Low-Profile, Smooth-Walled Inner Pipe Sealing Insert for Low-Pressure Applications

Project highlight. A pipe sealing technology design for a low-profile, smooth-walled, inner pipe sealing for low-pressure applications as been established. Various tests and designs have been demonstrated to test its effectiveness.

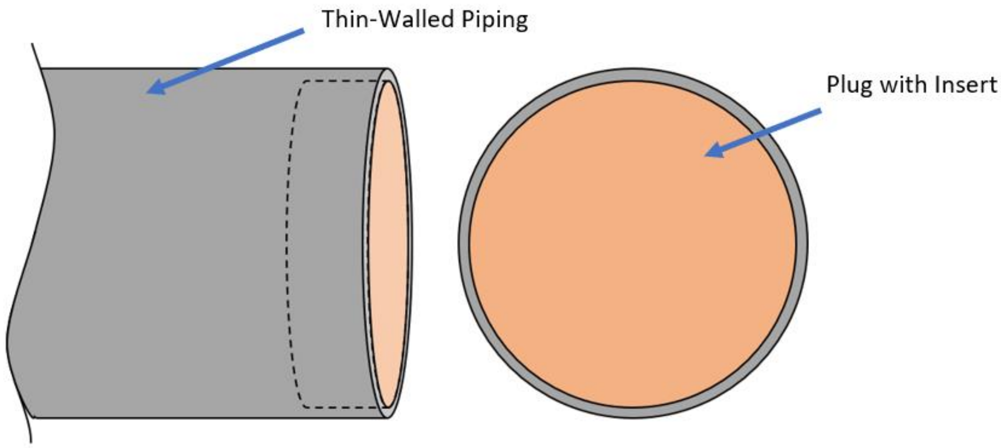

Figure 1. Plug inside thin-walled tube with undisclosed fitting.

Intellectual Property Review

This report has been reviewed by SRNL Legal Counsel for intellectual property considerations and is approved to be publicly published in its current form.

SRNL Legal Signature

Signature **Date**

Low-Profile, Smooth-Walled Inner Pipe Sealing Insert for Low-Pressure Applications

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Project Type: Seedling

Project Start Date: October 1, 2019
Project End Date: September 30, 2020

This is a low-pressure (above ambient pressure) sealing insert for use inside smooth-walled piping where the pipe walls are too thin to have threads turned. It is installed inside the piping because some applications cannot clamp to the outside of the pipe. It is low profile because some applications cannot have their pipe lengths extended. The low-pressure plug is created by a two-piece construction consisting of a tapered polymer component that is press-fit into the end of the pipe, paired with a metal cylindrical component that is press-fit into the polymer. This design is selected to increase the sealing friction against the inner pipe walls.

FY2020 Objectives

- Create various designs then test its maximum pressure.
- Reach 200 psi in maximum pressure. If the plug reaches this goal, it is deemed effective for miscellaneous low-pressure applications.

Introduction

The current market of pipe sealing technologies includes being high profile (pipe seal extends past or wraps around the length of the pipe) and having a modified inner pipe wall (the inner pipe walls are fabricated to have threads for the seal) designs. However, there are applications where a pipe sealing technology must be low-profile (pipe seal does not extend past or clamp around the length of the pipe) and have a smooth-walled inner pipe (the inner pipe walls may not have threads or be modified).

Therefore, the design of a low-profile, smooth-walled, single-use inner pipe sealing technology for low-pressure applications was designed. Originally, the concept was designed for the UUV alane-based hydrogen storage system for the US Navy that require these design constraints. However, this design has commercial potential in any industry that has a need for similar design constraints. Since a concept of a plug insert for a low-profile, smooth-walled, thin-walled, low-pressure application does not exist, the design by SRNL can be patented and thus be used for commercial purposes.

Before patenting the design, experimental tests must be conducted to prove the effectiveness of the design. This report will detail the designs and pressure burst test results to determine its effectiveness.

Approach

To test the effectiveness of the pipe sealing technology, experimental tests must be carried out to determine the maximum pressure inside the sealed pipe before the seal bursts or leaks. Like Figure 1, various designs of the pipe sealing technology ("plug") have been drawn and fabricated to determine which design will be the most effective. With the designs, each pressure bursting test will be repeated to confirm consistent results.

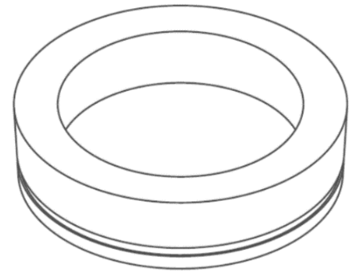

Figure 2. Final plug design.

Results/Discussion

Due to a pending patent, the specifics of the plug design are not disclosed in this report. Specifically, the details omitted include the variations of the design that lead to how the plug fits into the tube. Instead, ten different design parameters were consolidated into a legend with their appropriate pressure reading, as seen in Figure 2.

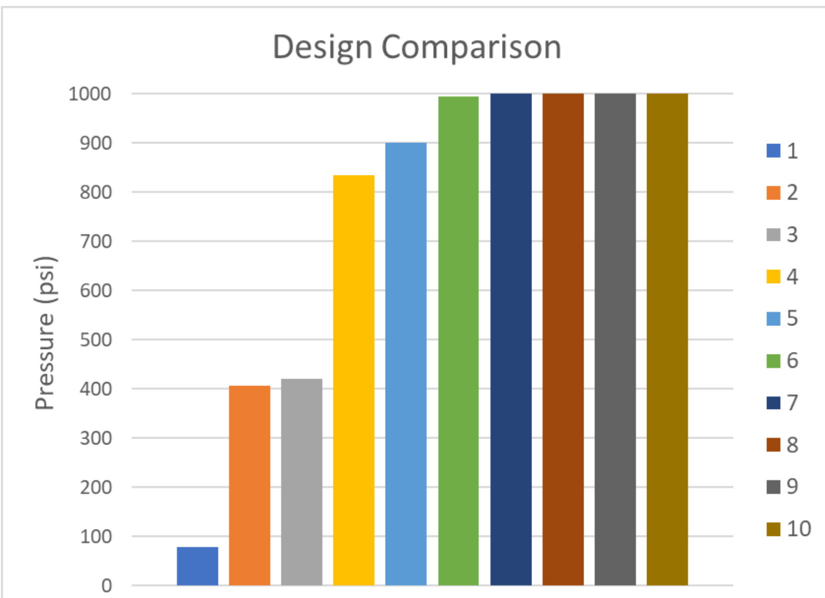

Figure 2. Visual comparison of design effectiveness.

Legend	Pressure (psi)
1	79.68
2	405.88
3	421.81
4	835.29
5	900.63
6	995.37
7	1001.02
8	1001.07
9	1000.20
10	1001.01

Table 1. Maximum pressure of ten designs.

The designs can be fabricated, assembled, then tested for a pressure burst. This is done by enclosing the pipe with an inert gas such as nitrogen or argon, then stop the test when there is a drop of pressure indicating a plug burst or leak. After testing, the maximum pressure of the plug design is found to be 1000 psi, as seen in Table 1. The initial goal is to reach 200 psi, but the plug design exceeds it by five times, thereby concluding this project to be a success. Since the testing set-up was not built to exceed a pressure of 1000 psi, the test is stopped if the pressure exceeds that. Because of this, Designs 7 through 10 likely have a pressure exceeding 1000 psi. The pressure versus time graph of Design 10 is seen in Figure 3.

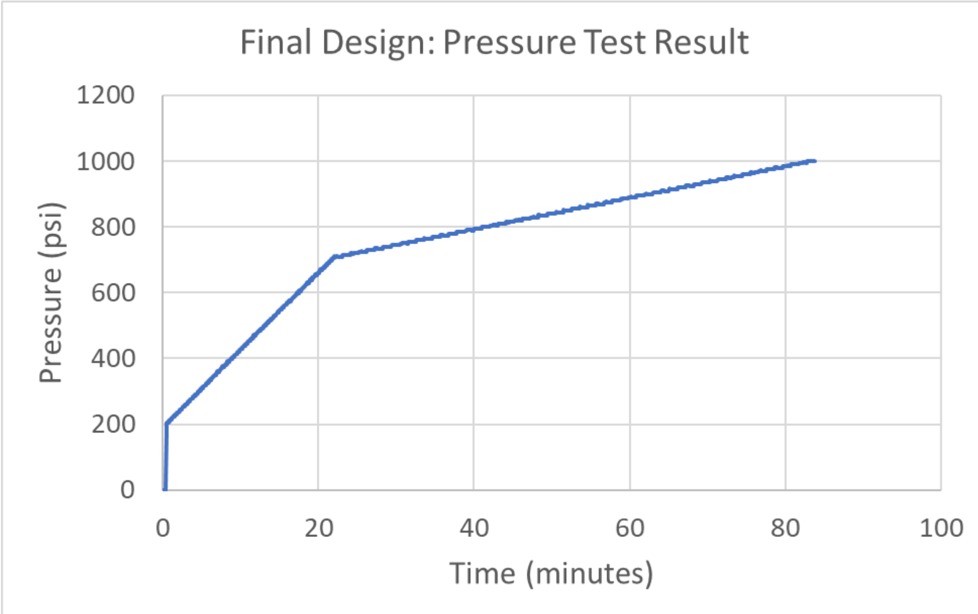

Figure 3. Maximum pressure of plug with the final chosen design parameters.

FY2020 Accomplishments

- Designed a low-profile, smooth-walled inner pipe sealing plug with a maximum pressure of 1000 psi, far exceeding the original goal of 200 psi for low-pressure applications.

Future Directions

With more funding, the following can be done to improve the results:

- Select different materials with the same design to further increase maximum plug pressure.
- Utilize a furnace for testing to determine the change of performance with higher temperature environments.
- Determine which of the four designs (Designs 7-10, per Figure 2) were the most effective.

Acronyms

- SRNL– Savannah River National Laboratory
- UUV – Unmanned Underwater Vehicle

Intellectual Property

Patent review pending per OSR 3-188.

External Collaborators

- Richard Douglas (Douglas Fluid & Integration Technology, LLC) performed the pressure burst tests.
- Michael Brown (SRNL, R&D Engineering) created the LabView program for pressure burst testing.