Lean Manufacturing Project to Increase Efficiency and Reduce Energy

Firmenich

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MnTAP Advisor: Paul Pagel
Company Overview

• Started in 1895
• World’s largest private company in the flavors & fragrances business
• Producer of liquid, dry, and encapsulated flavors
• 64 countries, 54 operational facilities, 26 manufacturing sites
• New Ulm, MN location is one of five in the US
  • Spray-dried, dry-blended, paste, and liquid flavors
Incentives for Change

- Lean manufacturing
- Continuous improvement
- Corporate sustainability
Reasons for MnTAP Assistance

• 40% of all products are spray-dried powders
  • Increase efficiency of spray drying operation (increase up-time)
  • Increase production capacity (continue expansion and leadership in market)

• Continue march towards sustainability goals
  • Constantly strive to be a good neighbor to the community
  • Utilize less energy, water, and discharge less waste

• MnTAP intern brought in as a fresh set of eyes & engineering expertise on these projects
Approach

• Spoke to operators & upper management about operations
• Reviewed SOPs, and documented details of conversations
• Worked hands-on to gain understanding of potential opportunities
• Utilized chemical engineering background to:
  • Develop mathematical models of spray dryer performance
  • Identify trends, plan tests, and evaluate results
## Opportunity 1: Time Reduction

<table>
<thead>
<tr>
<th>Location</th>
<th>Process &amp; Details</th>
<th>Reason for Desired Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Dryer</td>
<td>• Cleaning-in-place (CIP), 1 operator</td>
<td>• Production: 1-2 hours</td>
</tr>
<tr>
<td></td>
<td>• 7 hours: downtime</td>
<td>• Downtime reduction increases efficiency</td>
</tr>
</tbody>
</table>

**Proposed Solution: Add an additional operator**

7 hours → 4 hours

<table>
<thead>
<tr>
<th>Income</th>
<th>Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Production Rate: 75 KG/HR</td>
<td>• Labor costs: $25/HR</td>
</tr>
<tr>
<td>• Product Retail Price: $ 10/KG</td>
<td>• Energy Costs: 3 HR additional operation</td>
</tr>
</tbody>
</table>
Opportunity 1: Financial Evaluation

<table>
<thead>
<tr>
<th>Time Gained/YR</th>
<th>Annual Production Increase</th>
<th>Net financial benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>320</td>
<td>24,000 KG</td>
<td>US $ 100,000</td>
</tr>
</tbody>
</table>

Net Profit Analysis

Break Even Price = $ 5/KG

Selling Price of Product ($/KG)
Opportunity 2: Water Usage Reduction

Background: 3 Rinses – first rinse, chemical cleaner, final rinse
Current: Visual or timing based control of water & chemical usage
Proposed Solution: Use conductivity and turbidity sensors to monitor discharge
  • Aids operators, save water & chemicals, gives additional time for production

Baseline (Water)
- TDS: 860 ± 10 ppm
- Flow rate = 40 gpm
- Time saved = 5 min
- Water saved = 200 gal

First Rinse

TDS (ppm)

Time (s) From Start
Opportunity 2: Financial Evaluation

<table>
<thead>
<tr>
<th>Location</th>
<th>Annual Savings @ 400 washups/YR</th>
<th>Annual Production Time Gain</th>
<th>Production Increase @ 75 KG/HR</th>
<th>Net Annual Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Dryer</td>
<td>80,000 gallons</td>
<td>22 HR</td>
<td>1,650 KG</td>
<td>$ 15,200</td>
</tr>
</tbody>
</table>

• Possibility exists to reuse last rinse (or part) as first rinse of next wash-up (needs further evaluation)

Adding sensory equipment to manage this:

<table>
<thead>
<tr>
<th>Expenditure</th>
<th>Profits</th>
<th>Payback Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximately US $ 6,500</td>
<td>$ 15,200</td>
<td>5.5 months</td>
</tr>
<tr>
<td>Including PLC programming</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Opportunity 3: Production Rate Increase

- Different spray-dry products have feeds with different solids content
- Higher solids content in feed:
  - Increases production rate
  - Saves time
  - Increases flavor retention
  - Reduces energy consumption
  - Reduces amount of water used
- Pumping & quality constraints

Production Rate vs. Feed Solids%

\[ y = 425.94e^{0.02x} \]
\[ R^2 = 0.97 \]

- Production Rate @ 20% Solids: 126 KG/HR
- Production Rate @ 30% Solids: 217 KG/HR
  - 72% increase
Opportunity 3: Production Rate Increase

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- Higher solids content in feed:
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  - Saves time
  - Increases flavor retention
  - Reduces energy consumption
  - Reduces amount of water used

- Pumping & quality constraints

Evaporating 1000 KG Feed
- Cost @ 20% Solids: $174
- Cost @ 30% Solids: $102
41% decrease in cost for this step
Opportunity 3: Production Rate Increase

- Identified most heavily used carriers
- Modified SOPs to minimize dilution
  - Formula instructed ingredients to be added in certain solids ratio
  - SOPs suggested adding additional water to dilute

<table>
<thead>
<tr>
<th>Annual Capacity Increase</th>
<th>Annual Energy Savings</th>
<th>Annual Water Usage Reduction</th>
<th>Net Annual Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>17,000 KG</td>
<td>$ 2,600 (240,000 lb. steam)</td>
<td>30,000 gallons</td>
<td>$ 170,000</td>
</tr>
</tbody>
</table>
Opportunity 4: Waste Reduction

- Product deposits are difficult to remove (dryer & screw conveyor)

- Benefit:
  - Save on TSS & BOD discharge
  - Even better company image

Two Pronged Approach

- Capture solids before washing
  - Vacuuming
  - Pigging (currently being evaluated)

- Capture solids while washing
  - Filter socks (solubility an issue)

https://en.wiki2.org/wiki/HydraulicallyActivated_pipeline_pigging

<table>
<thead>
<tr>
<th>Solids Captured</th>
<th>TSS &amp; BOD Savings</th>
<th>Investment &amp; Payback Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>32,000 lb.</td>
<td>$ 9,500</td>
<td>Needs Evaluation</td>
</tr>
</tbody>
</table>
Other/Future Opportunities

• Spray-head optimization on all dryers & nozzle addition on Box Dryer
  • Increased moisture content, particle size, and capacity
  • Mass & energy balances
  • Needs time for testing

• Waste heat recovery/reuse from exhaust air
<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Benefits</th>
<th>Annual Savings</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add an Operator</td>
<td>320 hours</td>
<td>$ 100,000</td>
<td>Testing</td>
</tr>
<tr>
<td>Add Sensory Controls</td>
<td>80,000 gallons</td>
<td>$ 15,200</td>
<td>Recommended</td>
</tr>
<tr>
<td></td>
<td>22 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase Feed Solids</td>
<td>37,500 lb. product</td>
<td>$ 170,000</td>
<td>Testing</td>
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<td>Product Recovery</td>
<td>32,000 lb. solids</td>
<td>$ 9,500</td>
<td>Recommended</td>
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Personal Benefits

- Exposure to lean manufacturing
- Applied concepts to practical settings
- Learned from operators
- Project management skills
- Communications skills
- Real-world experience
Questions?