Environmental impacts of poultry litter gasification for power generation

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Overview

- Context
- Approach
- Results
- Conclusions
The poultry sector is growing globally

A large quantity of litter is generated

Litter traditionally used as a fertiliser

Energy recovery through combustion, pyrolysis & gasification

Gasification offers some advantages
Goal and scope

➢ To assess environmental impacts of electricity production in IGCC using poultry litter

➢ Unit of analysis (functional unit):
  ➢ generation of 1 kWh of electricity
Poultry litter collection

Storage

Gasification plant operation

Syngas cleaning

Gas turbine operation

Electricity (to national grid)

Plant components

Energy & other inputs

Ash to be used as a fertiliser

Waste for disposal

Recovered heat

Electricity for parasitic use
Data and assumptions

- IGCC Plant size: 250 kW
- Efficiency: 43% (gross) & 36% (net)
- Gasification modelling via ASPEN
- N₂O emissions during storage
- Credits for ash as a fertiliser
- Background LCA data: Ecoinvent
- LCA modelling: Gabi software

### Key characteristics of poultry litter*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>25</td>
</tr>
<tr>
<td>LHV (MJ/kg dry basis)</td>
<td>9.7</td>
</tr>
<tr>
<td>Ash (% dry basis)</td>
<td>21.6</td>
</tr>
<tr>
<td>C (% dry basis)</td>
<td>37.5</td>
</tr>
<tr>
<td>O (% dry basis)</td>
<td>30.6</td>
</tr>
<tr>
<td>H (% dry basis)</td>
<td>5.1</td>
</tr>
<tr>
<td>N (% dry basis)</td>
<td>3.7</td>
</tr>
<tr>
<td>P₂O₅ (% dry basis)</td>
<td>4.3</td>
</tr>
<tr>
<td>K₂O (% dry basis)</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Comparison with fossil fuel alternatives

Carbon footprint (g CO2 eq./kWh):
- Poultry litter gasification: 42
- Natural gas: 470
- Coal: 977
- Oil: 1170

PED x 0.01 (MJ/kWh):
- Poultry litter gasification: 870
- Natural gas: 1080
- Coal: 1550
- Oil: 1550
Sensitivity analysis

- **Carbon footprint (g CO2 eq./kWh)**
  - Base case: 42
  - 2-week storage: 30
  - 6-week storage: 54
  - Ash landfilling: 62
  - Economic allocation: 50

- **PED x 0.01 (MJ/kWh)**
  - Base case: 14
  - 2-week storage: 14
  - 6-week storage: 14
  - Ash landfilling: 50
  - Economic allocation: 44

Legend:
- **Base case**
- **2-week storage**
- **6-week storage**
- **Ash landfilling**
- **Economic allocation**
Challenges

- Biomass gasification is still at demonstration stage
- Fouling due to tar formation
- Risk of agglomeration and sintering due to higher P & K content in poultry litter
- IGCC has 35% higher capital costs compared to conventional power plants
- Health & safety risks
Conclusions

- Energy recovery from poultry litter via gasification is an environmentally viable option.
- It has 10-30 times lower carbon footprint and 60-110 times lower primary energy demand.
- Reducing storage time of litter would reduce impacts further.
- Successful application will depend on reduction in installation costs.
Acknowledgements

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