Simulation Plan: Wall Shape Testing

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Simulation Plan: Testing Wall Shapes for Energy Optimization

Objective

Analyze how different wall shapes (smooth, honeycomb, spiral, vessel-inspired) affect energy flow, resonance, and energy density distribution in the prototype.

Key Metrics to Measure:

1. Airflow Dynamics:
- Velocity profiles at entry, exit, and focal zones.
- Pressure drop across the structure.
- Turbulence intensity.

2. Resonance Behavior:
- Frequency response (constructive interference zones).
- Energy density distribution (heatmaps).

3. Efficiency Metrics:
- Energy output via simulated piezoelectric response.
- Energy amplification across the tube geometry.

Simulation Setup:

1. Software Tools:
- CFD: OpenFOAM, ANSYS Fluent, or Autodesk CFD.
- Wave Simulation: MATLAB or Python libraries (NumPy, SciPy).

2. Tested Geometries:
- Smooth Walls: Baseline comparison.
- Honeycomb Walls: Localized resonance and wave interactions.
- Spiral Walls: Guided wave amplification.
- Vessel-Inspired Curves: Energy redistribution and density gradients.

3. Parameters:

- Airflow speeds: 5 m/s, 10 m/s, 15 m/s.
- Resonance frequencies: 10 Hz to 1000 Hz.
- Material properties: PLA/PETG with standard density and elasticity.

Deliverables:

1. Results for airflow dynamics, resonance patterns, and energy output.
2. Visuals: Streamline plots, heatmaps, and energy amplification graphs.
3. Insights into the most effective wall shape for the design goals.