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Highly Refined Bio Energy Products through Gasification

Utilization of by-products formed in biogasification

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HighBio project seminar
18.5.2010

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Figure 1. Bioash from biogasification.

Figure 2. Pre-treated bioash.

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Introduction

- Physical and chemical properties and leaching properties have to be known
- Neutralizing and reactivity values are important quantities in order to assess the potential use of ash as soil conditioning agent and as a forest fertilizer
- Determination of leaching properties has an important role for environment pollution
- For example particle size determination is important evaluating potential utilization applications
- Before analysis samples were dried, crushed and sieved under 0,150 mm

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Table 1. Physical and chemical properties of ashes

Parameter	According to standard	Ash from gasification	Ash from burning
Electrical conductivity		0.84 mS/cm	3.6 mS/cm
pH		9.6	10.5
Dry matter content	SFS-EN 12880	19.8 %	42.4%
Loss on ignition	SFS-EN 12879	94.1 %	80.7 %
DOC	SFS-EN 1484	649 mg/l	570 mg/l
TC		89.4 %	72.3 %
Neutralizing value	SFS-EN 12945	3.8 % (Ca)	7.9 % (Ca)
Reactivity value	SFS-EN 13971	1.6 % (Ca)	6.6 % (Ca)

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Buffer capacity

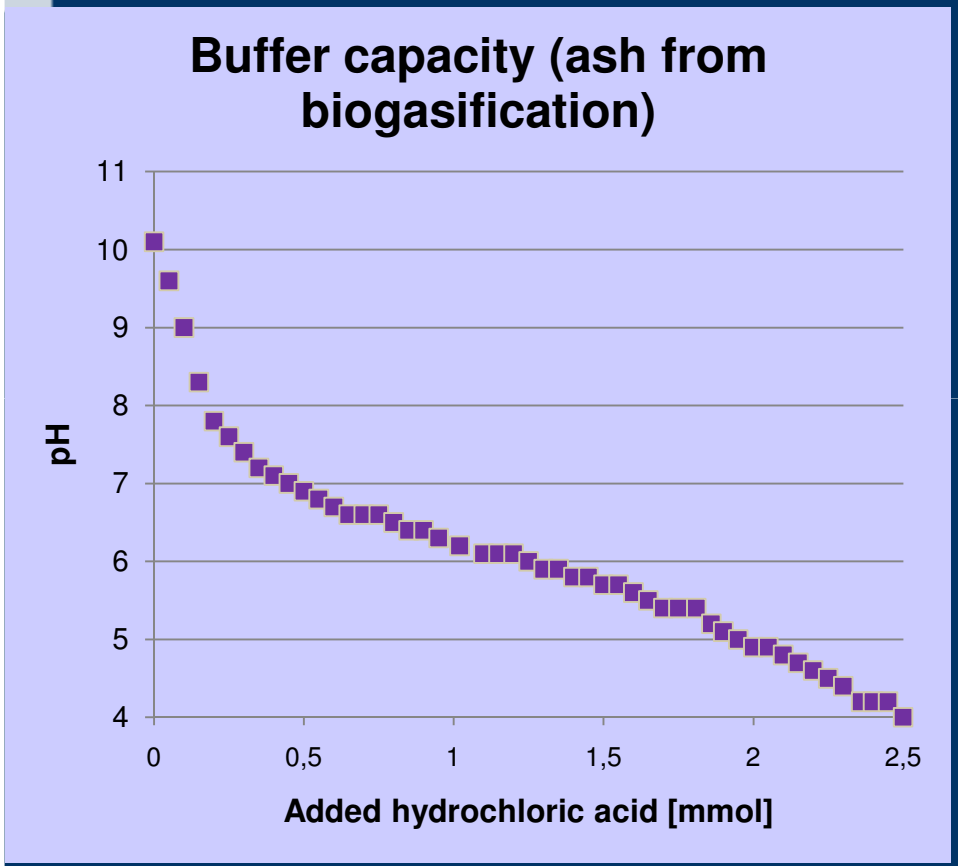

Figure 3. Buffer capacity graph (ash from gasification), pH as a function of added HCl [mmol].

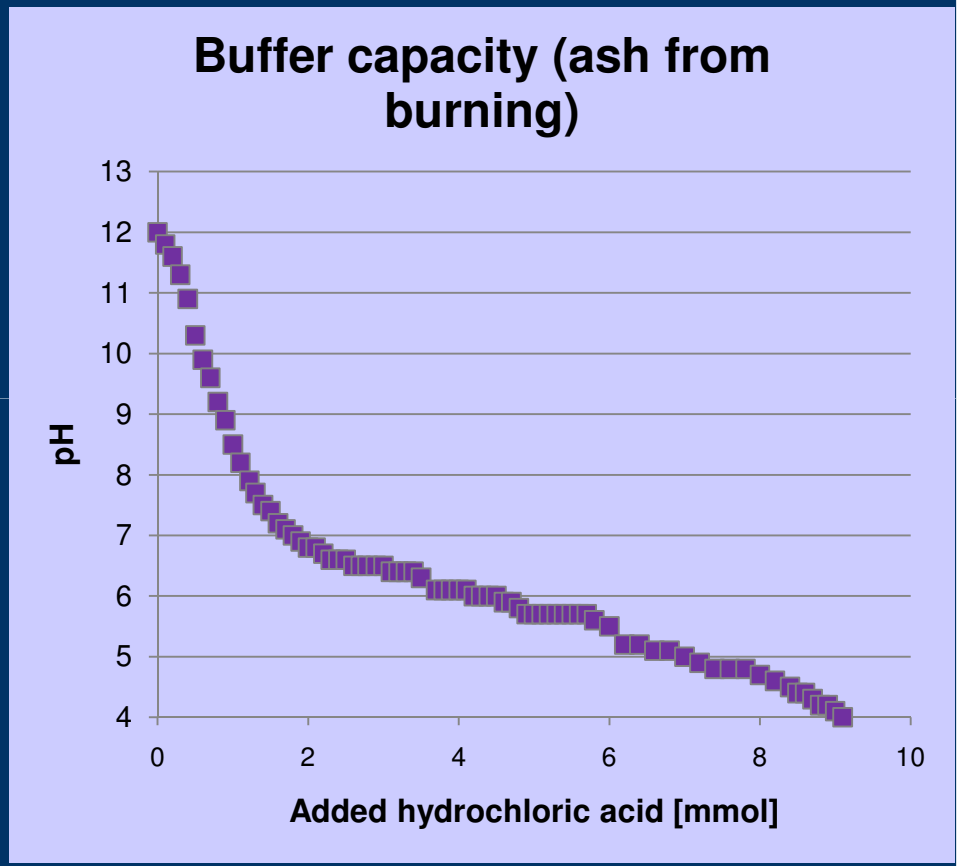

Figure 4. Buffer capacity graph (ash from burning), pH as a function of added HCl [mmol].

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Particle size measurement

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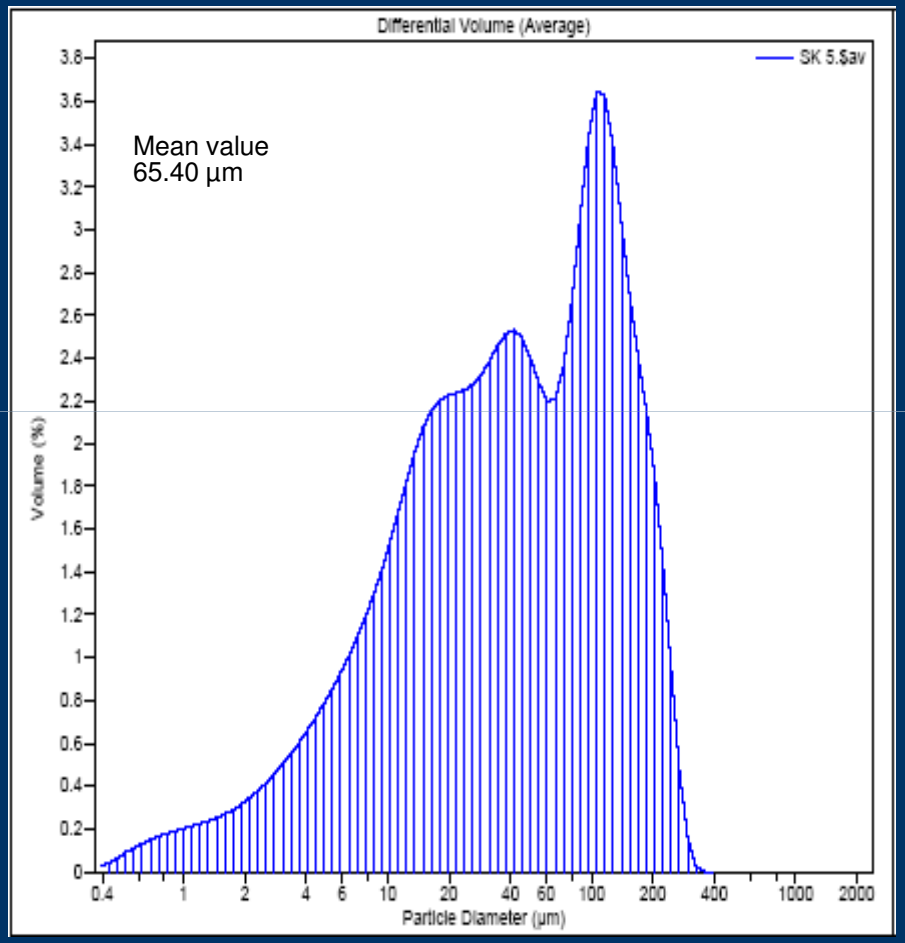

Figure 5. Particle size distrubution of ash from biogasification process.

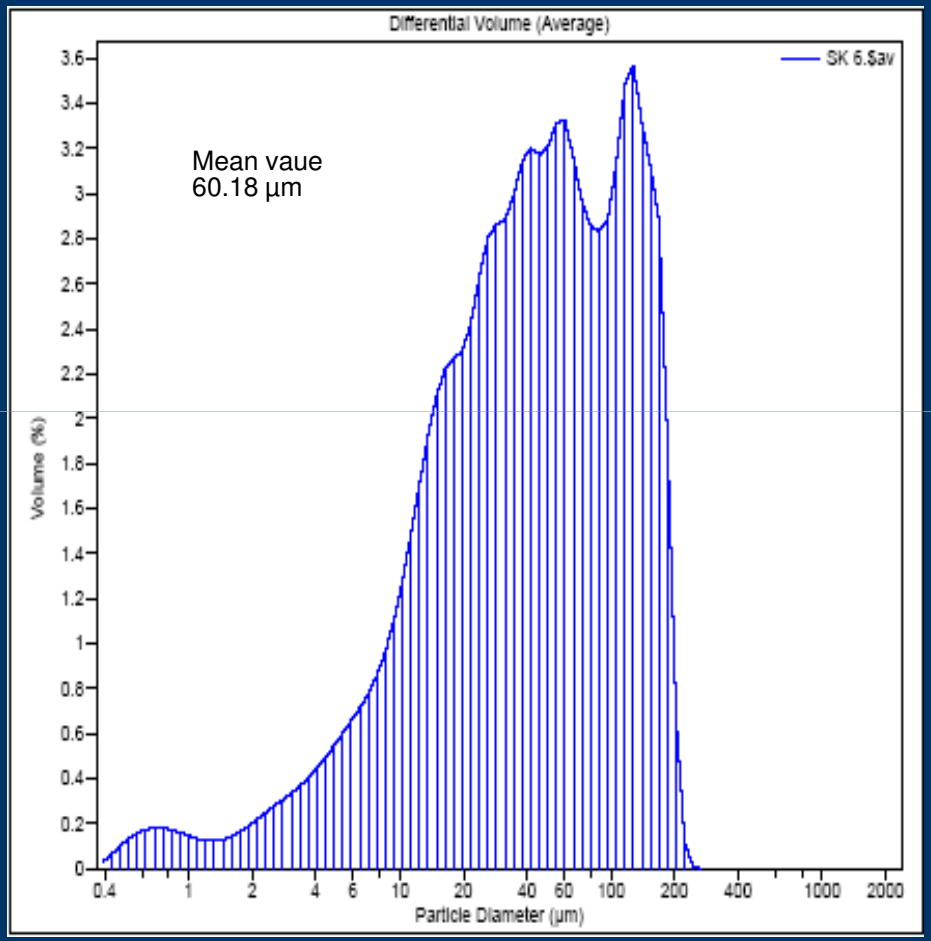

Figure 6. Particle size distrubution of ash from burning process.

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Table 2. Finnish limit values for total heavy metal concentrations.

Element	Limit value [mg kg^{-1}]	Limit value (forest fertilizer) [mg kg^{-1}]	Ash from gasification [mg kg^{-1}]	Ash from burning [mg kg^{-1}]
Cd	1.5	17.5	< 0.3	1.6
Cu	600	700	15	21
Pb	100	150	< 3	10
Cr	300	300	7	9
Zn	1500	4500	85	130
As	25	30	< 3	< 3
Ni	100	150	3	10

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Table 3. Nutrient determination.

Macro-nutrient	Ash from gasification [g kg^{-1}]	Ash from burning [g kg^{-1}]
P	0.34	0.38
Ca	8.4	37.3
K	3.2	10.2
Mg	1.6	5.9

Determination of nutrients is carried out according to the procedure of MTT Agrifood Research Finland

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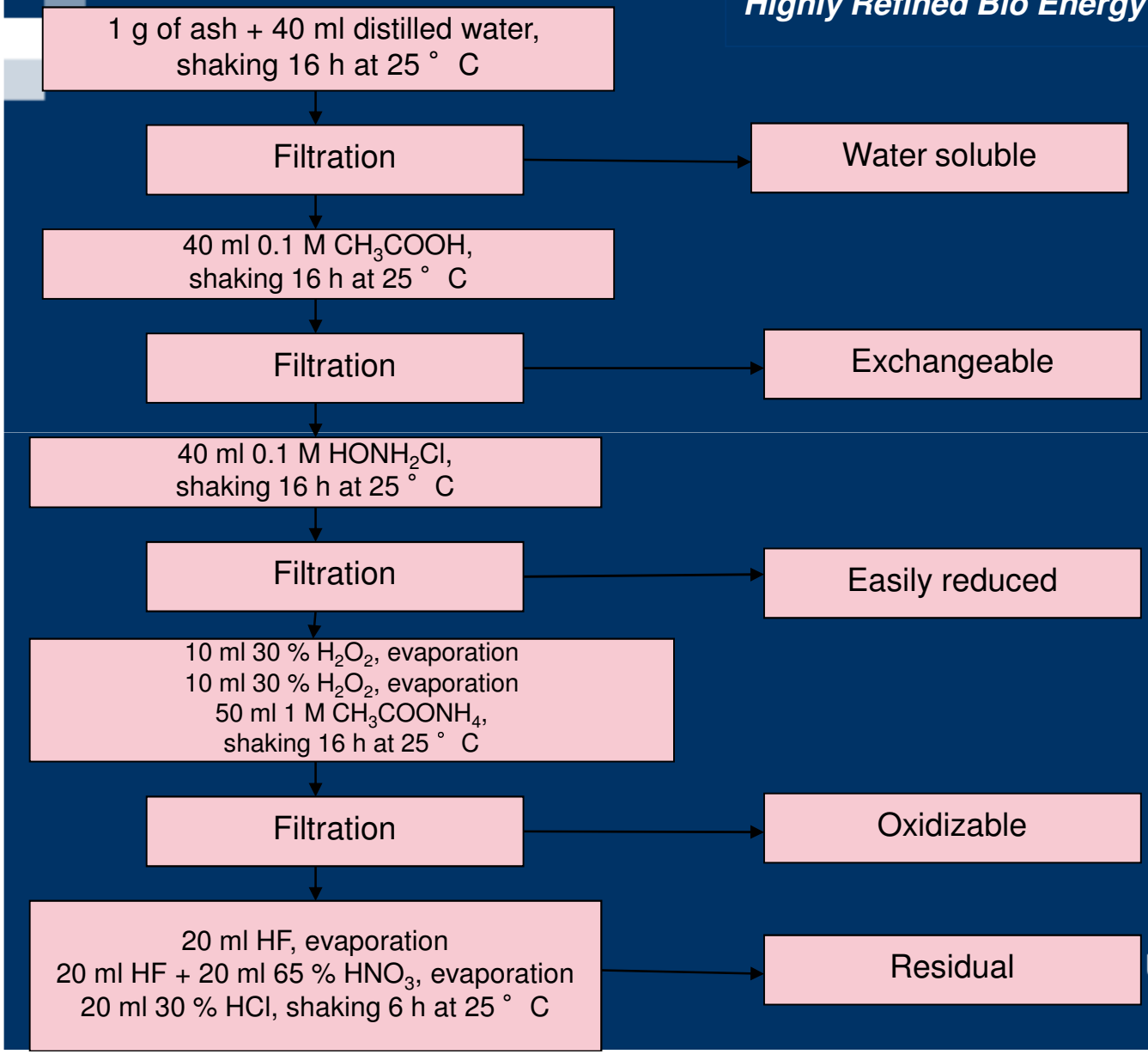

Figure 7. A five-stage sequential leaching procedure.

Table 4. Sequential leaching results, ash from burning process.

Metal	Stage I	Stage II	Stage III	Stage IV	Stage V	Total
Cd	< 0.08	0.71	0.73	0.15	< 0.2	< 1.87
Cu	< 0.4	< 0.4	< 0.4	3.9	19.0	< 24.1
Pb	< 0.6	< 0.6	2.2	5.3	2.9	< 11.6
Cr	< 0.4	< 0.4	< 0.4	1.7	8.7	< 11.6
Zn	0.4	35.5	68.5	11.5	11.2	127.1
As	< 0.6	< 0.6	< 0.6	< 0.75	< 1.5	< 3.8
Ni	< 0.4	0.60	1.1	1.4	6.0	< 9.5

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Table 5. Sequential leaching results, ash from gasification process.

Metal	Stage I	Stage II	Stage III	Stage IV	Stage V	Total
Cd	< 0.08	< 0.08	< 0.08	< 0.1	< 0.2	< 0.54
Cu	< 0.4	< 0.4	< 0.4	2.7	14.0	< 17.9
Pb	< 0.6	< 0.6	< 0.6	< 0.75	< 1.5	< 4.05
Cr	< 0.4	< 0.4	< 0.4	0.97	7.0	< 9.17
Zn	< 0.4	31.6	9.9	21.6	23.0	< 86.5
As	< 0.6	< 0.6	< 0.6	< 0.75	< 1.5	< 4.05
Ni	< 0.2	< 0.2	0.40	0.55	2.89	< 4.24

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Conclusions

- Physical and chemical properties of ashes from burning and gasification processes vary
- Ash from gasification process includes more carbon
- Particle size distribution is quite same
- Ash from burning includes more nutrients and heavy metals than ash from gasification

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Removal of odorous and organic compounds from wastewater by bioash and activated carbon

- Unpleasant odours typical problems in many wastewaters
- Various physical, chemical and biological treatment processes available
- Activated carbon
- Why not bioash?

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Adsorbents

- Commercial activated carbon
- Bioash from biogasification

Pre-treatment of adsorbents

- Washing with distilled water
- Drying at 105 ° C
- Sieving (particle size < 150 µm)

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Characterization of adsorbents

- Specific surface area (BET)
- Untreated (u) and pre-treated (p) samples

Table 6. Specific surface area of adsorbents.

Sample	BET [m^2 g^{-1}]
U bioash	70
P bioash	100
U activated carbon	920
P activated carbon	930

Figure 8. Micromeritics ASAP 2020 device for the specific surface area measurements.

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Adsorption experiments

- Adsorbent loads from 5 to 20 g L^{-1}
- Wastewater load 500 mL
- Reaction time 2 hours at room temperature
- Water samples were taken periodically during the reaction

Figure 9. Set-up for the adsorption experiments.

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Analyzing of the water samples

- Odour change
  - Determined by a sensory method
  - Scale from 5 (initial odour) to 1 (odourless sample)
- pH
- DOC (Dissolved Organic Carbon)
  - From filtrated samples

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Results, odour removal

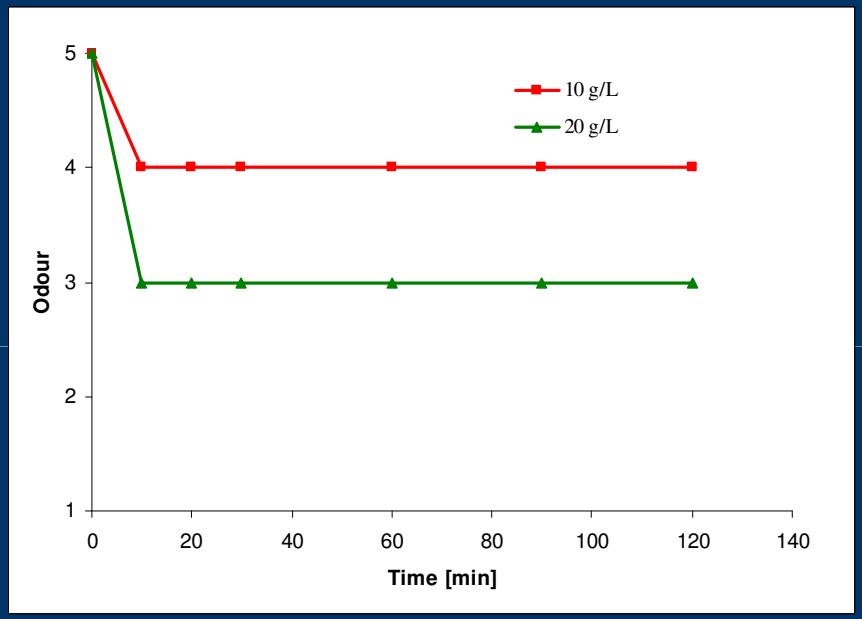

Figure 10. Odour levels of food industry ww as a function of time with different bioash concentrations: 10 to 20 g L^{-1}

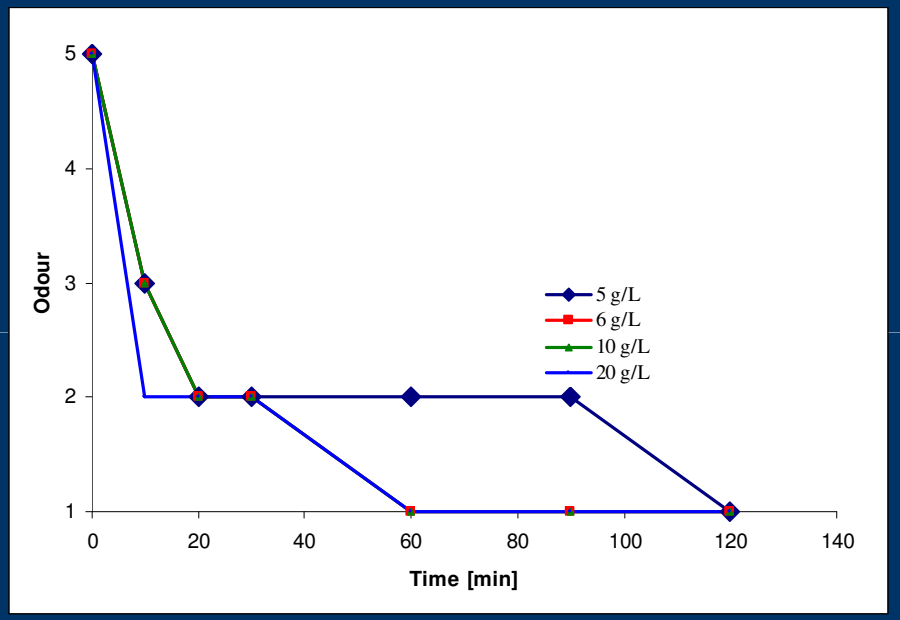

Figure 11. Odour levels of food industry ww as a function of time with different activated carbon concentrations: 5 to 20 g L^{-1}

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Results, removal of organic compounds

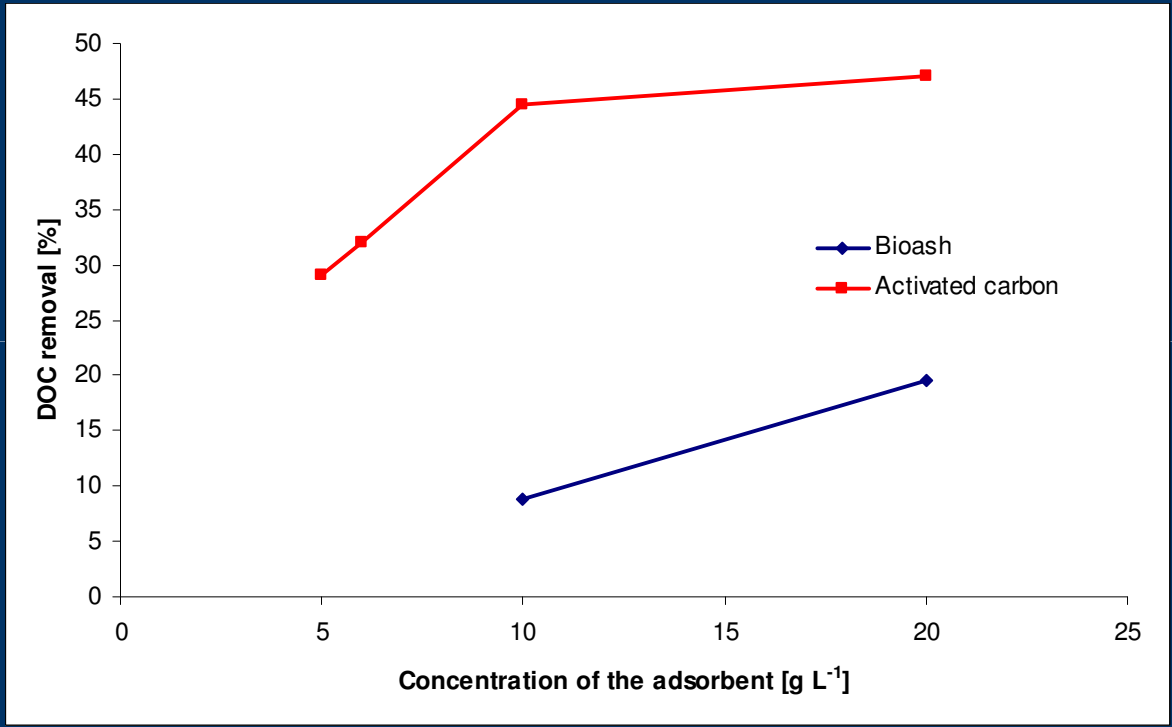

Figure 12. DOC removal as a function of adsorbent concentration. Reaction time two hours.

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Conclusions

- The efficiency of odour removal increased with increasing adsorbent concentration

- Bioash
  - Adsorbent loads 10 to 20 g L^{-1}
    - odour removed only slightly (5 to 3)
- Activated carbon
  - Adsorbent loads 5 to 20 g L^{-1}
    - Ww was odourless after 2 hours experiments

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Further studies

- Bigger loads of bioash
- Different pre-treatment
  - Larger specific surface area?

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Thank you for your attention!

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