Use what's left? Yes, please! – Evaluation of the Energetic potential of the residuals from Uganda's composting plants

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Background (1)

- 12 composting plants constructed in Uganda within the framework of the UN Clean Development Mechanism (CDM)[1]

- Mixed solid waste ends up in composting plants due to lack of separation at the source

- Rejects dumped into plant's surroundings or landfilled

Background (2)

- Utilisation of refuse-derived fuels (RDF) produced from municipal solid waste in Uganda’s cement industry not yet very well-established[2], coal predominantly used fuel[3]

- Utilisation of RDF can lead to a reduction of fossil CO_2 emissions[4]

- Sieving rejects of CDM composting plants possibly suitable as RDF

Scope

- Evaluate the energetic potential of the residuals of two CDM composting plants

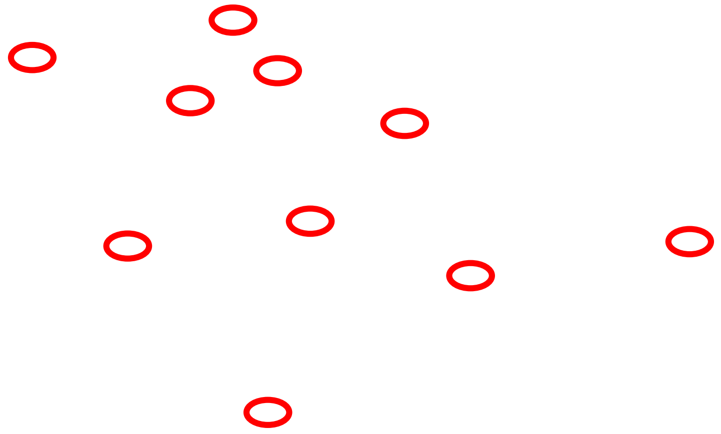
- Provide RDF for Uganda‘s cement industry and reduce fossil CO_2 emissions

- Minimise pollution of plants‘ surroundings

Methods

Sampling – how it was done

2/h



Fractions

- Plastics
  - Kaveera
  - Foils
  - PVC
  - PET
  - Hard plastics
  - Foamed plastics
  - Other plastics
- Textiles
- Hair
- Glass
- Organics
- Metals
- Composites
- Hazardous/Medical
- Liquids
- Rubber
- Paper/Cardboard
- Batteries
- Electronics
- Wood
- Others (incl. Stones)
- Mixed sample for Hg measurements

RDF Fractions

- Plastics
  - Kaveera
  - Foils
  - PVC
  - PET
  - Hard plastics
  - **Foamed plastics**
  - **Other plastics**
- **Textiles**
- **Hair**
- Glass
- Organics
- Metals
- **Composites**
- Hazardous/Medical
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- **Rubber**
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- Others (incl. Stones)
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Sample preparation and analysis

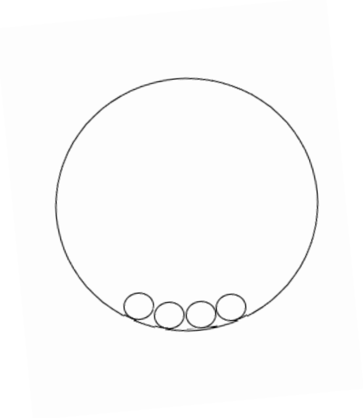
Drying

→

Sorting
FTIR

Preparation

→



Milling <0,5 mm

→

Heavy metals
Heating value
Cl content

Analysis

Analysis

- Heavy metals
  - XRF
  - ICP-OES
  - Hg analyser

- Heating value
  - Calculated based on material composition

$$LHV_w = 22{,}1 * Pa + 28{,}1 * Pl + 24{,}6 * Tx + 12{,}7 * Wd + 6 * Fo + 57{,}4 * Ru + 17{,}2 * Mi$$ [5]

- Chlorine content
  - Calculated via molar masses using PVC share
  - XRF results

Classification

ISO 21640 Solid recovered fuels – Specification and classes[6]

Classification property	Stat. measure	Unit	Classes				
			1	2	3	4	5
Heating value (NCV)	mean	MJ/kg	≥25	≥20	≥15	≥10	≥3
Chlorine (Cl)	mean	wt%	≤0,2	≤0,6	≤1	≤1,5	≤3
Mercury (Hg)	mean	mg/MJ	≤0,02	≤0,03	≤0,05	≤0,1	≤0,15
	80th percentile	mg/MJ	≤0,04	≤0,06	≤0,1	≤0,2	≤0,3

Results and Discussion

Mass share main fractions

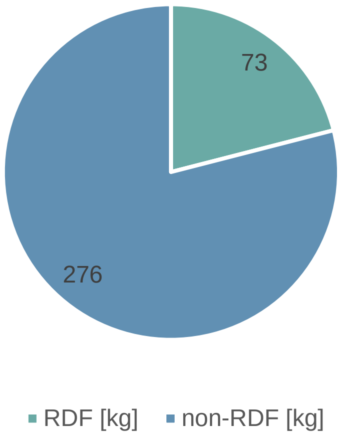
Fractions	Plant 1	Plant 2
Plastics	29%	38%
Textiles	10%	10%
Hair	2%	3%
Glass	1%	2%
Organics	44%	33%
Metals	1%	1%
Composites	0,5%	0,3%
Hazardous/Medical	0,2%	0,1%
Liquid	0,1%	0,05%
Rubber	1%	3%
Paper/Cardboard	0,7%	0,2%
Batteries	0,05%	0,1%
Electronics	0,4%	0,2%
Wood	2%	2%
Others (incl. Stones)	7%	8%

Composition similar in both plants!

Share of potential RDF

21% RDF

Plant 1

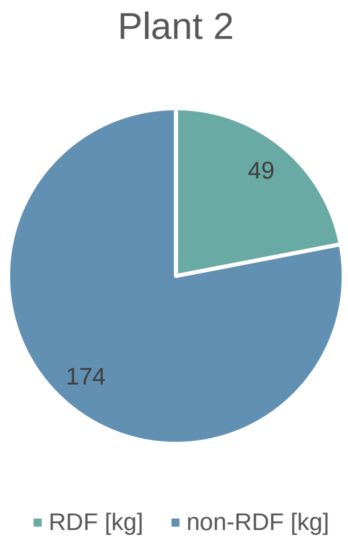


349 kg $m_{total,\ wet}$

Fraction	Plant 1
Kaveera	16%
Foils	5%
PET	0,4%
Bottle caps	0,2%
Hard plastics	2%
Glass	1%
Metals	1%
Paper/Cardboard	0,6%
Foamed plastics	0,3%
Other plastics	5%
Textiles	10%
Hair	2%
Composites	0,5%
Rubber	1%
Wood	2%
Organics	44%
Hazardous/Medical	0,2%
Liquids	0,06%
Batteries	0,04%
Electronics	0,4%
PVC	0,2%
Stones	2%
Others	6%

Share of potential RDF

22% RDF



223 kg $m_{total, wet}$

Fraction	Plant 2
Kaveera	23%
Foils	5%
PET	2%
Bottle caps	0,2%
Hard plastics	2%
Glass	2%
Metals	1%
Paper/Cardboard	0,2%
Foamed plastics	0,2%
Other plastics	4%
Textiles	10%
Hair	3%
Composites	0,3%
Rubber	3%
Wood	2%
Organics	33%
Hazardous/Medical	0,1%
Liquids	0,05%
Batteries	0,1%
Electronics	0,2%
PVC	0,1%
Stones	3%
Others	6%

Mass shares within RDF

Fraction	Plant 1	Plant 2
Textiles	47%	45%
Hair	9%	14%
Composites	2%	1%
Rubber	6%	11%
Wood	9%	8%
Foamed plastics	1%	0,9%
Other plastics	26%	21%

- Within potential RDF, Textiles have highest share, followed by Other plastics and Hair
- Mass shares of both plants similar

Heavy metal content of RDF

	Plant 1 [mg/kg]	Plant 2 [mg/kg]	Limit [mg/kg]
Cr	255,74	172,52	275
Pb	76,74	46,83	220
Co	6,52	4,67	16,5
Sb	14,73	14,60	77
Cd	3,40	1,62	2,53
As	4,35	4,30	22
Ni	71,72	49,91	110
Hg	0,04	0,03	8,25

- Heavy metal results compared to the limits given in the Austrian Directive on Waste Incineration for the utilisation of RDF in the cement production

- Cd levels in Plant 1 above limit, most Cd found in Other plastics and Rubber

Heating value of RDF

	Heating value [MJ/kg]
Plant 1	11
Plant 2	12

- LHV lower than expected
- RDF can probably still be used in secondary firing system, for utilisation in main burner LHV ≥20 MJ/kg necessary[7]

Chlorine content

	$m_{RDF\ dry,\ excl.\ Organics}$ [kg]	m_{Cl} [kg]	Cl content (whole sample)	Cl content (RDF)
Plant 1	35,66	0,323	2%	0,5%
Plant 2	34,92	1,548	3%	1,1%

- Highest Cl levels found in Other plastics due to PVC, should be removed before utilisation
- Cl content should be below 1%

Classification

Classification property	Stat. measure	Unit	Classes				
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RDF Plant 1: NCV4, Cl2, Hg1

RDF Plant 2: NCV4, Cl4, Hg1

Conclusion and Outlook

Conclusion

- 21% of the sieving residuals of Plant 1 and 22% of Plant 2 theoretically suitable as RDF
- Potential RDF might be used in secondary firing system after Cd and Cl levels are lowered
- Utilisation of RDF can help reduce pollution in surrounding environments
- Substituting coal with RDF reduces fossil CO_2 emissions of Uganda's cement industry

Outlook

- Samples from second sampling campaign during dry season currently under investigation

- Minor differences between samples in terms of composition

- Fossil and biogenic CO_2 emissions will be determined using TU Wien developed adapted balance method

Sources

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Thank You!

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