Automating Reagent Production Process for Use in Microfluidic Chips

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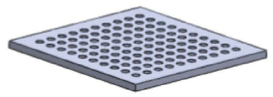
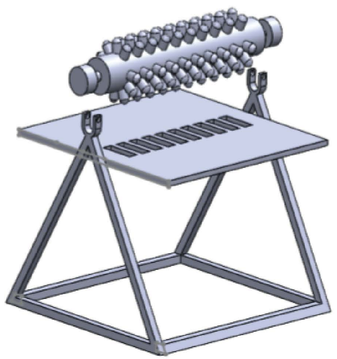
Motivation

Point-of-care diagnostic devices enable rapid disease detection but can require labor-intensive fabrication [1]. This study aimed to automate the lyophilization process for microfluidic chip reagents by designing a 3D-printed rig to transfer frozen reagent pucks [2]. The device was evaluated for efficiency and reagent integrity, demonstrating reduced handling time, improved reproducibility, and minimized reagent loss.

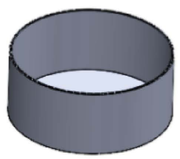
Research Methods



Reagents are frozen in silicone mold at -80°C for a minimum of 15 minutes so that their shape is maintained.



The frozen mold is thawed for one minute or until it becomes flexible. It is then fed through the rig, where the cylinder's pegs align with the mold's wells to press the reagents through the support structure.



As the reagents are ejected, they fall directly into a bowl of liquid nitrogen, flash-freezing them in preparation for lyophilization.

Fig. 1: Process Flow Chart

Results

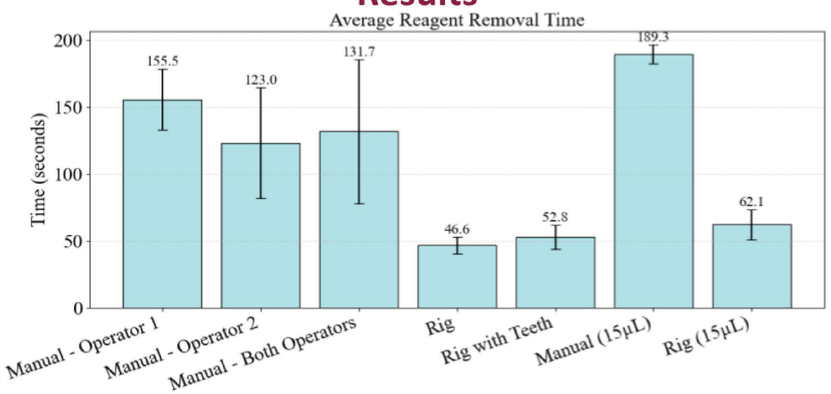


Fig. 2: Average time required to remove frozen reagents across different methods. Rig-assisted approaches significantly reduced removal time compared to manual methods.

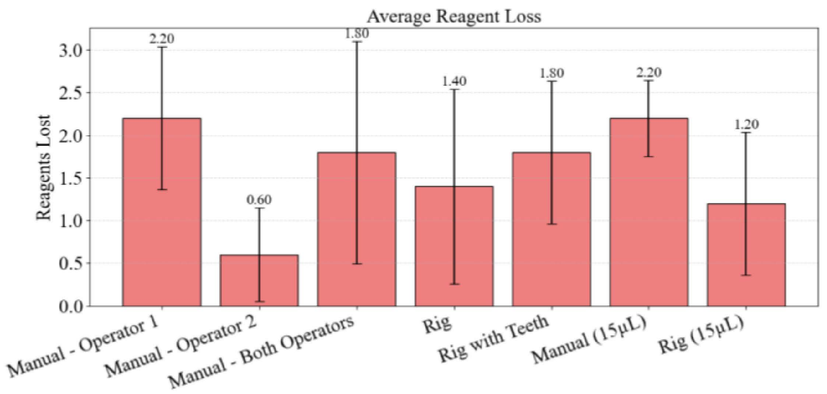


Fig. 3: Average reagent loss by removal method. Rig-based methods maintained comparable viability to traditional manual techniques.

Conclusions and Future Work

- The 3D-printed rig significantly reduced 15 µL reagent removal time compared to manual methods (p<0.001).
- Reagent loss remained consistent between techniques (p=0.087).
- The rig offers an efficient and reliable solution for streamlining the reagent freezing and removal process.
- Refine the mold insertion method to ensure more consistent and replicable use of the rig.
- Utilize multiple supporting components to prevent cross-contamination between different reagents.
- Explore automation of additional steps in the lyophilization process and broader microfluidic chip manufacturing.

Resources

[1] S. Vashist, "Point-of-Care Diagnostics: Recent Advances and Trends," *Biosensors*, vol. 7, no. 4, p. 62
[2] Nayra Oliveira Prado *et al.*, "Development and evaluation of a lyophilization protocol for colorimetric RT-LAMP diagnostic assay for COVID-19," *Scientific Reports*, vol. 14, no. 1

Acknowledgements

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