Green Manufacturing Initiative

Assessment Follow-up and Solutions

Fabri-Kal

Assessment Follow-up and Solutions

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Outline

- The GMI Assessment
  - PLA Landfill Waste
- IAC Assessment
- Oven Energy Solutions
  - Compare
  - Confirm
  - Savings
Assessments

- Fabri-Kal Site Assessment
  - Material Waste
  - Oven Heat Loss
  - Finite Element Analysis
  - Completed Aug. 5, 2011

- IAC Energy and Waste Survey Report
Quick Win

• Material Waste Audit
  – “Dumpster Dive”
• PLA represented 45% of landfill waste
• Solution: facilitate a Waste Exchange
• Results:
  – 300,000 pounds waste potentially diverted from landfill annually with re-sale value of $3,000
  – Monthly landfill costs reduced from $1,400 to $640

$12,000 / year
Assessments

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REPORT NUMBER UM0590

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Table 1: Summary of Recommendations

Table 2: Summary of Audits

Table 3: Summary of Case Studies
• Reduce energy usage and heat loss
• Compare GMI and IAC oven data

<table>
<thead>
<tr>
<th></th>
<th>GMI 2011</th>
<th>IAC</th>
</tr>
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<tbody>
<tr>
<td>Energy Lost</td>
<td>12,281 btu/hr</td>
<td>11,260 btu/hr</td>
</tr>
<tr>
<td>Potential Savings</td>
<td>$2931 per year</td>
<td>$2517 per year</td>
</tr>
<tr>
<td>Surface Temp.</td>
<td>150 °F</td>
<td>160 °F</td>
</tr>
<tr>
<td>Ambient Temp.</td>
<td>75 °F</td>
<td>85 °F</td>
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<tr>
<td>Surface Emissivity</td>
<td>0.12</td>
<td>0.9</td>
</tr>
<tr>
<td>Surface Area</td>
<td>89 ft²</td>
<td>80 ft²</td>
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<tr>
<td>Operating Hours</td>
<td>7300 per year</td>
<td>8760 per year</td>
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<tr>
<td>Price of Energy</td>
<td>0.12 $/kwh</td>
<td>0.054 $/kwh</td>
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</table>
• Collect measurements
• Investigate assumptions

<table>
<thead>
<tr>
<th></th>
<th>GMI 2012</th>
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<tbody>
<tr>
<td>Energy Usage</td>
<td>31.1 kw/h</td>
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<tr>
<td>Oven Temp.</td>
<td>615° F</td>
</tr>
<tr>
<td>Surface Temp.</td>
<td>146° F</td>
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<tr>
<td>Surface Area</td>
<td>87.5 ft²</td>
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<tr>
<td>Operating Hours</td>
<td>6500 per year</td>
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<tr>
<td>Price of Energy</td>
<td>0.083 $/kwh</td>
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</table>
• Choice of material
  – R-value
• Physical restrictions

1” Melamine Lightweight Foam
(R-value = 4)
Costs

- 4 sheets melamine lightweight foam
- 8 braces
- 2 hours maintenance
**To do**

- Directly measure energy usage on oven
- Determine heat capacity of PLA
- Evaluate alternative insulations

### Insulation

<table>
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<tr>
<th>Energy Savings</th>
<th>Cost</th>
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<tbody>
<tr>
<td>1” Melamine Insulation</td>
<td>2.78 kw/hr</td>
</tr>
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</table>

*$1536 / year*
Minimizing Radiation/Atmospheric Losses

- Reduced height of opening from 7” to 2” with 12” thickness
- View factor reduced from 1.0 to 0.32
- 2.54 kW in energy savings

$1403 \text{ / year}$

Proposed Oven
• Currently Implemented  
  – $0 implementation costs
• Recommended  
  – $562 implementation costs  
  – 4 month ROI
• Total
  – Company wide (x36)
  $12,000 / year
  $1536 / year
  $1403 / year
  $15,000 / year
  $120,800 / year
Next Steps

• Energy Usage
  – direct meter reading

• PLA heat capacity
  – DSC lab equipment re-calibration

• Future Project
  – Finite Element Analysis of PLA sheet during molding