College of Engineering
Department of Mechanical & Industrial Engineering

College of Engineering
School of Electrical Engineering & Computer Science

To Predict ▶ To Design ▶ To Perform

ME, ECE Capstone Design Programs

Jack Rettig

Team 13: 3D-Printed Micro-Reactor

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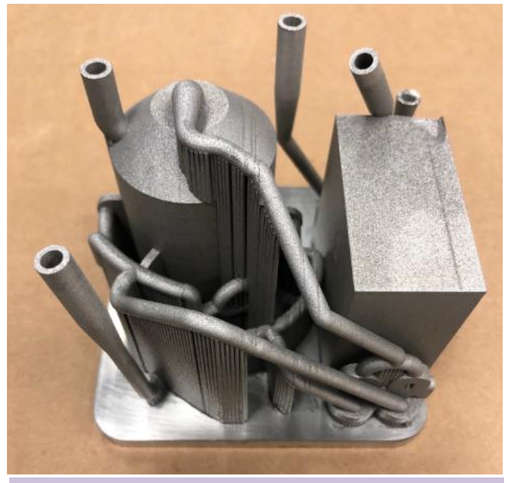
Objective

To create a 3D-printed micro-scale chemical reactor that continually synthesizes product using heat exchanging elements to increase the efficiency and speed of reaction.

Engineering Specifications	Value
Pressure Drop	≤ 1 atm
Maximum Operating Pressure	≤ 2 atm
Maximum Size	90 x 90 x 80 mm^3
Residence Time	≤ 20 min
Manufacturing Budget	≤ $2700
Reaction Yield	≥ 95 % Reaction Completion
Flow Rate	≥ 15 mL/min

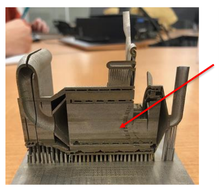
Manufacturing Results

First, supports must be added to SolidWorks model.

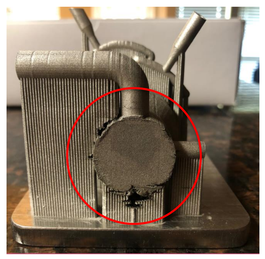


Final print completed after ~50 hours

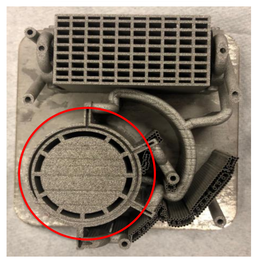
First test print



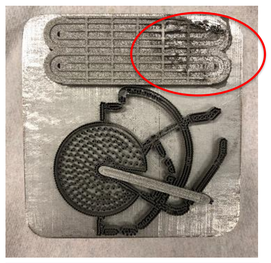
First test print was sliced for internal analysis. Horizontal pipes with a diameter larger than 50 mm require internal supports to prevent sagging.



First test print w/ failure due to damaged wiper blade

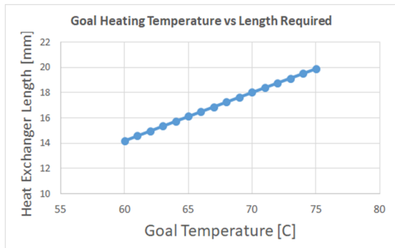


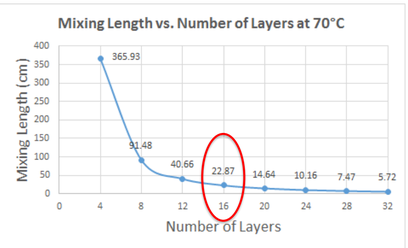
Second attempted print w/ failure due to software



Third attempted print w/ failure due to dosing

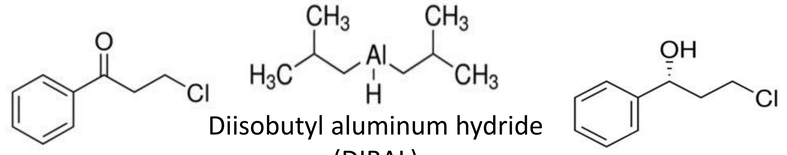
Diffusion & Heating Analysis





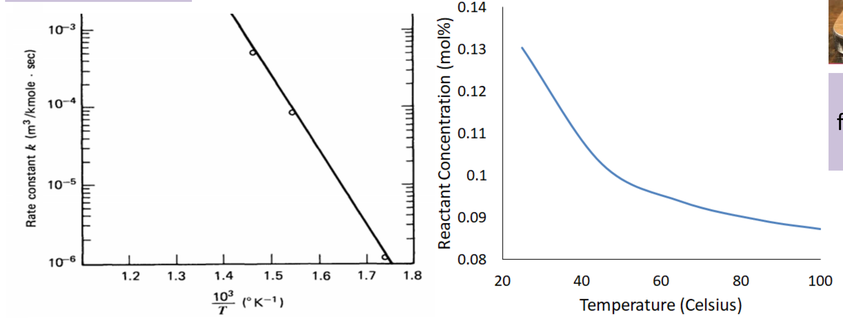
Safety Concern	Safeguard
Chemical inhalation	Operation under vacuum hood
Pressure buildup	Pressure gauges to monitor pressures
Heated metal surfaces	Reactor protected from contact during operation
Leaking	Operating under low pressure to reduce leaks
Operator safety	PPE including gloves, goggles, respirator & coveralls

Reaction Testing



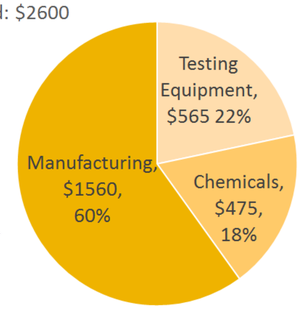
1-Chloropriophenone (CPP) → Diisobutyl aluminum hydride (DIBAL) → 3-Chloro-1-phenyl-1-propanol (CPPOL)

Kinetics Results:



Hill, C. G., & Root, T. W. (2014). *Introduction to chemical engineering kinetics and reactor design*. Hoboken, NJ: Wiley.

Budget: $5000
Total Used: $2600



Sept-Oct	Oct-Jan	Jan-Mar	Mar-Apr	Apr
Concept Generation & Reaction Selection	Engineering Analysis & Prototype Design	Chemical Experiments & Test Prints	Testing & Validation	Final Results

Sponsors: Chevron Corporation, Mr. Jack Rettig, Dr. D. E. Nikitopoulos Advisers: Dr. Kevin McPeak, Mr. Jim Melancon