wt. dry	MJ/kg, dry	% wt. dry	% wt. dry	% wt. dry	% wt. dry	mg/kg	mg/kg
Meat and bone meal	26	65	18.8	42	6.0	8.6	19.0	3800	5000
ESKA paper rejects	14	75	26.3	57.0	8.1	0.30	23.0	894	18014
RDF	24	67	22.6	49.0	6.7	0.95	23.0	2933	14381

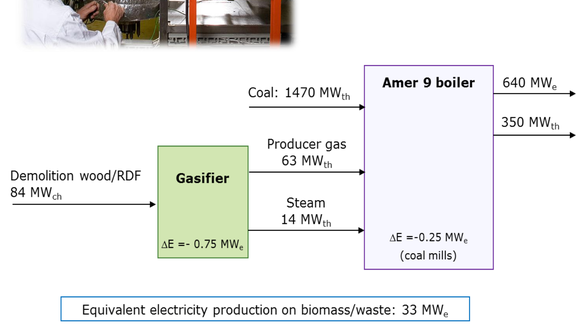


Paper rejects: raw (left), and after 8 mm pelletization (right).

Test facilities



5 kW_{th} BFB gasifier, ECN

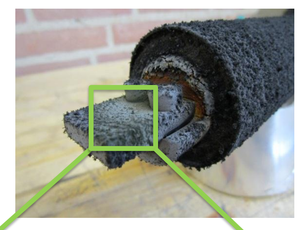


80 MW_{th} CFB gasifier, Amercentrale 9 plant, Geertruidenberg, NL

SEM/EDX analysis of deposits

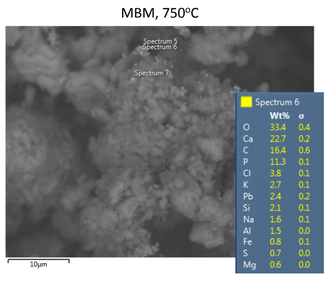
- More dense, partially molten and sintered at 850°C, with higher Cl content. More porous and fluffy at 750°C.
- ⚠ Paper rejects: high content of salts e.g. $CaCl_2$, NaCl, KCl, particularly at higher T. Similar deposits from RDF but with more $PbCl_2$.

Deposition probe, paper rejects, 750°C

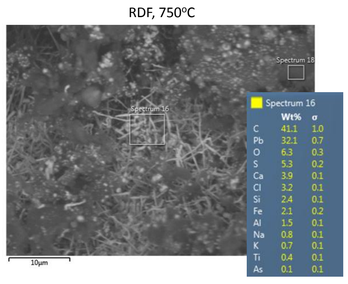


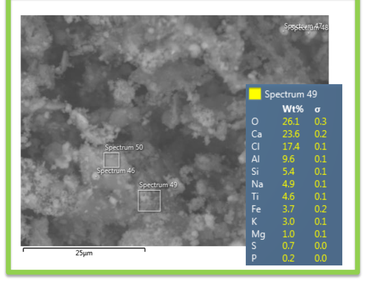
Low-temperature gasification:

MBM, 750°C



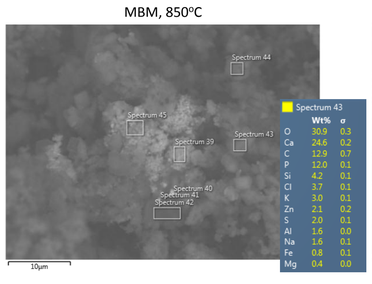
RDF, 750°C



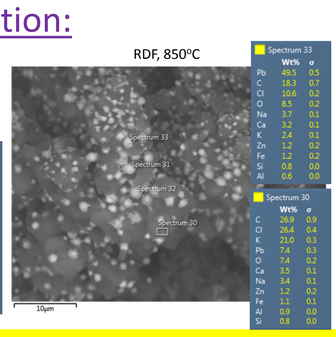


High-temperature gasification:

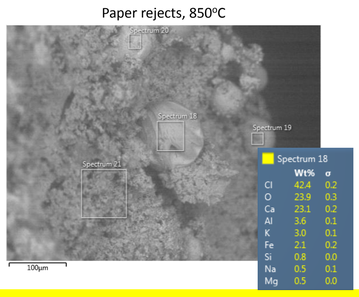
MBM, 850°C



RDF, 850°C



Paper rejects, 850°C



RDF/wood co-gasification at the 80 MW_{th} CFB gasifier in Amer 9 plant

- Preliminary tests with 20% wt. RDF/80% wt. wood at 840°C →fast fouling of the gas cooler by $CaCl_2$ ⚠
- 770-800°C: critical range for the vaporization and condensation of salts.

Wood and RDF supply and consumption

- **January-March 2014: long-duration co-gasification test at ~ 750°C.**
- RDF: 0% → 20% wt. → 40% wt.
- 5685 ton fuel (3717 ton demolition wood + 1968 ton RDF) gasified during 302 hours.
- **Reduced gas cooler fouling observed.**

Conclusions

Decrease in gasification temperature from 850°C to 750°C:

- Trade-off: lower fuel conversion, but different quantitative distribution of Cl in the solid- and gas phase (less release to gas phase and filter dust, higher fraction retained in cyclone ash and bed material).
- SEM/EDX analysis: lower content of Cl (i.e. salts) in deposits → less prone to fouling and corrosion.
- 80 MW_{th} tests: reduced gas cooler fouling (main concern). Operation with up to 40% wt. RDF is possible→ ↑ plant availability.

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