THE UNIVERSITY OF ALABAMA IN HUNTSVILLE | COLLEGE OF ENGINEERING

Research and Creative Experience for Undergraduates (RCEU) Program 2024

Computational Modeling of Resilience, Failure, and Repair of Microreactor Networks

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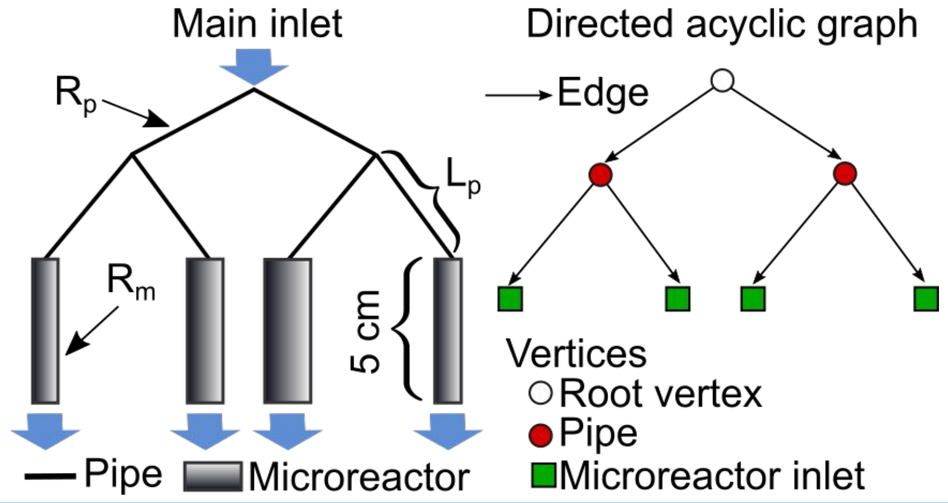
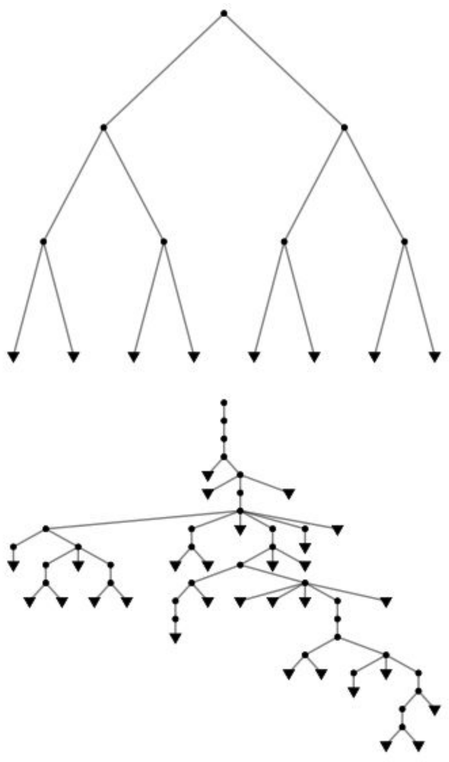
Introduction

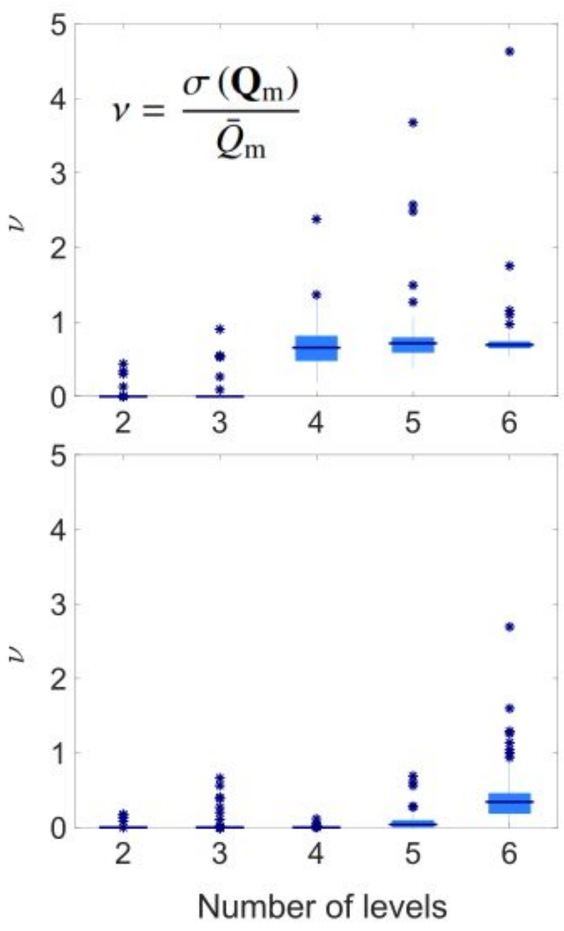
- Microreactors are small devices that facilitate chemical reactions.[1]
- A large number of interconnected microreactors is needed to increase the number of materials made.
- We worked on the best way to connect these microreactors in a network with one common source.
- The networks were evaluated based on their performance, resilience to failure, and ease of repair.

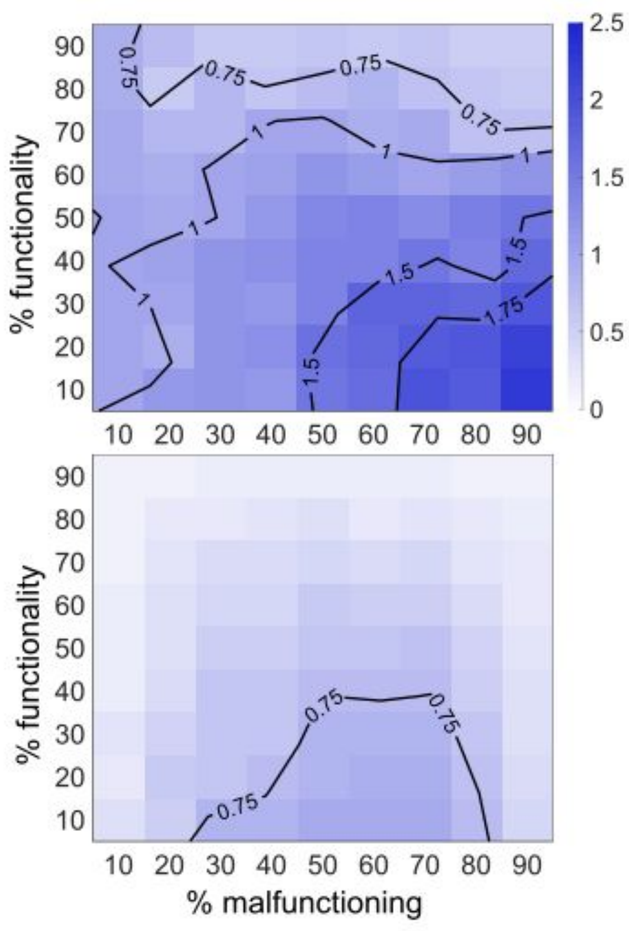


Results



- An irregular microreactor network with small microreactor clusters and similar pipe lengths provides the most uniform flow and resilience against failure of individual devices
- The shorter networks are most likely to achieve performance recovery when repaired.
- All setups have acceptable performance and can sustain substantial damage.





Impact

We discovered how to connect microreactors more efficiently and how well they work when damaged and repaired. This will allow the microreactors to be scaled up into cost-effective networks to create more products while still having all the benefits of using a microreactor over a regular chemical reactor. In the future, we plan to examine larger networks and use advanced tools to design them.

Conceptual Framework

It is already known that microreactors are safer, more efficient, and more easily controlled than regular-sized chemical reactors. Putting microreactors into networks can increase the production volume; however, it is difficult to find the proper way to chain these devices together so that each microreactor operates with the same volumetric flow rates of reactants while the connections remain economical[2]. Our designs were inspired by experimentally studied hierarchical microreactor networks[3] and graph theory.

References

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2. Zhang, Jisong, et al. "Design and scaling up of microchemical systems: a review." Annu. Rev. Chem. Biomol. Eng. 8.1 (2017): 285-305.
3. Nagaki, Aiichiro, et al. "Design of a numbering-up system of monolithic microreactors and its application to synthesis of a key intermediate of valsartan." Org. Process Res. Dev.20.3 (2016): 687-691.

Acknowledgements

All RCEU projects were sponsored in part by the Alabama Space Grant Consortium, the UAH Office of the President, Office of the Provost, Office of the Vice President for Research and Economic Development, the College of Science, the College of Arts, Humanities, and Social Sciences, and the College of Education.

Alabama Space Grant Consortium — Industry University Community — est. 1989

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