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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:

$$N_{Re,mf} = \sqrt{(33.7)^2 + 0.0408 \frac{D_p^3 \rho (\rho_p - \rho) g}{\mu^2}} - 33.7$$



- Proof that fluid bed can roast malt
- Problems with condensation in return line
- Want to apply recirculation into larger-scale model

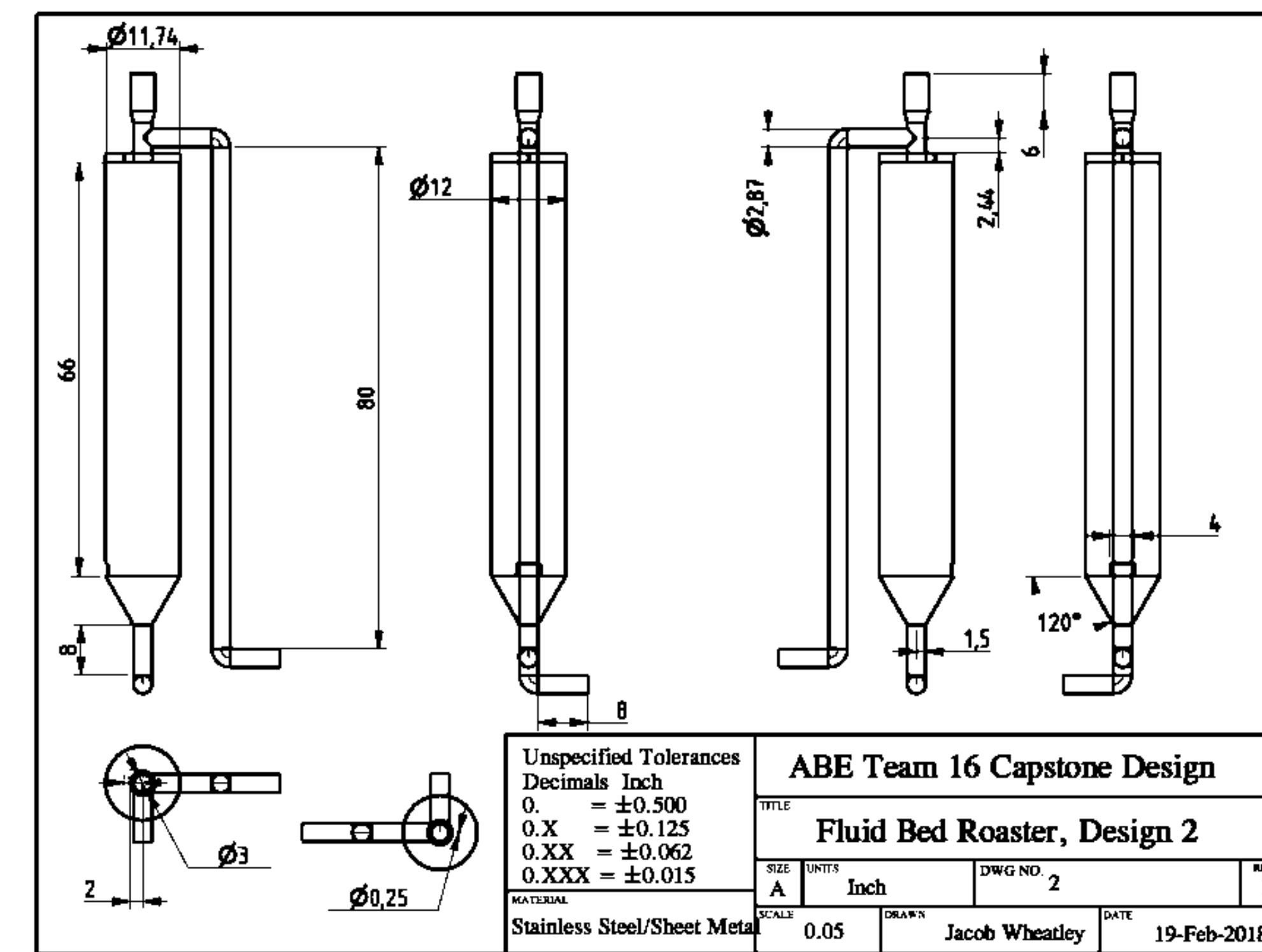
Requirements:

1. 150-600° F Roasting Temperature
2. Quenching system
3. Construction cost <\$10k-20k
4. 12-15 bushel capacity



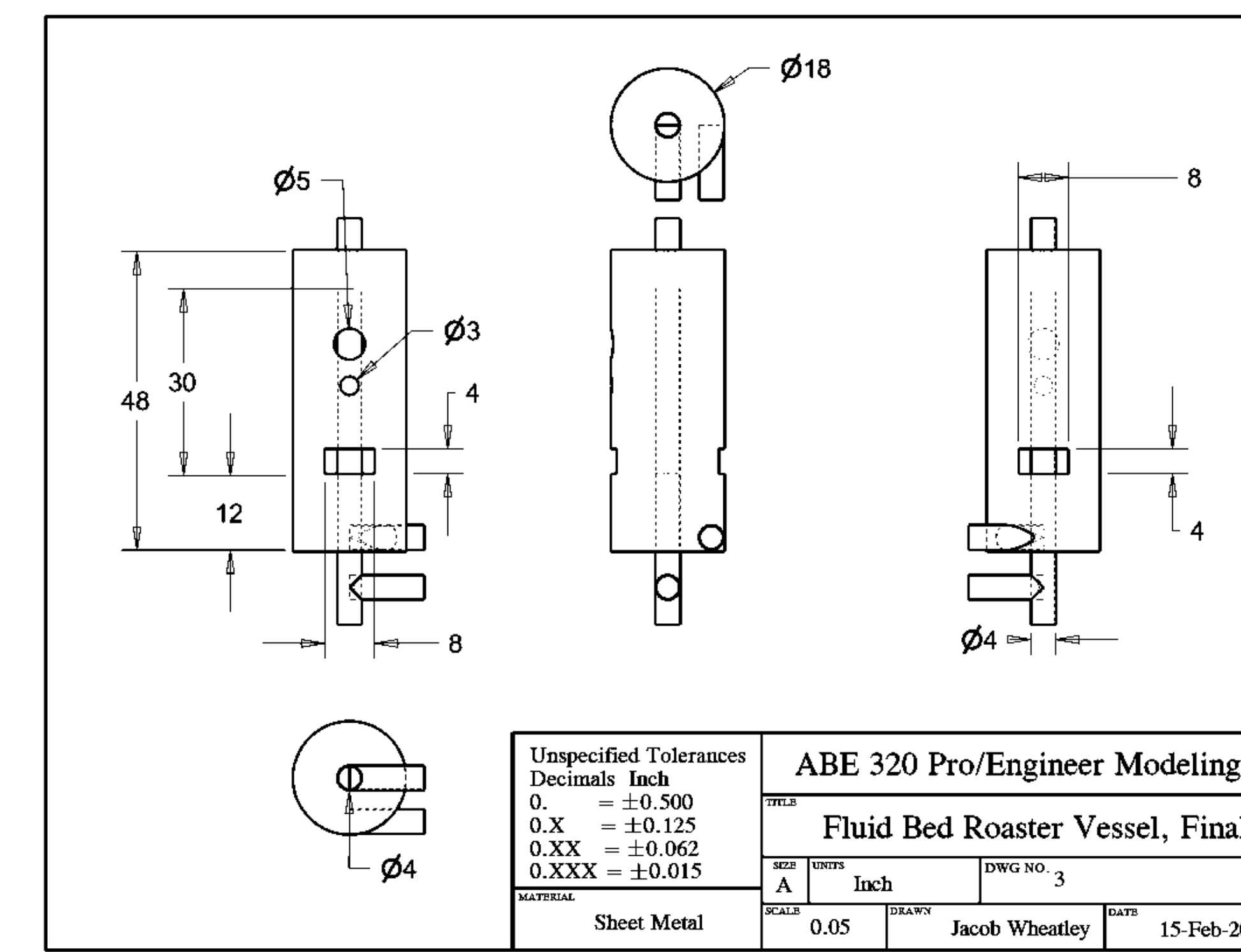
- Over half of all malt produced in the world comes from 10 different malting companies
- Inexpensive small batch roasters have potential to disrupt malting market

3. Alternative Solutions & Evaluations



Option 1: External Return

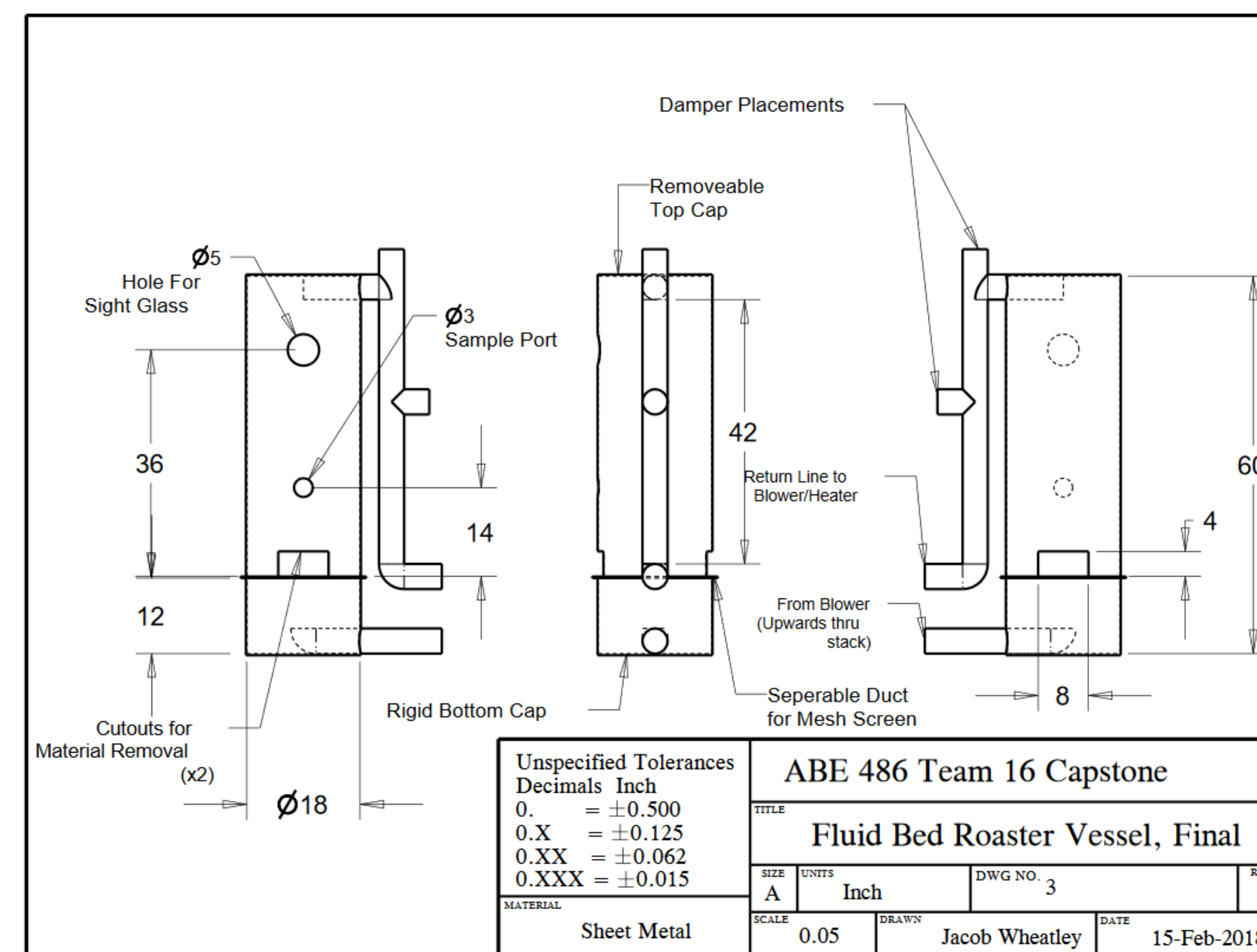
- Easy but bulky construction
- Condensation issues
- Less compact
- Loading/ unloading issues



Option 2: Internal Return

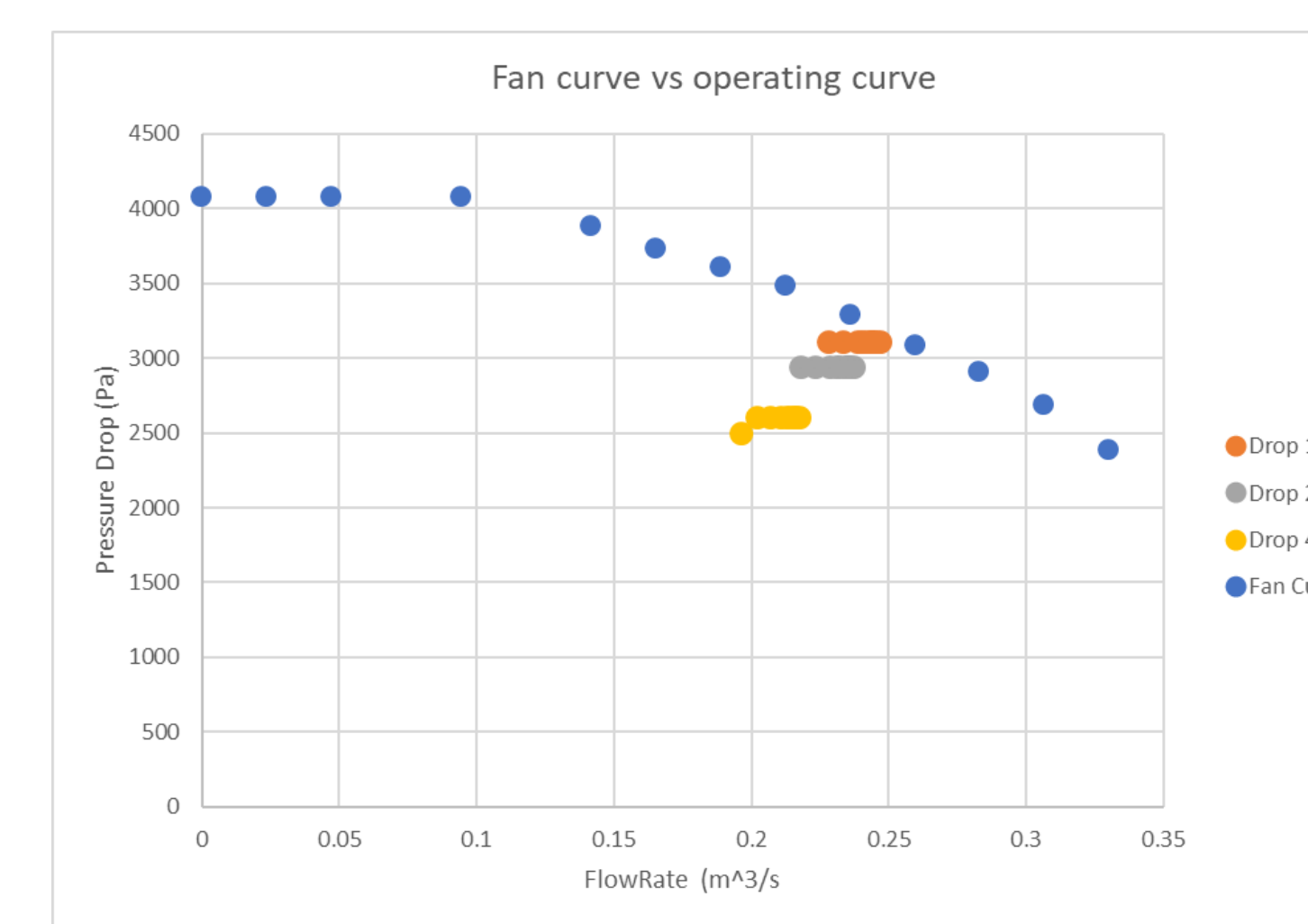
- Compact but complicated construction
- Better efficiency
- Disrupted fluidization area
- No condensation in return

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

Item	Quantity	Total Price
Fan	1	\$2,433.00
Dampers	3	\$80.76
Ducting Parts & Assembly	12	\$2,443.13
R-38 Insulation	5	\$224.90
Thermocoupling and Electronics	7	\$84.65
18" Round metal mesh	1	\$34.98
Sight Glass	1	\$43.95
Misc. Hardware	4	\$95.00
Total		\$5,440.37

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