Recycling paint sludge in asphalt pavements: cost-benefit and life cycle assessment

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Paint sludge

Waste product generated during automotive painting, when the overspray is captured by air flows and collected with water.

<table>
<thead>
<tr>
<th>Sample</th>
<th>TS (%)</th>
<th>VS (%)</th>
<th>C (%)</th>
<th>H (%)</th>
<th>N (%)</th>
<th>Fe (%)</th>
<th>Al (%)</th>
<th>Ti (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primer (3)</td>
<td>57±22</td>
<td>61±7</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>0.9 ± 1.4</td>
<td>0.5 ± 0.2</td>
<td>8.3 ± 3.6</td>
</tr>
<tr>
<td>Basecoat (6)</td>
<td>40±9</td>
<td>73±8</td>
<td>48±6</td>
<td>6.4 ± 0.8</td>
<td>3.0 ± 1.4</td>
<td>0.5 ± 0.2</td>
<td>2.1 ± 0.9</td>
<td>7.4 ± 3.1</td>
</tr>
<tr>
<td>Clearcoat (3)</td>
<td>35±11</td>
<td>95±1</td>
<td>60±2</td>
<td>8.1 ± 0.1</td>
<td>7.5 ± 0.8</td>
<td>0.2 ± 0.2</td>
<td>1.0 ± 0.6</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>
Demonstration at a lab scale of the feasibility of using paint sludge in mixtures for asphalt pavements.
INPUT DATA

M = 3,000 t/y
TS = 35-40%
t = 250 d/y, 24 h/d

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Cost Benefit Assessment

DEWATERING & MILLING: 95 €/t
MIXING WITH BITUMEN: 49 €/t
ASPHALT CONCRETE PREPARATION

144 €/t treatment cost
450 €/t neat bitumen cost

Amount of sludge in bitumen: 10%
Amount of binder in HMC: 5.5%
Hot mix concrete density: 2.3 kg/dm³
Thickness of the wearing course: 3 cm
Road wideness: 6 m

3.7 \times 10^6 \text{ m}^2
Life Cycle Assessment
«from cradle to gate»

- SimaPro software
- Comparison of 2 scenarios
  Production of traditional HMA
  Production of HMA with modified binder (20% paint sludge in the binder)

Asphalt concrete plant

Quarry for aggregates

Paint sludge generation and treatment

Refinery
Bitumen production

Quarry for aggregates

20 km

Asphalt concrete plant

20 km

Paint sludge generation and treatment

7 km

Incinerator

350 km

• electricity
• fuel

• energy

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Life Cycle Assessment
«from cradle to gate, scenario 1»

- SimaPro software
- Comparison of 2 scenarios

**Production of traditional HMA**
Production of HMA with modified binder

- **Quarry for aggregates** 20 km
- **Asphalt concrete plant**
  - electricity
  - fuel
  - Refinery Bitumen production 350 km
- **Paint sludge generation and disposal** 10 km
- **Incinerator**
Life Cycle Assessment
«from cradle to gate, scenario 2»

- SimaPro software
- Comparison of 2 scenarios

Production of traditional HMA
Production of HMA with modified binder

Quarry for aggregates
Asphalt concrete plant
Paint sludge generation and treatment

- 20 km
- 7 km
- 350 km

Refinery
Bitumen production

- 20%
- energy
- electricity
- fuel

Incinerator

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**Life Cycle Assessment**

**GER, Gross Energy Requirement (MJ/kg)**

- HMA P.S.: 2.67 MJ/kg
- STANDARD HMA: 3.18 MJ/kg

16% increase

**GWP, Global Warming Potential (gCO₂eq/kg)**

- HMA P.S.: 31.7 gCO₂eq/kg
- STANDARD HMA: 52.6 gCO₂eq/kg

40% increase
Conclusions

• The generation of paint sludge (PS) in Italian plants is in the order of 3 kg/car on a wet basis (FCA, 2016).

• Reuse of paint sludge as a substitute of a part of the conventional binder for the production of concrete for asphalt pavements was proposed and the technical feasibility of the process was successfully demonstrated (Dalmazzo et al., 2017).

• The unit cost of treatment, that includes the operations of dewatering and milling and mixing PS with neat bitumen, was of 144 €/t.

• The economic balance was positive, because a PS treated at a cost of 144 €/t could substitute up to 20% of neat bitumen (at a cost of 450 €/t) in a binder used for asphalt concrete production without worsening the performances of the pavement.

• The LCA analysis revealed that the production of a hot mix asphalt by employing a bitumen with the addition of 20% (w/w) PS, reduced the Gross Energy Requirement (GER) by approximately 16% respect to the traditional process.

• The Global Warming Potential (GWP) index decreased from 52.6 to 31.7 g CO$_2$eq/kg asphalt mixture.
Thanks for your kind attention!

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