Non-Invasive Pipeline Unplugging Technology for Hanford High-Level Waste *Asynchronous Pulsing System*

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Abstract

With the plugging of pipelines obstructing the transfer of high-level waste (HLW) from single shell tanks (SSTs) to double shell tanks (DSTs), effective unplugging technology is prudent. Commercial techniques utilize invasive methods that lead to contamination and subsequent clean-up. FIU's Applied Research Center has developed a non-invasive unplugging technology that can prove advantageous in the transfer of high-level waste, the Asynchronous Pulsing System (APS). This is based on the principle of utilizing asynchronous pressure waves on either end of the plug in order to clear the pipeline blockage.

Introduction

- During the transfer of high-level waste from SSTs to DSTs, the pipelines utilized have become plugged.
- Commercial unplugging technologies made available to the DOE have proven ineffective in clearing the plugged pipeline.
- FIU's Applied Research Center has developed the Asynchronous Pulsing System off the principle of clearing the blockages with pressure waves.
- The asynchronous waves are utilized to create a pressure differential large enough to clear the blockage without compromising the integrity of the pipeline.

Figure 1: Asynchronous Pulsing System test platform.

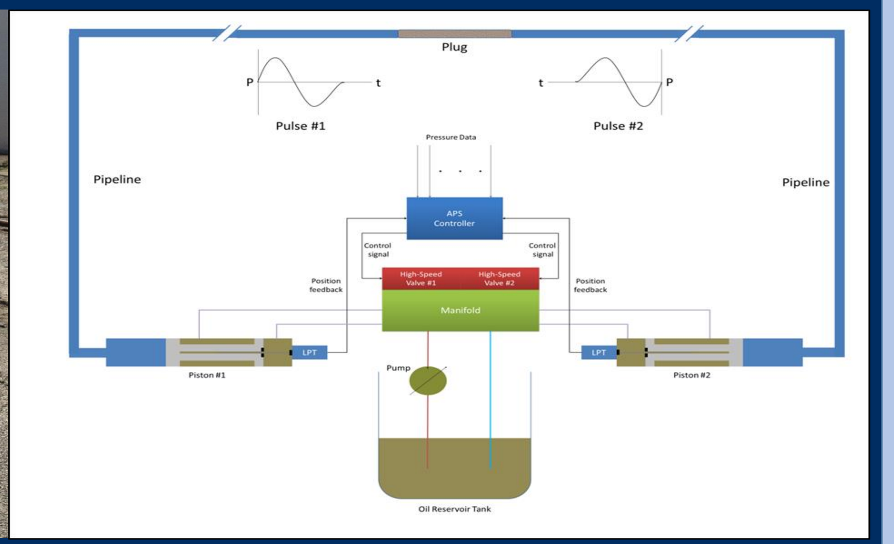

Figure 2: Asynchronous Pulsing System diagram with elements labeled.

Testing

Parametric Testing

- Parametric tests were conducted to determine optimal operating parameters for pipeline unplugging.
- All tests were performed with a static pressure of 50 psi and a simulated plug made from a solid piece of aluminum.
- Types of pulse waves: saw tooth, triangle, square, sine.

Pulse Amplitude (PSI)	Pulse Frequency (Hz)							
10	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
25	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
50	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
100	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0

Table 1: Parametric Test Parameters

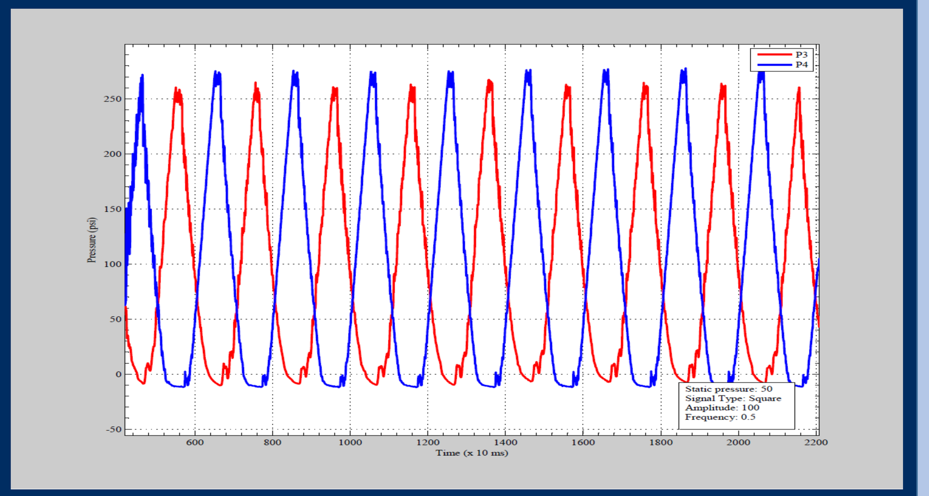

Figure 3: 100 psi amplitude with a 0.5 Hz pulse frequency.

Unplugging tests

- Utilized kaolin-plaster plugs which mimics the physical behavior of HLW plugs.
- Optimal plug strength obtained when the weight-percent ratio of 35% kaolin, 35% plaster of Paris, 30% water.
- A test matrix was developed that produced the greatest pressure differential across the plug, and included triangle, square, and sine wave types.
- Pulse frequencies of 1, 2, and 3 Hertz were used in the unplugging tests. All tests were conducted at 50 psi static pressure, and 100 psi pulse amplitude.

Pulse Wave Type	Pulse Frequency (Hz)		
Triangle	1.0	2.0	3.0
Square	1.0	2.0	3.0
Sine	1.0	2.0	3.0

Table 2: Unplugging Test Parameters

Figure 4: Plug blowout test.

Results

- Just as observed in the parametric tests, when the pulse frequency increased, the pressure amplitude decreased.
- The triangle waves had the greatest average amplitude, followed by the sine waves, and finally the square wave. (The saw tooth wave was omitted due to its tendency to allow the pulse waves to deviate.)
- The shortest time to clear the plug was with the triangle pulse wave at 2 Hz, while the longest was with the triangle pulse wave at 3 Hz.
- As can be seen in the graph below, the pulse peaks become flat as the plug becomes dislodged.

Pulse Wave Type	Pulse Frequency (Hz)	Unplugged (Y/N)	Average Pressure Amplitude (PSI)	Cycle Count	Cycling Time (min)
Triangle	1.0	Yes	192.5	1973	33
Triangle	2.0	Yes	96.5	2805	23
Triangle	3.0	Yes	92.5	15818	88
Square	1.0	Yes	162.5	2708	45
Square	2.0	Yes	123.5	4344	36
Square	3.0	Yes	97	9892	55
Sine	1.0	Yes	180.5	1816	30
Sine	2.0	Yes	106	5113	43
Sine	3.0	Yes	82.5	8162	45

Table 3: Unplugging Test Results

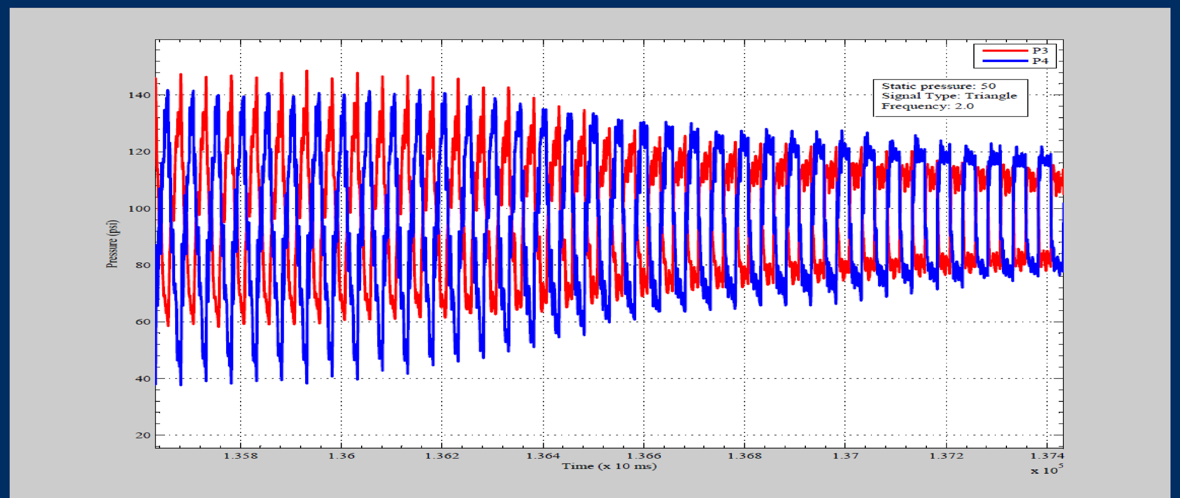

Figure 5: Pressure pulses during an unplugging at 2 Hz triangle wave.

Future Work

- In the next phase of testing the effect that air entrainment has on the APS will be observed.
- Attempts will also be made to quantify the maximum amount of air in the pipeline where the APS can operate effectively.

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