SAMPLE CASE · CALIBRATED DESIGN LOOP

Convection heater: 79% lighter, 345 °C air in about 1 s

Inventor-owned design (David Y. Guo, patent pending) · Battery-powered, 7.4 V pack

Joule-heating study by Truepath CFD™, published with the owner's permission

MODEL Transient Joule heating with airflow: puff after puff, with the heater still warm from the last one.

THE RISK YOU ALREADY CARRY

Every gram of heater is battery spent before the air gets hot.

THE CHALLENGE

Make hot air on demand from a small battery pack: hot enough in about a second, even across the material, and light enough to run many puffs per charge.

YOUR QUESTIONS, OUR EXPERTISE

1. How much heater mass can I remove without losing response time?
2. Does my heater still perform on the 4th puff, not just the first?
3. How big a battery does my puff sequence really need?
4. Is the air heated evenly across the material, or only at the core?
5. Is my design ready to build, or am I about to pay for a prototype to find out?

Which of these can you answer with confidence today?

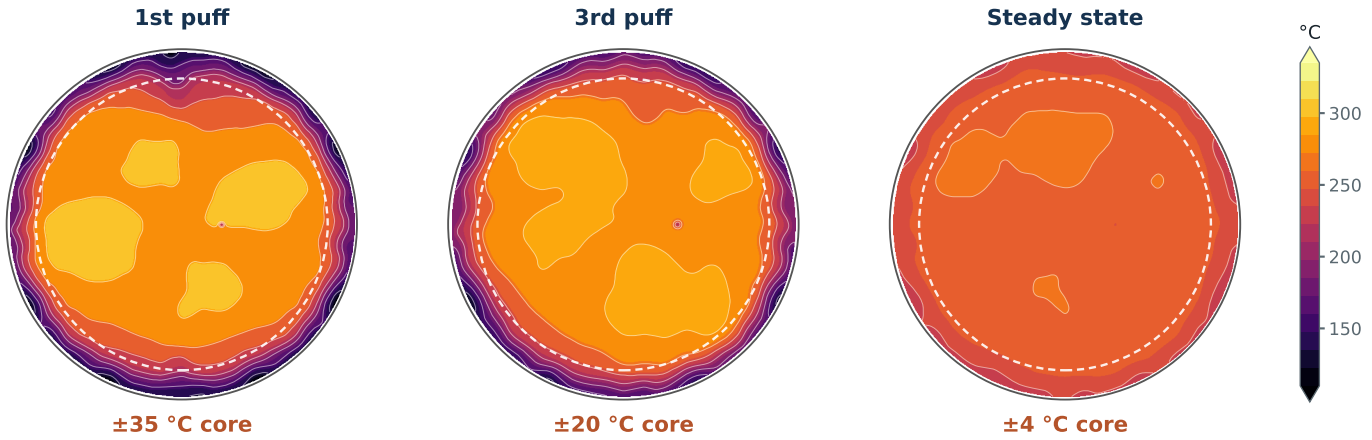
RESULTS (SIMULATED)

4.00 g
heater mass, from 18.74 g over 3 design rounds

345 °C
peak air in 1.1 s, first puff, 7.4 V pack

−79%
less heater mass than the first design

AIR ENTERING THE MATERIAL (LATEST DESIGN, SIMULATED)



Core = inner 70% of face area (dashed); 5th–95th percentile spread. Ramp drops to 0.5 s by the 4th puff.

KEY INSIGHT

A heater that reaches temperature once on a bench is not the product: real use is a string of puffs with the heater still warm. Simulating that sequence let 79% of the mass come out with the response still about 1 s. 12 puffs use 2,823 J in total, which sizes the battery.

KNOWN ASSUMPTIONS

Puff sequence: back-to-back, heater still warm: modeled.
Device body: 20.3 → 25 °C after 4 puffs: simulated.
An earlier design's energy: estimate, not a like-for-like puff sequence.
Material properties at temperature: not yet test-validated.

DECISION GATE

Build the prototype now, or prove the puff sequence first?

The latest design hits 345 °C air in 1.1 s at 21% of the original heater mass.
The open risks are material properties at temperature and battery voltage under load, and both can be checked in simulation.
A **Calibrated Design Loop, from $12,000 by milestone,** runs rounds like these calibrated to your test data, before you build.

Book a 20-minute scope call at truepathcfd.com

Smaller first steps start there too.

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