Manufacturing of a Pressure Vessel for the Micro-encapsulation of Phase Change Materials

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Overview

With the effects of human-driven climate change becoming increasingly present and energy demand ever growing. There is a need for clean, renewable, and affordable energy. Utilizing phase change materials in concentrated solar power operations has emerged as a method of storing thermal energy for heating and power generation applications. These materials are heated past melting and then release stored latent heat energy during solidification. These phase-change materials, however, become degraded with use due to contamination. Micro-encapsulation solves this issue by encasing the phase-change material in a glass layer which protects the material while allowing radiation to penetrate. To perform micro-encapsulation, flow focusing is used. Flow focusing forces high-pressure gas around a stream of liquid to aid in breaking the liquid into consistently sized droplets. This process of micro-encapsulation aims to lower costs and increase manufacturing efficiency to meet the demand for renewable energy. This project focuses on the manufacturing of components for the previously mentioned pressure vessel apparatus.

Materials

- Copper
- G10 Flame Retardant Composite
- Fluxtrol Feutron 559H
- Alumina Ceramic
- Aluminum-Nitride Ceramic

Assembly

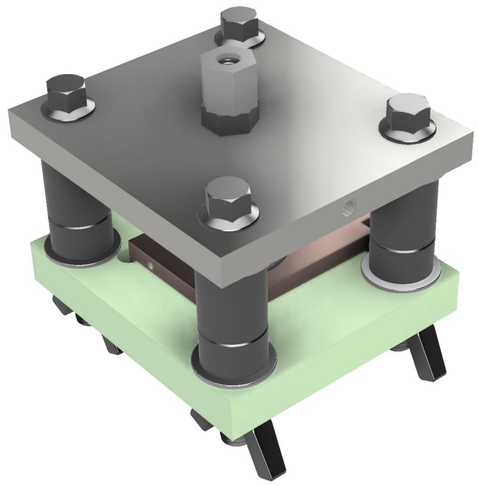

Figure 1: Pressure Vessel Assembly

Parts Manufactured Externally

Figure 2: Steel and Glass Assembly

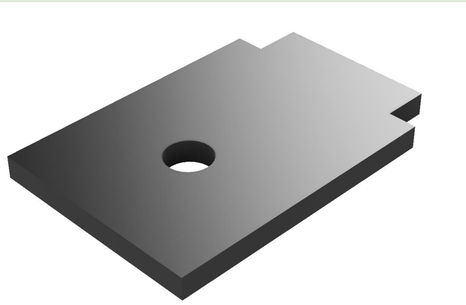

Figure 3: Feutron 559H

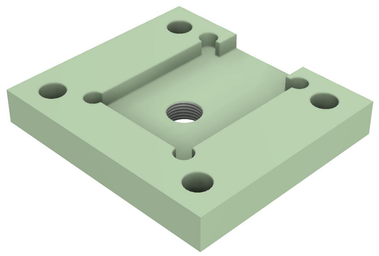

Figure 4: G10 Plate

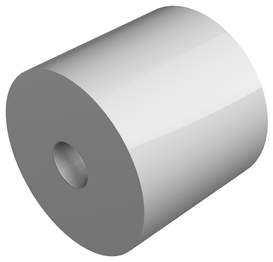

Figure 5: Alumina Ceramic

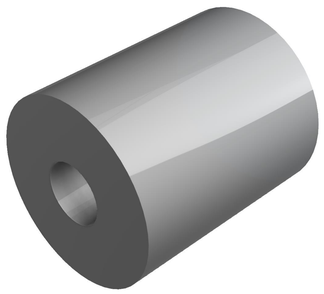

Figure 6: Aluminum-Nitride Ceramic

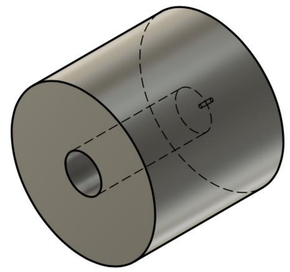

Figure 7: Ceramic Rod Internal Design

Results and Challenges

Results

- External manufacturing of parts complete
- Assembly of pressure vessel in progress

Challenges

- Working with new and advanced materials
- Communication and compatibility issues when working with external machine shop
- Manufacturing limitations on dimensions of design

Conclusion

- High-pressure gas may expand the narrow inlet of the ceramic nozzle
- Copper plate will require addition Wire Electrical Discharge Machining (EDM)

Future work

- Completion of pressure vessel apparatus by end of the semester
- Perform physical testing on ceramic nozzles for expansion under high-pressure