Experimental Investigation Of Bubble Mobility In Porous Media During Resin Transfer Molding

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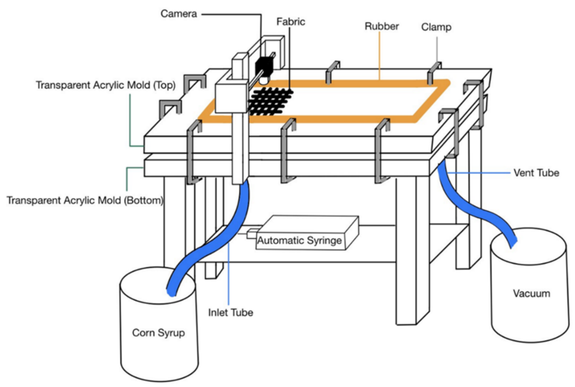
Introduction

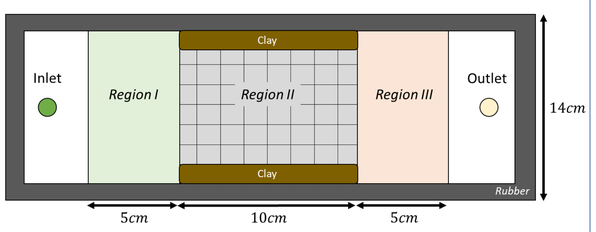
- Liquid Composite Molding (LCM) is a class of manufacturing processes such as Resin Transfer Molding (RTM) and Vacuum Assisted Resin Transfer Molding (VARTM) used to produce composite materials.
- One of the challenges in LCM is elimination of voids or air pockets in the final composite part as they compromise its structural integrity.
- We conducted an experimental study to characterize the bubble movement through the porous media formed by the fabric weave architecture.

Experimental Procedure

Experiment setup



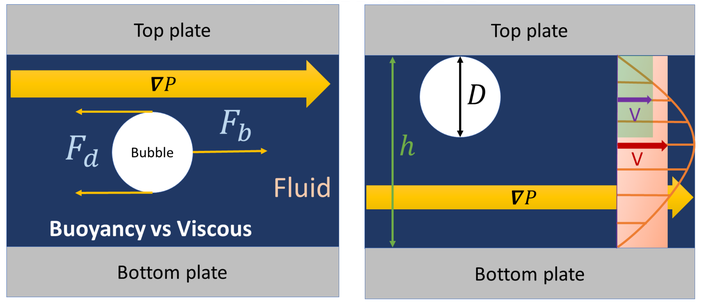
Measurement



Physics-based Modeling

Model I – Bubble mobility between thin plates

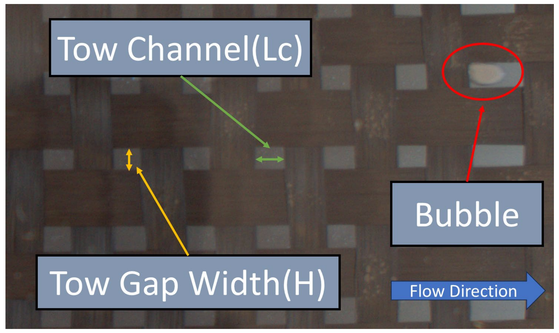
$$Mobility(U) = \frac{v_{bubble}}{v_{fluid}}$$



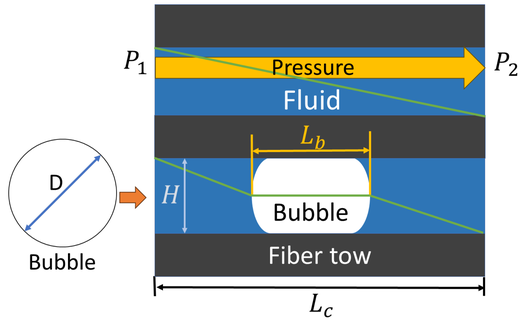
$$U = \left(1 + \frac{2}{3}\left(\frac{D}{h}\right)^2\right)$$

$$U = \left(1 + \frac{2}{3}\left(\frac{D}{h}\right)^2\right) * \left(3 * \frac{D}{h} - 2 * \left(\frac{D}{h}\right)^2\right)$$

Model II - Bubble mobility through fabrics



Experimental Observation: Bubble travelling through the gap between fiber tows in Region II

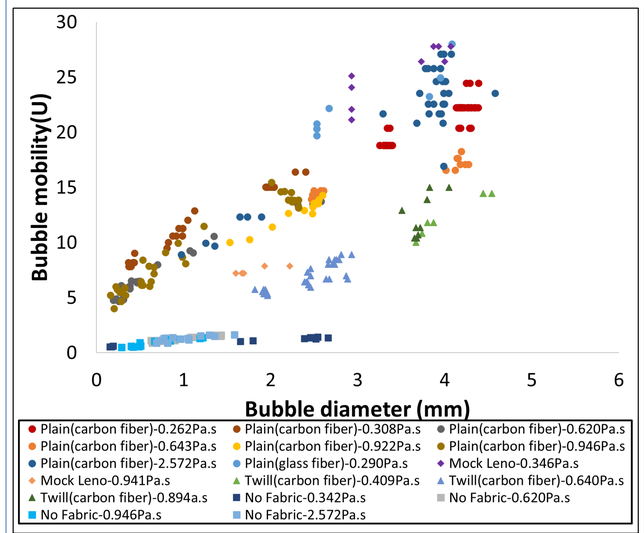


$$L_b = \frac{2}{3}\frac{D^3}{H^2}$$

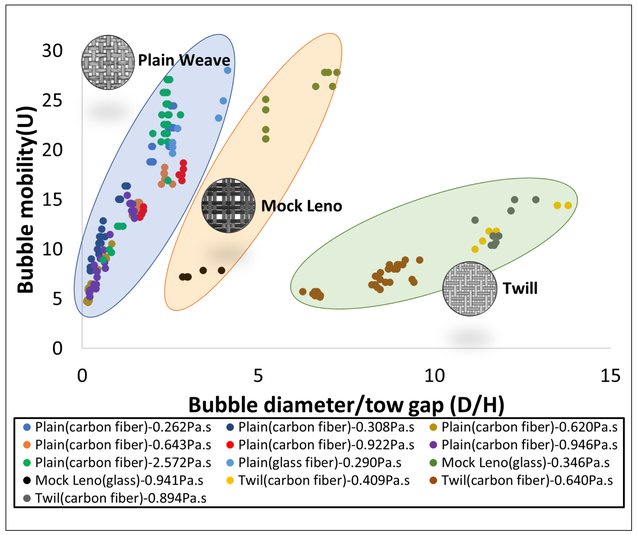
$$U = \frac{1}{1 - \frac{2}{3}\left(\frac{D}{H}\right)^2\left(\frac{D}{L_c}\right)}$$

Results

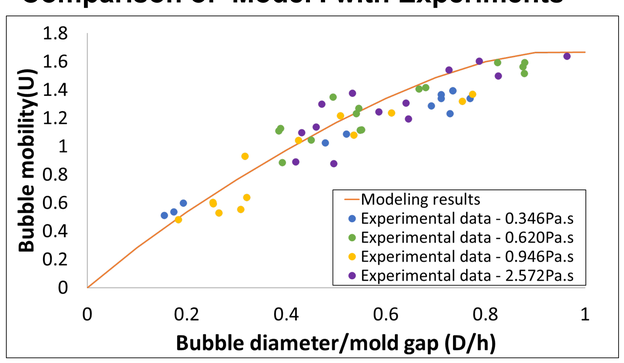
Experimental Data: Bubble Mobility



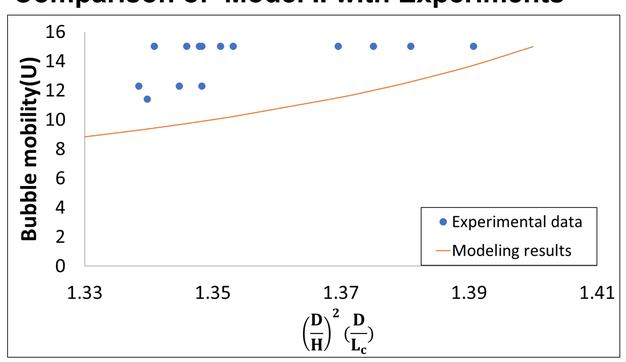
Bubble mobility vs dimensionless bubble size



Comparison of Model I with Experiments



Comparison of Model II with Experiments



Conclusions

Findings

- Bubble mobility is order of magnitude faster through the fabric as compared to between two plates before it enters the fabric.
- Negligible viscosity effect on bubble mobility through porous media.
- Architecture of fabrics affects bubble mobility.
- Larger bubbles move faster through the fabric.

Future approach

- Improve bubble mobility model through the fabric.

Acknowledgements

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