Activated carbon by co-pyrolysis and steam activation from particle board and melamine formaldehyde resin:

techno-economic evaluation

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Promoters

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dr. Sonja Schreurs
1. Introduction: Activated Carbon
2. Objective
3. Cost-benefit analysis
   - Methodology
   - Process design
   - Results
4. Conclusion
Activated carbons → large number of applications
- water treatment
- chemical and pharmaceutical processing
- air and gas purification
- ...

Average growth 5.2%/year
1.2 Mt/Year by 2012
Specialty AC 3,3 – 6,0 kEUR/t (2008)
Activated carbons $\rightarrow$ Normal low N ($\sim$0.5%) $\rightarrow$ N **key parameter** for adsorbents, catalytical activity and catalyst supports

Introduction

N introduction → treatment with N-reagents
→ Raw material

Waste processing company
In situ nitrogen incorporation
Gate fee

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N: 5.9 wt%
N: 54.1 wt%

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Investigation of the **feasibility** for the production of nitrogenised **activated carbon** from **PB and MF waste streams**.

→ in function of processing rate and mixing ratio
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Cost-benefit analysis: methodology

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Cost-benefit analysis: Results

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<td>(5/0)</td>
<td>(4/1)</td>
<td>(3/2)</td>
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**AC Yield (wt%)**
- PB – MF (5/0): 22
- PB – MF (4/1): 21
- PB – MF (3/2): 19
- PB – MF (2/3): 15
- PB – MF (1/4): 11

**Ultimate analysis (%) (dry and ash free)**

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<tr>
<td></td>
<td>91 ± 1</td>
<td>2.24 ± 0.04</td>
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<td>85 ± 4</td>
<td>4.3 ± 0.2</td>
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<td>86 ± 2</td>
<td>7.35 ± 0.07</td>
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<td>83 ± 2</td>
<td>9.6 ± 0.3</td>
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<td>83.4 ± 0.7</td>
<td>14 ± 1</td>
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**AC from PB → N: 1.5 – 2 wt% → 2.0 kEUR/t** (Girods et al. 2009)

**We expect → 2.0 kEUR/t – 2.5 kEUR/t**
Cost-benefit analysis: Results

NPV (MEUR)

Ratio PB - MF (5/0)
Ratio PB - MF (4/1)
Ratio PB - MF (3/2)
Ratio PB - MF (2/3)
Ratio PB - MF (1/4)

Minimal selling price (NPV > 0)

1,6 kEUR/t  1,8 kEUR/t  2,0 kEUR/t  2,6 kEUR/t  3,9 kEUR/t
Are the obtained results valid?

→ only in case of **100% certainty** of the base variables

→ some variables are uncertain by definition, others might change the NPV strongly if its value changes slightly

→ Monte Carlo sensitivity simulation
Cost-benefit analysis: Results

Monte Carlo simulation

→ Total Capital Investment; Electricity Cost; Water Cost; Delivered feed cost; Discount rate; Liquid nitrogen cost; Char output; AC output; Staff cost / shift;

Annual working hours facility

→ Triangulair distribution

→ Calculation of numerous NPVs (10 000 runs)
Cost-benefit analysis: Results

NPV (MEUR)

Price of active carbon (kEUR/ton; feed 1 ton/h)

Minimal selling price (min 95% chance on NPV > 0)

2.0 kEUR/t

2.2 kEUR/t

2.5 kEUR/t

3.1 kEUR/t

4.5 kEUR/t

PB - MF (5/0)

PB - MF (4/1)

PB - MF (3/2)

PB - MF (2/3)

PB - MF (1/4)
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Really encouraging results are obtained for a profitable production of nitrogenised AC!

Even as the current assumptions start from a rather pessimistic scenario

- In situ incorporation of N
- Ability to reuse 2 waste streams
- The feasibility depends largely on the
  - AC yield
  - the product quality

Future research
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