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Integrating batch pyrolysis and fractional condensation (2D MFR) to get high-value products from biomass

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Integrating Batch Pyrolysis and Fractional Condensation (2D MFR) to get High-value Products from Biomass

Mohammad Hossain, Chiara Barbiero, Ian Scott, Franco Berruti, Cedric Briens
High-Value Products from Biomass

Solvent extraction:
- Expensive
- Time consuming
- Not environmental friendly

Traditional pyrolysis is much cheaper, easier and safer

**but:**
- Complex liquid mixtures
- Thermally unstable products → distillation is difficult
Objectives

Develop a better process combining:

• Batch pyrolysis
• Fractional condensation

• Apply the technology to:
  • Tobacco leaves
  • Tomato plant waste
  • Spent coffee grounds
  • Lignin
Experimental Setup

Mechanically Fluidized Reactor (MFR):
- Mechanically stirred bed of char particles → can process particles that regular fluidization cannot
- No fluidization gas → easier condensation

Hot condenser for valuable products
Concept

![Graph showing the concept with hot bath condenser temperature (°C) on the y-axis and reactor temperature (°C) on the x-axis. The graph contains a shaded area indicating the temperature range.](image)
Nicotine from Tobacco Leaf

- 260-275 °C
- 245-275 °C
- 230-275 °C (2D-MFR)
- 210-275 °C
- 180-275 °C
- 25-275 °C

% average nicotine concentration vs % cumulative nicotine recovery

1D-MFR
Pesticides from Tobacco leaf and Tomato plant waste

Colorado potato beetle (CPB)

Assay: % of beetles killed by bio-oil
Pesticides from Tobacco leaf and Tomato plant waste

![Bar chart showing % mortality for tobacco and tomato plant waste at different reactor temperatures.](chart.png)
# Pesticides from Tobacco leaf and Tomato plant waste

<table>
<thead>
<tr>
<th>Reactor temperature cuts (°C)</th>
<th>LC$_{50}$ (mg/g)</th>
<th>Tobacco</th>
<th>Tomato</th>
</tr>
</thead>
<tbody>
<tr>
<td>300-350</td>
<td>2.1</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>350-400</td>
<td>2.5</td>
<td>2.8</td>
<td></td>
</tr>
</tbody>
</table>

LC$_{50}$: concentration of bio-oil for 50% mortality
Anti-oxidants from Tobacco leaf, Tomato plant waste & spent Coffee grounds

Gallic acid is a strong anti-oxidant used as standard
Anti-oxidants from Tomato plant waste

Reactor temperature: 400-565 °C
Conclusions: Biorefinery applications