PulmonUs: Creating an Environmentally Friendly Dry Powder Inhaler

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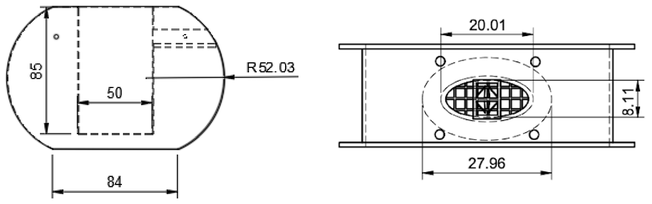
Background

The PulmonUs team designed ReLung, a refillable multi use dry powder inhaler that is biodegradable and also easier to use for patients across all ages. The current aerosol inhalers that are available on the market utilize hydrofluoroalkanes (HFAs) to deliver asthma medication to patients. Recent emerging studies have shown that the HFAs in a single asthma inhaler emits as much carbon dioxide as driving 25 miles in a gasoline car (Tirumalasetty et al. 2024). Our team is committed to creating the Green Inhaler, a refillable dry powder inhaler that reduces carbon emissions and can be used by patients across all ages for a cleaner and brighter future.

Mission Statement

PulmonUs aims to reduce greenhouse emissions by providing an affordable, environmentally friendly dry powder inhaler with biodegradable, refillable cartridges for asthma patients.

Final Product Specifications



Specification Name	Specification Description	Importance
Dimensions(LxWxH)	(80mm x 20mm x 90mm)	Final result of 3D CAD model resulted in this dimensional profile. Within bounds to remain hand-portable and ergonomic for the patient to use.
Weight	200g	200-400g - Within bounds to remain hand-portable and ergonomic for the patient to use.
Material	HDPE/Polypropylene Material of the inhaler should be made of injection molded HDPE or Polypropylene to ensure biocomp and durability for the reusable portion of the inhaler. Mouthpiece should be made of HDPE or Polypropylene to remain sanitary. Is replaceable.	The material selection for the inhaler plays a critical role in defining key characteristics such as durability, reliability, biocompatibility, and ergonomics.
Device shelf life	2 years	Device must have a specified shelf life.
Operational lifespan	Device will last 12 refills from first use or 1 year, whichever comes first.	Device must have a time period in which it is operational.
Replaceable mouthpiece	Device has a detachable mouthpiece that may be cleaned throughout use of the product, or replaced if needed.	NA
Dosage chamber window	Device features a clear, acrylic window into the inhalation chamber for the user to visually confirm loading of device.	NA
Biodegradable consumables	Product consumable portion (blister strip) should be biodegradable.	Biodegradability is a key value proposition of our device prototype.
Specified Target Delivered Dose	160mcg budesonide 4.8mcg formoterol	The drug serves as the primary mode of action for the inhaler. This design does not involve any modification to the pharmaceutical compound; instead, it utilizes a commercially available dry powder formulation.
Inhaler resistance	Medium-high resistance	Product must have a resistance low enough that most patients can overcome, yet high enough to minimize side effects
Number of actuations tolerated before mechanical/structural failure	1500 actuations	Product must be durable enough to ensure proper function throughout its lifespan

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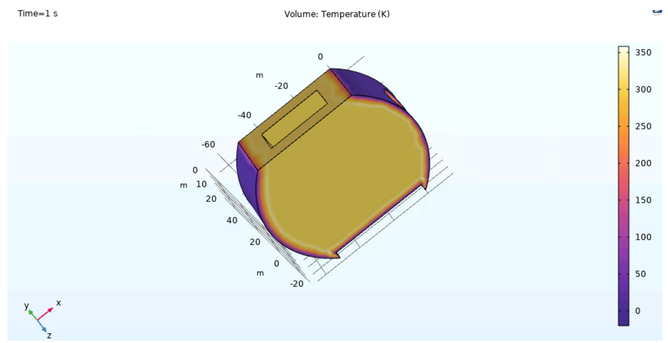
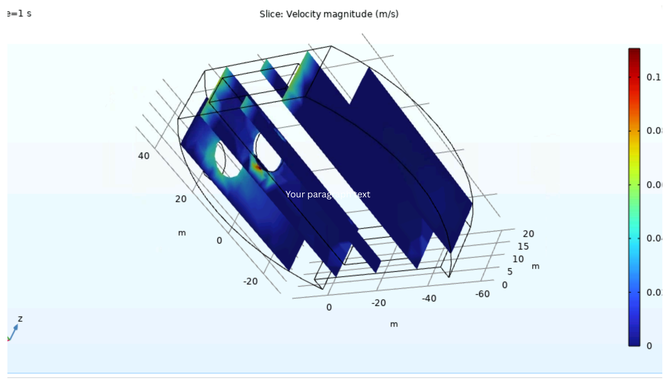
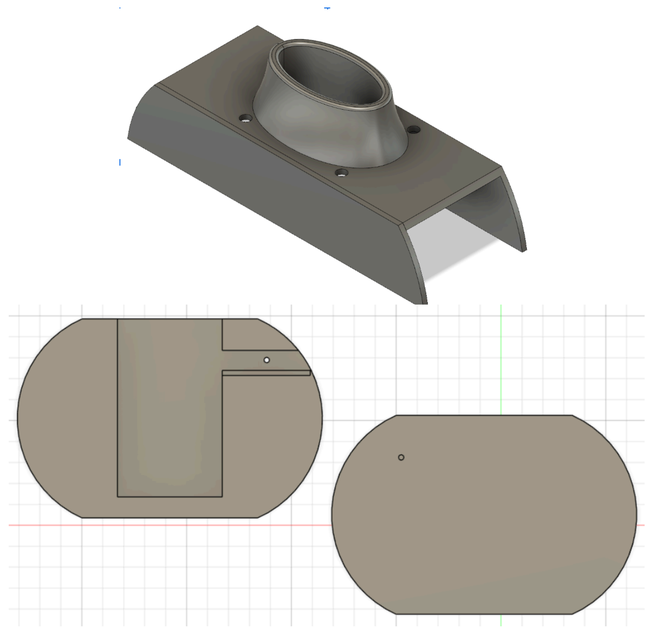
Breathe Easy, Live Green

Final Technical Model





Prototype



Verification Results

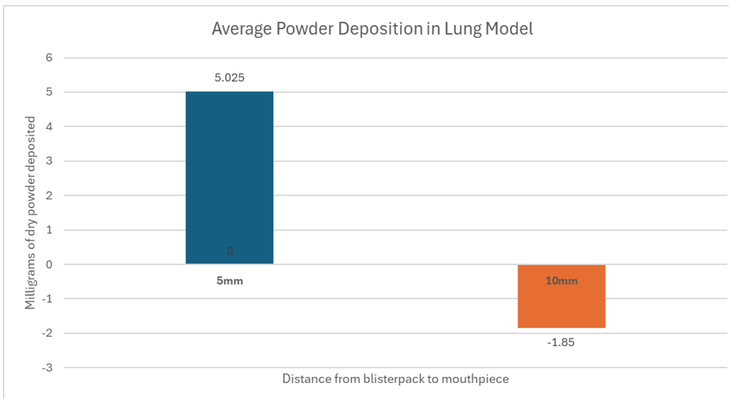


Figure 1. Tested dry powder deposition from our inhaler prototype to our human lung model. 5 mm distance from the blister pack to the mouthpiece deposited an average of 5.025 mg of medication.

Design Status and Future Steps

Design Status

The intial ReLung prototype has been completed and evaluated based on our design criteria and fits our expected design specifications. We successfully created an inhaler prototype capable of depositing dry powder medication to lungs in a similar fashion to industry standard inhalers.

Future Work

Further validation testing can assess performance under additional real-world conditions (such as different orientations, inspiratory flow rates, and environmental factors). Usability testing with target populations, such as pediatric and elderly users, could help identify potential operational challenges. The device has potential for future patent filing or industry collaboration to support continued development. Regulatory approval would require submission of a New Drug Application (NDA), which would rely on partnership with a pharmaceutical company for testing, manufacturing, and compliance.

Acknowledgements

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