Fluidized Bed Malt Roaster

1. Problem Statement
   - Design and develop a fluidized bed roaster for roasting malted barley under designated humidity and temperature conditions
   - Utilize principles of particle bed fluid flow and energy efficiency
   - Decrease cost and energy requirement for roasting
   - End result: 2 bushel test size that can be easily scaled up to 12-15 bushels

2. Background
   Approximated Ergun Equation to calculate air velocities needed to suspend a given bed of particles:
   \[ N_{Re,mf} = \frac{(33.7)^2 + 0.0408 D_p^2 \rho_p (\rho - \rho_g)}{\mu^2} - 33.7 \]
   - Proof that fluid bed can roast malt
   - Problems with condensation in return line
   - Want to apply recirculation to larger-scale model

3. Alternative Solutions & Evaluations
   - Option 1: External Return
     - Easy but bulky construction
     - Condensation issues
     - Less compact
     - Loading/unloading issues
   - Option 2: Internal Return
     - Compact but complicated construction
     - Better efficiency
     - Disrupted fluidization area
     - No condensation in return

4. Final Design & Qualification Analysis
   Considerations:
   - Avoiding condensation problem through close return pipe and insulation
   - Spouted bed to prevent root tangling
   - Fan selected to make design compact
   - Easy unloading mechanism
   - Damper placements to control/mix air flow
   - Control of heater/blower for different malt needs
   - Loading problem fixed

5. Impact & Sustainability
   - Offers low-cost solution for malt roasters over drum roasters
   - Accessibility for smaller brewers due to small batch size and lower up-front cost
   - Long-term life of heater/blower still in question

6. Economic Analysis
<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Total Price</th>
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7. Assessment/Recommendations
   - Full construction and testing of the prototype design still needed
   - Gauge market interest
   - Develop operating safety guidelines in accordance with OSHA
   - More automation possible
   - Ensure proper roasting and operation to scale up to full size model

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