Technological and economical feasibility of a 40,000 t/y tyre pyrolysis plant: results of a H2020 SME Phase 1 study

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ETRA conference, 18th March 2016

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Waste Tyre Pyrolysis

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1. Requirements for a commercial process
2. Composite Recycling Ltd’s process
3. Technical assessment
4. Market analysis
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This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No. 672558.
Requirements for a commercial process
Requirements for a commercial process

Scale

Scale Scale Scale Scale
Requirements for a commercial process

Scale – Amount of tyres

Economies of scale and sales of: P-oil, rCB & steel
Requirements for a commercial process

Economic tyre recycling process

1. Scale of plant (40,000 - 100,000t/y)

2. Whole tyres – no shredding, no granulating

3. Continuous

4. Simple (low tech, low pressure, existing technology)

5. Accessible markets for all products
Composite Recycling Ltd’s process
Composite Recycling Ltd’s process

Reactor

- Pyrolysis vapours
- Carbon black
- Steel
- molten zinc
- leg A
- leg B
- Direct heat transfer – tyres are insulators
Composite Recycling Ltd’s process

Whole process
Technical Assessment
Technical assessment

Concept layout of a 40,000 t/y plant

20m long, 2m wide

P-oil storage

rCB storage
Technical assessment

Scrap tyre feeding system
Technical assessment

Pyrolysis chamber – hot dip galvanizing

MOC = 316 SS
Technical assessment

Carbon black recovery
Technical assessment

Carbon black recovery

Analysis: rCB is free of rubber
Technical assessment

Steel removal – hot dip galvanizing

Steel is galvanized
Technical assessment

Safety - Hot dip galvanizing

Industrial thermoprocessing equipment - Part 1: Common safety requirements for industrial thermoprocessing equipment
Technical assessment

Pyrolysis oil - conventional

Analysis of pyrolysis liquid obtained from whole tyre pyrolysis with molten zinc as the heat transfer media using comprehensive gas chromatography mass spectrometry

Philipp Rathsack, Frank Riedewald, Maria Sousa-Gallagher

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+ Institute of Analytical Chemistry, TU Bergakademie Freiberg, Leipziger Str., 09596 Freiberg, Germany
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© Process and Chemical Engineering, School of Engineering, University College Cork, Ireland
Market analysis
## Market analysis

### Market value of products – P-oil, rCB, steel

<table>
<thead>
<tr>
<th>Product</th>
<th>Market price</th>
<th>Market</th>
<th>Competitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tipping fee</td>
<td>€97/t</td>
<td>-</td>
<td>Not given</td>
</tr>
<tr>
<td>P-oil</td>
<td>€218/t</td>
<td>Heavy fuel oil</td>
<td>€400-600/t</td>
</tr>
<tr>
<td>rCB</td>
<td>€30/t</td>
<td>Coal</td>
<td>€75-600/t</td>
</tr>
<tr>
<td>Steel</td>
<td>€80/t</td>
<td>Recycled</td>
<td>€75-200/t</td>
</tr>
</tbody>
</table>

Valid: December 2015
Financial Assessment
Financial assessment

40,000 t/year or 4m tyres/year

- **Gate Fees**
  - €97/t
  - €3,880,000

- **Oil (50%)**
  - €218/t
  - €4,360,000

- **Carbon Black (30%)**
  - €30/t
  - €360,000

- **Steel (10%)**
  - €80/t
  - €320,000

- **Gas (10%)**
  - Self-sustaining
## Financial assessment

### General assumptions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Assumption</th>
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</thead>
<tbody>
<tr>
<td>Location</td>
<td>Europe</td>
</tr>
<tr>
<td>Currency</td>
<td>Euro</td>
</tr>
<tr>
<td>Operating time</td>
<td>7,500/h, 85% uptime</td>
</tr>
<tr>
<td>Loan period</td>
<td>10 years</td>
</tr>
<tr>
<td>Interest rate</td>
<td>6%</td>
</tr>
<tr>
<td>Inflation</td>
<td>3%</td>
</tr>
<tr>
<td>Plant life</td>
<td>20 years</td>
</tr>
<tr>
<td>Discount rate</td>
<td>10%</td>
</tr>
<tr>
<td>Government support</td>
<td>None (financial)</td>
</tr>
<tr>
<td>Shifts</td>
<td>5</td>
</tr>
<tr>
<td>Personnel</td>
<td>33</td>
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</tbody>
</table>
# Financial assessment

## Financials 40,000t/y plant; amounts in thousands

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td></td>
<td>9,830</td>
<td>10,125</td>
<td>10,429</td>
<td>12,090</td>
<td>12,452</td>
<td>12,826</td>
</tr>
<tr>
<td>Expenditures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>28,377</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital payments</td>
<td>-3,856</td>
<td>-3,856</td>
<td>-3,856</td>
<td>-3,856</td>
<td>-3,856</td>
<td>-3,856</td>
<td>-3,856</td>
</tr>
<tr>
<td>Operating cost</td>
<td>-1,029</td>
<td>-1,060</td>
<td>-1,092</td>
<td>-1,266</td>
<td>-1,304</td>
<td>-1,343</td>
<td>-1,343</td>
</tr>
<tr>
<td>Overall expenditures</td>
<td>-3,856</td>
<td>-8,416</td>
<td>-8,553</td>
<td>-8,694</td>
<td>-9,464</td>
<td>-9,633</td>
<td>-6,821</td>
</tr>
<tr>
<td>Profit</td>
<td>-3,856</td>
<td>1,414</td>
<td>1,572</td>
<td>1,735</td>
<td>2,625</td>
<td>2,820</td>
<td>6,005</td>
</tr>
<tr>
<td>Discounted Cash Flow</td>
<td>-3,856</td>
<td>1,414</td>
<td>1,572</td>
<td>1,735</td>
<td>2,625</td>
<td>2,820</td>
<td>5,404</td>
</tr>
<tr>
<td>Cumulative Cash Flow</td>
<td>-3,856</td>
<td>-2,442</td>
<td>-870</td>
<td>865</td>
<td>11,288</td>
<td>14,107</td>
<td>19,511</td>
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</table>

### Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRR (10 years)</td>
<td>20%</td>
</tr>
<tr>
<td>NPV (10 years)</td>
<td>€2.1m</td>
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<tr>
<td>Payback period</td>
<td>2.5 years</td>
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</tbody>
</table>

40,000t/y minimum throughput of an economic plant.
Financial assessment

Financials 40,000t/y plant – effect of shredding

<table>
<thead>
<tr>
<th>Measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRR (10 years)</td>
<td>20%</td>
</tr>
</tbody>
</table>

Shredding €25/t

<table>
<thead>
<tr>
<th>Measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRR (10 years)</td>
<td>Negative</td>
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</tbody>
</table>
## Market analysis

### Future profitability

<table>
<thead>
<tr>
<th>Product</th>
<th>Price (today)</th>
<th>Price (future)</th>
<th>Reason</th>
<th>IRR (Sensitivity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-oil</td>
<td>€218/t</td>
<td>€400/t</td>
<td>Oil price increase</td>
<td>100%</td>
</tr>
<tr>
<td>rCB</td>
<td>€30/t</td>
<td>€100/t</td>
<td>rCB upgrade</td>
<td>40%</td>
</tr>
</tbody>
</table>

\[ \text{€400} = \sim$80/\text{bbl} \text{ in 2020} \]
Summary

Use proven, existing technologies

IRR over 20%
Composite Recycling Ltd

The next steps

1. Investment, H2020 Phase 2
2. Demonstration plant
References