2017

Development of a Tabletop Soft Gel Encapsulation Machine

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CAPSTONE DESIGN EXPO 2017

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Project number: 201 | **Team members:** Brigitte Ha, Emily Miller, Haya Rizvi | **Faculty adviser:** Christina Tang Ph.D. | **Sponsor:** Pfizer Consumer Healthcare
Sponsor adviser: Mallik Karamsetty Ph.D., John Bachert Ph.D.

Motivation

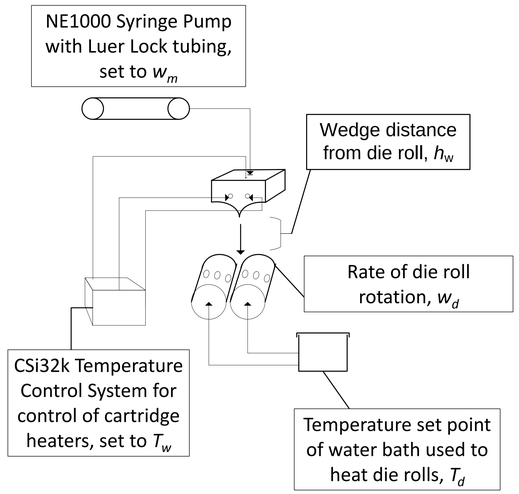
Currently, when the R&D team at Pfizer wishes to test new formulations of material in gel capsules, they must use the large-scale machine that requires a minimum of 25 kg of gel melt and produce hundreds of capsules per run. Production at a smaller scale to enable rapid changeover for research and development is desired.

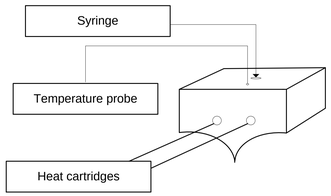
Project Aims

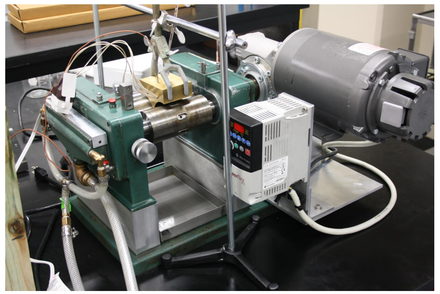
The focus of the 2016-2017 team has been automated production of sealed capsules from premade gelatin ribbons. The specific objectives are to:

- Design and implement localized heating system to promote capsule sealing
- Automate production of sealed capsules
- Achieve liquid filled capsules with 80% of the maximum fill capacity

Design Scheme

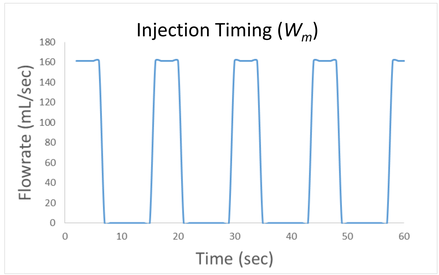






The parameters of interest were:

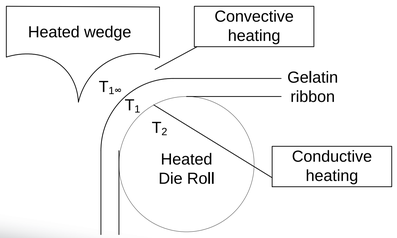
- T_d - die roll temperature
- T_w - wedge temperature
- h_w - wedge height
- w_d - rotational rate of die rolls
- w_m - timing/amount of liquid injected



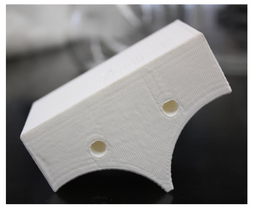
Heat Transfer Considerations

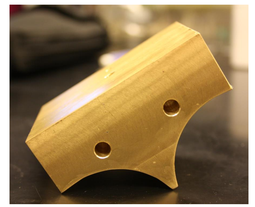
Fin efficiency and convective heat transfer calculations were performed to verify the heated wedge would promote gelatin sealing.

	Without Wedge Heating	With Wedge Heating
Gelatin Surface Temp. (°C)	25	40
Temp. Necessary for Sealing (°C)	38-42	



Results and Discussion

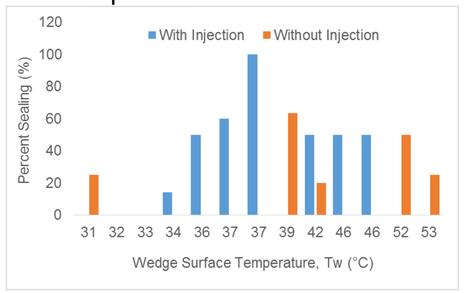


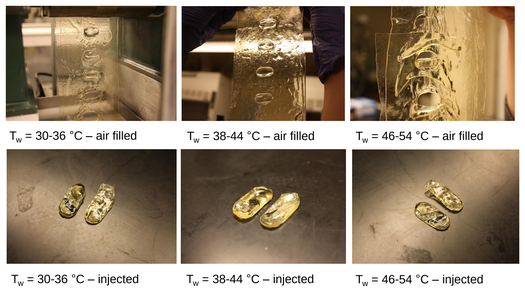


Preliminary testing with a 3D prototype indicated the minimum h_w = 0.9 ± 0.1 cm.

Sealing efficiency (# of capsules sealed/total # of capsules) was measured at

- T_d = 42°C, h_w = 0.9 ± 0.1 cm, w_m = 2.69 mL/min for 2 seconds with a down time of 9 seconds
- Varied T_w, from 31.0 to 55.0 °C , w_d = 0.33- 0.72 RPM to produce 2-4 capsules/min





In general, capsules formed without injection sealed better than those with injection.

- The optimal wedge surface temperature for sealing was 38-42 °C.
- Capsule sealing efficiency was highest at a rate of 4 capsules/min (0.72 RPM). For air filled capsules, a sealing efficiency of 100% was achieved. For capsules injected with model fluid, a sealing efficiency of 50% was achieved.

Conclusions and Future Work

- Sealed, filled capsules were produced continuously at a rate of 4 capsules per minute
- Next steps are to integrate and automate gelatin feed system
- To increase the fill amount, incorporate a vacuum system at the point of capsule formation

Acknowledgements

We would like to thank Dr. Christina Tang, Dr. Carlos Castaño, and Dylan Rodene for their continuous support throughout this project, and would like to thank Pfizer for their sponsorship and cooperation.

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