W2Plastics: The mixed plastics waste recycling technology

Resources & Recycling group
- W2Plastics principles
- W2Plastics production video
- W2Plastics products tests
- W2Plastics business cases
Background

Current recycling methods

- **Sources of polyolefins**
  - Gray bags (incinerated)
  - Separately collected (recycled)

- **Sorting methods for polyolefins**
  - NIR (Near Infrared)
    - Needs large pieces (e.g. bottles)
    - 95-97% product quality
    - Low recovery (60%)
  - Ordinary sink-float
    - Density separation (flake)
    - Expensive
    - Complex process
    - Limited separation flexibility
Particle is at equilibrium if it has the same weight as the volume of replaced ferrofluid.
W2Plastics principles

Equilibrium height above magnet for various plastics

Particle floats in a liquid if it has the same weight as the volume of replaced liquid
W2Plastics principles

Magnetic liquid is attracted both by the earth and by magnets: variable weight!
W2Plastics principles

- Magfluids have no densities limits
- Magfluids have different densities at different positions: multiple products
- Magfluids for plastics separation can be used as ordinary water
Industrial MDS
Industrial MDS
W2Plastics products tests
W2Plastics products tests

Density distribution of Romanian households waste

![Graph showing density distribution of Romanian households waste]

- HDPE
- LDPE
- PP
W2Plastics products tests

Romanian Household Waste

\[ E_p = 5 - 6 \text{kg/m}^3 \]
Recovery for PP and PE: 93%, 96%
Four products in one go
W2Plastics products tests

![Graph showing separation accuracy against polymer density for various materials:
- PP
- PE
- PS
- ABS
- Rubber
- PVC
- PET]
W2Plastics products tests

Tensile strength

<table>
<thead>
<tr>
<th>Density</th>
<th>kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>P4</td>
<td>880-920</td>
</tr>
<tr>
<td>P3</td>
<td>920-960</td>
</tr>
<tr>
<td>P2</td>
<td>960-980</td>
</tr>
<tr>
<td>P1</td>
<td>970-990</td>
</tr>
</tbody>
</table>

References:
- PP: Moplen HP 400 H: 24 MPa
- PE: TIPELIN BA 550-13: 27 MPa

Cutting density: 920 kg/m³
W2Plastics products tests

Visual classification (3 zones)

Real time acquisition window

Instantaneous results

Cumulative results
W2Plastics products tests

- Recovery of rigid PP and PE with both high grade and high recovery (>93% for PP, 96% for PE)
- Separation accuracy is $E_p = 5-6\, \text{kg/m}^3$
- Both PP and PE products have good mechanical properties
W2Plastics business case
Progress in recycling

Billion EUR in current prices

- 2004
- 2006
- 2007
- 2008
- 2009

- Other metals
- Precious metals
- Iron and steel
- Copper, aluminium and nickel
- Plastic
- Paper and cardboard
- Glass

Earnings, jobs and innovation (EEA)
W2Plastics business case

East Europe case

1 ton of rigid PP-PE mix  -200 €

Cutting & washing
150 €/t (in house)

0.7 t of clean PP-PE mix  -150 €

W2Plastics MDS
60 €/t

0.3 t PP 95% grade
0.4 t PE 95% grade
Residue 5% (30 €/t)  -42 €  -1 €

Compounding
150 €/t (in house)

0.3 t PP regranulate
0.4 t PE regranulate
Melt filtration residue 2-3%  -105 €  -0.5 €

Sales
800 €/t

0.3 t PP regranulate
0.35 t PE regranulate  520 €

COSTS = 200 € + 150 € + 43 € + 105 € = 498 €
REVENUES = 520 €
W2Plastics business case

Figure 1. Approximate statistics for the Dutch Hefzorg system: the recycling of separately-collected packaging waste from households by NLR.
W2Plastics business case
West Europe case

IR sorting

1 ton of rigid and films plastic residue
70 €

Cutting & washing (CW)
200 €/t (in house)

1 t of rigid and films plastic residue
-200 €

Film removal (FR)

0.250 t films
0.025 t heavy (50 €/t)
0.450 t rigid plastics mix to MDS
0 € -1.5 €
W2Plastics business case

West Europe case

W2Plastics MDS
65 €/t

0.3 t recyclables 95% grade (PP, PE, PS) -30 €

0.15 t residues (PET, PVC, etc.) -9 €

Compounding (C)
150 €/t (in house)

0.3 t recyclables 95% grade (PP, PE, PS) -45 €

Sales
800 €/t

0.3 t recyclables 95% grade (PP, PE, PS) 240 €

COSTS = (CW) 200 € + (FR) 1.5 € + (MDS) 39 € + (C) 45 € = 285.5 €

REVENUES = 70 + 240 = 310 €
W2Plastics pros and cons

**Advantages**
- Continuous and fast separation process
- High separation efficiency
- Not influenced by the particle shape and color
- High flexibility
- Low energy consumption
- Safe working conditions (compared to organic-water mixture sink-float)
- Environmental friendly (no hazardous residues)
- Fast and on line assessment
- Economically feasible

**Disadvantages**
- New technology
**Project Title:** Magnetic Sorting and Ultrasound Sensor Technologies for Production of High Purity Secondary Polyolefins from Waste (W2Plastics)

**Budget:** 3,9 MEuro

<table>
<thead>
<tr>
<th>Participant no.</th>
<th>Participant organisation name</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Delft University of Technology</td>
<td>The Netherlands</td>
</tr>
<tr>
<td>2.</td>
<td>Università’ di Roma La Sapienza</td>
<td>Italy</td>
</tr>
<tr>
<td>3.</td>
<td>Technical University of Denmark</td>
<td>Denmark</td>
</tr>
<tr>
<td>4.</td>
<td>Transylvania University of Brasov</td>
<td>Romania</td>
</tr>
<tr>
<td>5.</td>
<td>Barcelona Supercomputing Centre Centro Nacional de Supercomputación</td>
<td>Spain</td>
</tr>
<tr>
<td>6.</td>
<td>Budapest University of Technology and Economics</td>
<td>Hungary</td>
</tr>
<tr>
<td>7.</td>
<td>Recycling Avenue</td>
<td>The Netherlands</td>
</tr>
<tr>
<td>8.</td>
<td>Alcufer kft</td>
<td>Hungary</td>
</tr>
<tr>
<td>9.</td>
<td>Urban S.A.</td>
<td>Romania</td>
</tr>
<tr>
<td>10.</td>
<td>Oldelft</td>
<td>The Netherlands</td>
</tr>
<tr>
<td>11.</td>
<td>DV – Tecnologie d’Avanguardia s.r.l.</td>
<td>Italy</td>
</tr>
<tr>
<td>12.</td>
<td>REDOX Waste Recycling B.V.</td>
<td>The Netherlands</td>
</tr>
</tbody>
</table>
Thank you for attention

www.W2Plastics.eu

f.dimaio@tudelft.nl

Acknowledgements
The project is realized thanks to the financial support of the European Commission in the framework of the FP7 Collaborative project. Grant Agreement No. 212782.