Rice Bran Oil Extraction System

Final Presentation
MECH 440B
Senior Project
Introduction

The Design Team
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- Stephanie Enz
- Robert Spiller

Project Advisor
- Professor Joe Greene

Course Instructor
- Professor Greg Watkins

Industrial Sponsor
- Lundberg Family Farms

Other Sponsorship
- CSU AS Sustainability
- Center for Entrepreneurship
Background & Need

Lundberg Family Farms

- Large Northern CA Rice Producer
- Interested in Sustainable Agricultural Practices
- Teamed up with Center for Entrepreneurship in a feasibility study for a rice bran oil extraction system.

The Need

Currently there is an under utilization of rice bran, the byproduct of the rice milling process.
Problem Definition

- **Goal**
  - Develop an Oil Extraction method for use with rice bran

- **Objectives**
  - Extract 25 gallons of rice bran oil per week
  - Remove 10%-18% oil by weight from rice bran input

- **Constraints**
  - Produce a clean oil product
  - Conforms with Occupational Safety and Health Association (OSHA) standards
Design Solution

Key Components
1. The Shaft (Screw)
2. The Nozzle
3. The Casing
4. The Hopper
5. The Agitator Unit

Purchased Components
1. Raw Materials for Manufacturing
2. Motor
3. Bearings
4. Drive Belt/Chain
5. Gears
   - Beveled
   - Sheaves
Compression Screw Design

The Screw

Motor Input

Rice Bran Input

Oil Exit Area

Compression Zone

Rice Bran Out
Screw Fabrication
Operation and Testing
## Testing

<table>
<thead>
<tr>
<th>Item</th>
<th>Test 1 (7 holes)</th>
<th>Test 2 (20 holes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run Time</td>
<td>35 min</td>
<td>50 min</td>
</tr>
<tr>
<td>Steady State Flow Time</td>
<td>10 min</td>
<td>15 min</td>
</tr>
<tr>
<td>Case Temperature (Avg.)</td>
<td>150 F</td>
<td>148 F</td>
</tr>
<tr>
<td>Bran Output Temperature (Avg.)</td>
<td>141 F</td>
<td>137 F</td>
</tr>
<tr>
<td>Bran Input</td>
<td>16 oz.</td>
<td>64 oz.</td>
</tr>
<tr>
<td>Cake Output</td>
<td>14.5 oz.</td>
<td>59.6 oz</td>
</tr>
<tr>
<td>Oil Output</td>
<td>1.5 oz.</td>
<td>4.4 oz.</td>
</tr>
</tbody>
</table>
# Testing

<table>
<thead>
<tr>
<th>Item</th>
<th>Test 1 (7 holes)</th>
<th>Test 2 (20 holes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Yield</td>
<td>9.375%</td>
<td>6.875%</td>
</tr>
<tr>
<td>% Efficiency (@14% available oil)</td>
<td>66.96%</td>
<td>49.11%</td>
</tr>
<tr>
<td>Flow Establishment Energy Consumption</td>
<td>0.13 kW/hr</td>
<td>0.18 kW/hr</td>
</tr>
<tr>
<td>Steady State Testing Energy</td>
<td>0.34 kW/hr</td>
<td>0.43 kW/hr</td>
</tr>
<tr>
<td>Total Motor Energy Consumption</td>
<td>0.47 kW/hr</td>
<td>0.61 kW/hr</td>
</tr>
<tr>
<td>Potential Energy of Oil (80% conversion)</td>
<td>0.7 kW/hr</td>
<td>1.63 kW/hr</td>
</tr>
</tbody>
</table>
Meeting our Goals

❖ Goal
  - Develop an Oil Extraction method for use with rice bran

❖ Objectives
  - Extract 25 gallons of rice bran oil per week
    - 3 gallons per week
  - Remove 10%-18% oil by weight from rice bran input
    - 6.9%-9.4%

❖ Constraints
  - Produce a clean oil product
  - Conforms with Occupational Safety and Health Association (OSHA) standards
    - Exposed moving components (belts and sheaves)
    - Surface Heat
## Budget

### Funding
<table>
<thead>
<tr>
<th>Item</th>
<th>Budgeted Cost</th>
<th>Actual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS Sustainability Grant</td>
<td>$3,000.00</td>
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</table>

### Expenses

<table>
<thead>
<tr>
<th>Item</th>
<th>Budgeted Cost</th>
<th>Actual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor</td>
<td>$250.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Parts (Gears and Bearings)</td>
<td>$750.00</td>
<td>$700.54</td>
</tr>
<tr>
<td>Electrical Components and wiring</td>
<td>$200.00</td>
<td>$124.09</td>
</tr>
<tr>
<td>Steel</td>
<td>$800.00</td>
<td>$462.44</td>
</tr>
<tr>
<td>Manufacturing Lab Cost</td>
<td>$150.00</td>
<td>$150.00</td>
</tr>
<tr>
<td>Professional Fabrication Services</td>
<td>$750.00</td>
<td>$603.17</td>
</tr>
<tr>
<td>Hardware (nuts, bolts, washers, etc)</td>
<td>$100.00</td>
<td>$121.18</td>
</tr>
<tr>
<td>Testing</td>
<td>$0.00</td>
<td>$28.37</td>
</tr>
<tr>
<td><strong>Materials Cost</strong></td>
<td><strong>$3,000.00</strong></td>
<td><strong>$2,189.79</strong></td>
</tr>
<tr>
<td><strong>Labor Cost</strong></td>
<td><strong>$22,599.36</strong></td>
<td><strong>$22,599.36</strong></td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$25,599.36</strong></td>
<td><strong>$24,789.15</strong></td>
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</tbody>
</table>
Recommendations

• Create a rice bran specific compression screw design with increased L/D ratio.
• Use a starve feed hopper to reduce clumping.
• Use a compressed air valve in the feed section to boost flow into the system.
• Use a larger sheave diameter on screw shaft to raise torque through the shaft and reduce belt slippage.
• Implement design for manufacturing principles for faster disassembly and easier cleaning.
• Use an additive to the rice bran to improve oil extraction.
• Use a thermal controller in the compression zone to maximize extraction.
Acknowledgements

Tech Shop
• Steven Foute
• Mike Renwick
  ❖ Steve Eckart
  ❖ Oliver Hayes
  ❖ Tony Arena

Donations
❖ Professor Joe Greene (hopper)
❖ Professor Scott Brogden (table)
❖ Technician Mike Renwick (hardware)
❖ Thomas Welding & Manufacturing (discounted professional fabrication)
❖ Bearing Belt and Chain (discounted belts and sheaves)
❖ Lundberg Family Farms (motor, gear box, and rice bran)

Funding
❖ AS Sustainability

Industrial Sponsor
❖ Lundberg Family Farms
❖ Chico Center for Entrepreneurship