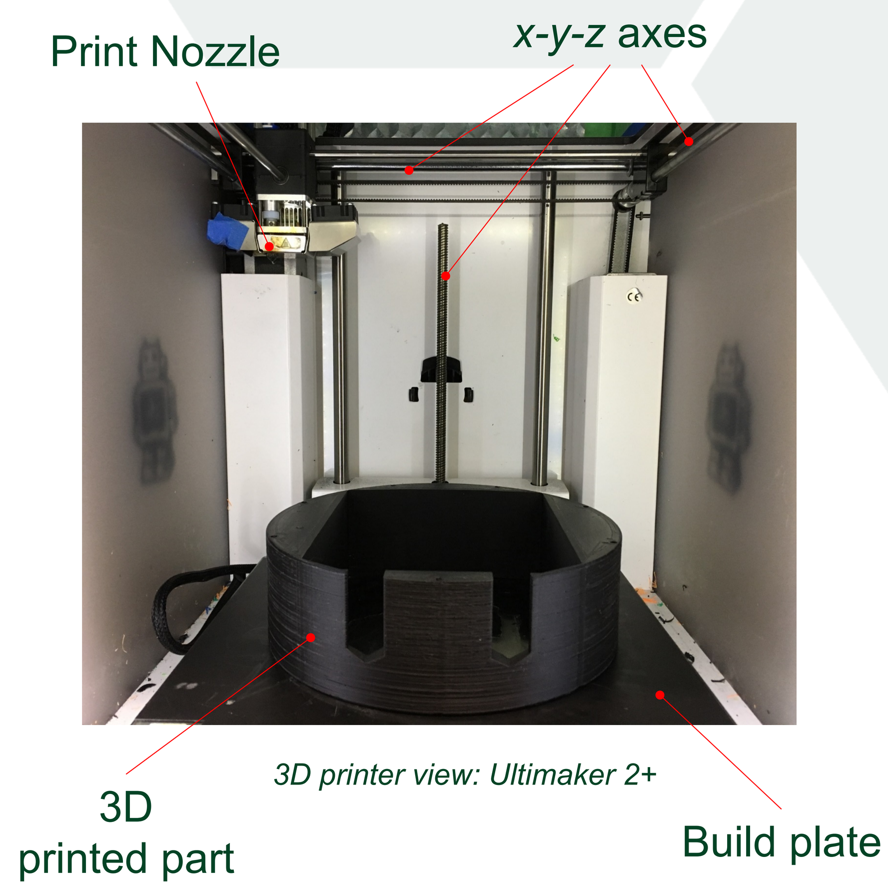
Effect of Coating on the Pressure Withstanding Capacity of 3D Printed ABS Cylinder

Gabriel Salata[1], Cagri Ayranci[1], David S. Nobes[1]

BACKGROUND

3D printing or additive manufacturing technology is becoming more common in manufacturing. It is capable of producing complex geometry parts faster and cheaper than traditional machining processes. This opens the scope of geometries for Stirling engine design. However, this technology has not been optimized to withstand pressure, raising concerns whether the layer-by-layer printing process can create 3D printed parts that will seal.



3D printer view: Ultimaker 2+

AIMS AND OBJECTIVES

This study aims to understand the effect of coating on 3D printed ABS parts for sealing. The respective capacities of (i) raw 3D printed ABS, (ii) spray painted 3D printed ABS and (iii) 3D printed ABS coated with epoxy to withstand pressure will be investigated. Form this design procedures for printing complex geometries for Stirling engine part that require pressure capability will be developed.

Bubbles indicating leakage

Spray painted sample

EXPERIMENT AND RESULTS

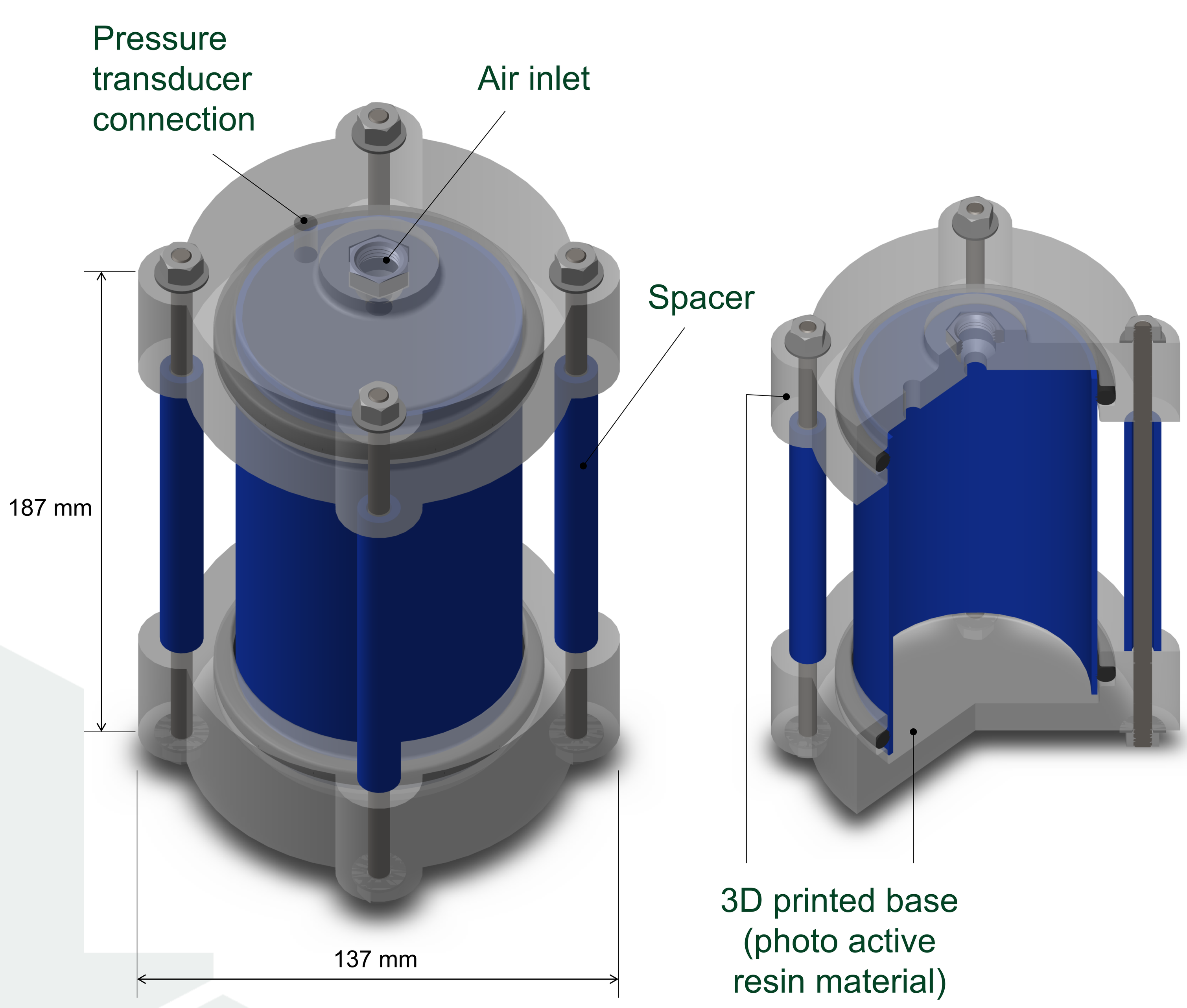
The experiments were conducted using the pressure vessel shown in the figure below. The main components include:

- Two 3D printed support bases (photo active resin material)
- Four rods connecting the bases
- One spacer for each rod (ABS) to control the distance between the support bases, avoiding compressive loads into the cylinder

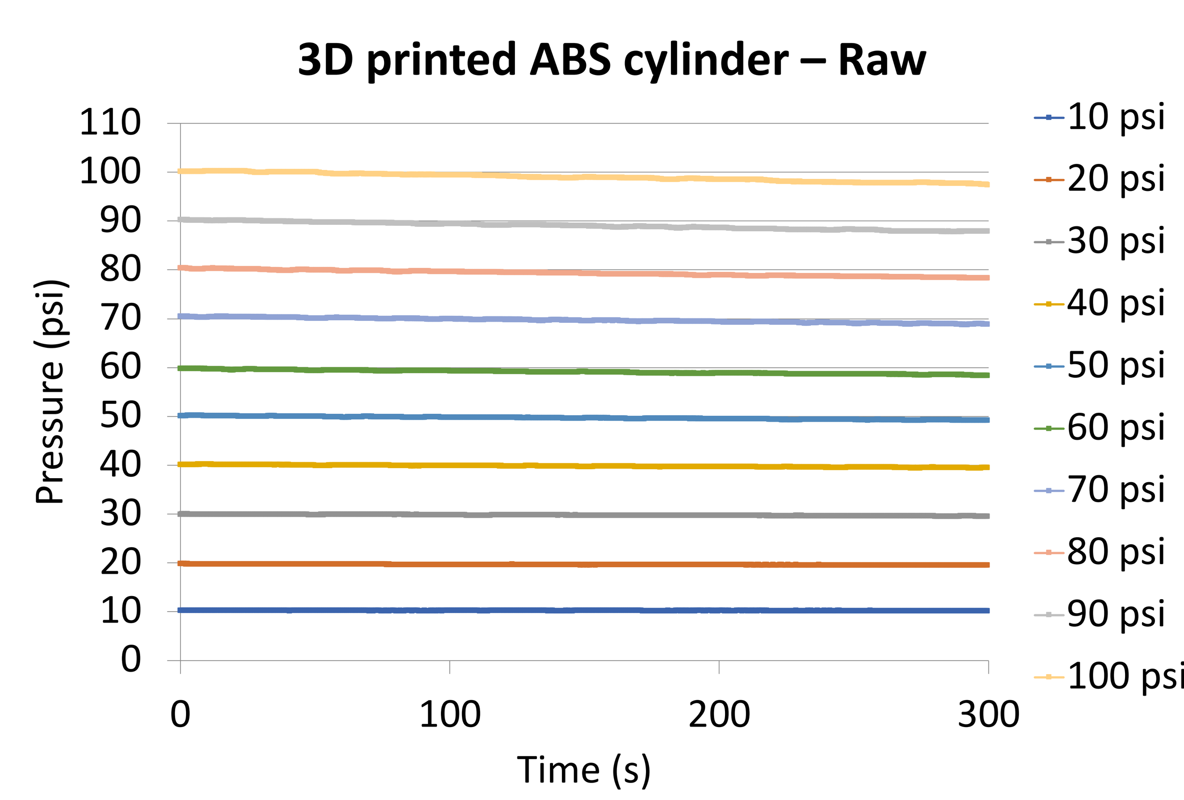
For each experiment, the following was undertaken

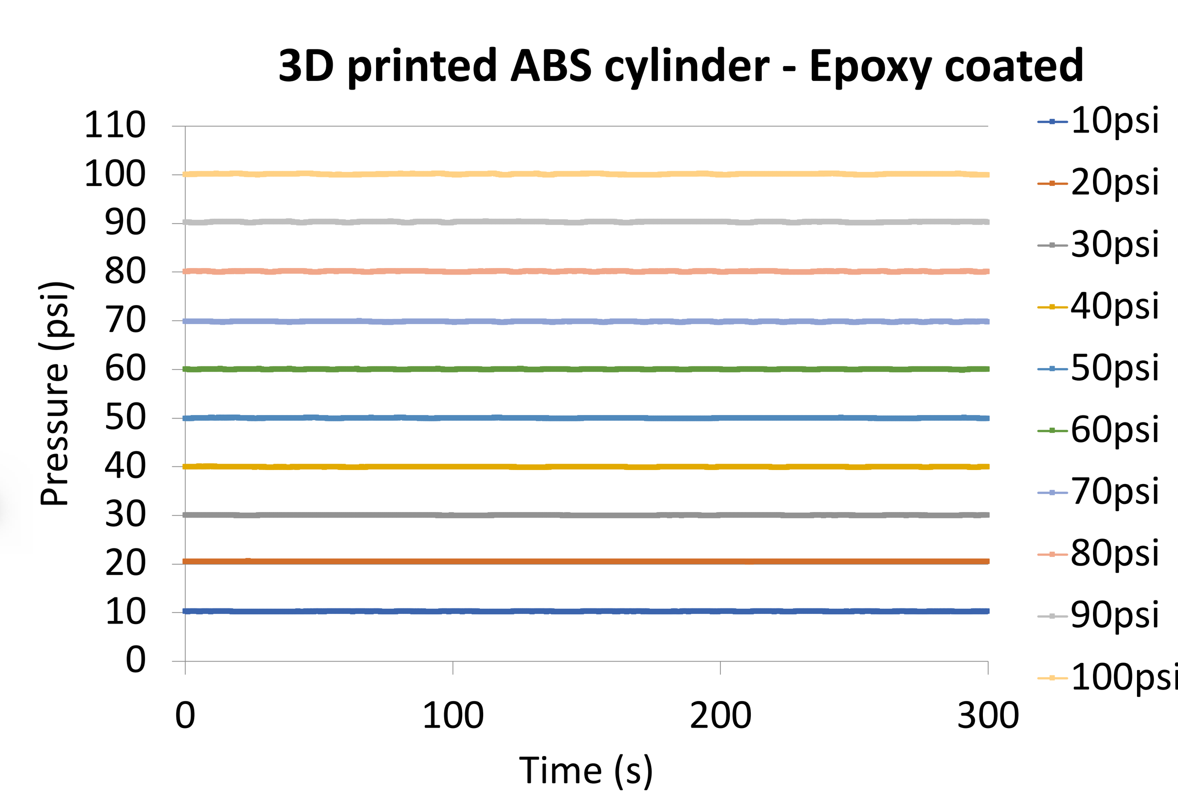
- Using air pressure was applied in steps of 10 psi and held for 5 min.
- A maximum pressure of 100 psi was applied for all specimens.
- A commercial pressure transducer was used to measure the pressure
- Pressure was logged to computer for later processing

.



Leakage was observed in the raw, and spray painted cylinders whereas epoxy-coated samples could withstand the maximum pressure (100 psi) without any leaking.





SUPPLEMENTARY STANDARD TENSILE TEST

Supplementary tests were also conducted on 3D printed ABS dog-bone samples to determine tensile strength properties

FUTURE DIRECTIONS

- Investigate printing and coating requirements to achieve effective sealing
- Measure cylinder stiffness and distortion under load using digital image correlation (DIC)
- Develop model and design approach for computer aided design (CAD) of these parts

PARTNERS

- Alberta Innovates
- Terrapin Geothermics Inc.

FES PROJECT OVERVIEW

This Future Energy Systems (FES) project is part of the Geothermal Theme, entitled **Optimizing Geothermal Energy Production and Utilization Technology** (FES T05_P03) With the vast amount of energy available in geothermal reservoirs identified throughout Alberta, a new technology is need to access and convert this low grade heat into a useful form. This means converting available fluid temperatures, typically <100 ℃ into electricity or space heating. This project focuses primarily on the development of proof-of-concept and viability studies of ultra-low maximum temperature (ULT_{max}) Stirling engines, their design and the development of predictive models for system scale up and development

[1] Department of Mechanical Engineering, University of Alberta

UNIVERSITY OF ALBERTA
FUTURE ENERGY SYSTEMS

CANADA FIRST
RESEARCH EXCELLENCE FUND

This research has been undertaken thanks in part to funding from the Canada First Research Excellence Fund.