



Innovative High-Level Waste Pipeline Unplugging Technologies for Hanford Site

Asynchronous Pulsing System

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ABSTRACT

The development of efficient unplugging technologies is critical to the transfer of High Level Waste (HLW) through pipelines. Pipeline blockages have remained a major issue in decommissioning facilities such as the Hanford Site located in Washington. In the event a blockage occurs within these pipelines, a reliable cost-effective method is being developed. As part of work being performed for DOE-EM, Florida International University has developed the Asynchronous Pulsing System (APS). The objective of this technology is to dislodge blockages by creating an asynchronous pressure disturbance at both ends of the blocked section of the pipelines.

BACKGROUND

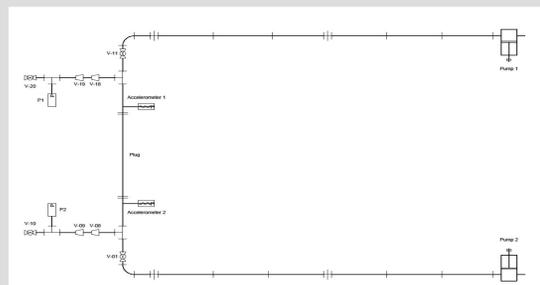
Currently, there are no commercially available pipeline unplugging technologies suitable for the removal of plugs occurring in High-Level Waste transfer lines at Hanford site, the most significant problem being that most unplug using high pressures which may damage the pipeline. The maximum pressure rating sustainable for the pipelines at Hanford Site is 350 psi. Additionally, these pipelines are buried approximately 6 ft underground with sharp 90° elbows and contain very few access ports, making it very difficult for monitoring. The Asynchronous Pulsing System was developed to provide a reliable method of unplugging that would adhere to these requirements, in that it would unplug without exceeding the maximum pressure rating and could be operated remotely.

OPERATION

- The Asynchronous Pulsing System (APS) is based on the idea of creating pressure waves in the pipeline filled with water from both ends of the blocked section in order to dislodge the blocking material via forces created by the pressure waves. Below is a sketch of how this technology can be utilized for a typical plugging scenario.



- To simulate a blockage that would occur in an actual waste transfer line, a 3-ft kaolin plaster plug is placed within the test pipeline loop.
- The test pipeline loop was built using 3-inch, schedule-40, threaded carbon-steel pipes and consists of two identical 135-foot pipeline sections with the 3-ft plug located in between. A schematic of this loop as well as actual images of the system can be seen in the figures below.
- The main components of the APS are two hydraulic piston pumps located at the inlets of the pipe sections.
- The hydraulic piston pumps are powered by a hydraulic power unit and two electronically controlled high-speed valves. The APS is entirely controlled using LabView software, in which the frequency and movement of the piston are regulated.



Engineering scale test loop piping and instrumentation diagram



Testbed of asynchronous pulsing system



Hydraulic power unit

MATERIALS AND TESTING

Plug Development

- The main objective behind the plug development was to develop a 3 ft plug with a high shear strength that could withstand a maximum static pressure of 300 psi. In the past, several plugs made from k-mag, kaolin-bentonite, and various combinations of chemicals were tested.
- The results of these tests proved that the kaolin-plaster plug was best at mimicking the physical behavior of actual waste.
- Upon testing, it was observed that the success of making this plug was highly affected by the plug development procedure and conditions. For instance, mixing for a prolonged or shortened time would yield different shear strengths for the same composition.
- Pressure blowout tests were conducted on a variety of 3-ft kaolin-plaster plugs in order to verify that the plugs could withstand a maximum static pressure of 300 psi. Results showed that the optimal plug was a composition of 30% kaolin, 35% plaster and 35% water (by weight) with a 4-day curing time.
- The images below show the set up of the pressure blowout tests and how they were able to unplug the 3-ft kaolin-plaster plug.



Pressure blowout tests on 3-ft kaolin-plaster plugs

CONCLUSION

The pressure limits on the pipelines have introduced a challenge that commercial applications at present time are unable to meet. The Asynchronous Pulsing System is one solution that is able to meet the requirements of unplugging while staying below the pressure specifications required by the DOE. It has been demonstrated that the effects of asynchronous pressure pulses are sufficient enough to break the bonds of the 3-ft simulated kaolin-plaster plug located in between the test pipeline loop. Further testing is needed to conclusively state which specified frequencies and wave types (square, sinusoidal, sawtooth) are the most efficient at unplugging.

RESULTS

After various tests, results indicated that the pressure waves exerted through asynchronous pulsing were effective in unplugging the 3-ft kaolin plug. The images below show the data received from pressure transducers and accelerometers of the Asynchronous Pulsing System before and after unplugging occurred.

- Fig.1 - Represents the pressure data taken from pressure transducers P1 and P2 on each side of the plug face.
 - Before unplugging, P1 started to increase as P2 was decreasing due to water starting to leak past the plug.

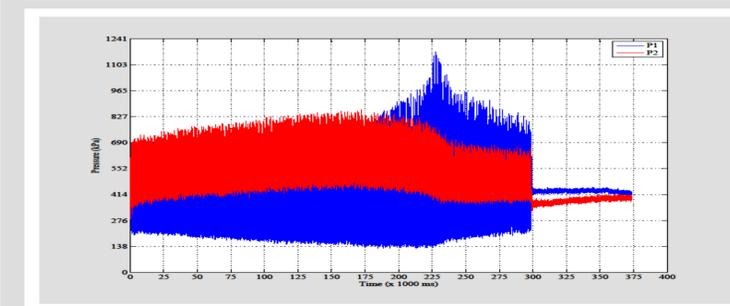


Fig. 1 Pressure data from unplugging of a kaolin-plaster plug at 1.5 Hz

- Fig. 2 - Represents the data taken from the accelerometers mounted on each side of the plug.
 - It can be seen from the graph that the force applied to the pipeline started to increase just before unplugging and reached its maximum when unplugging occurred.

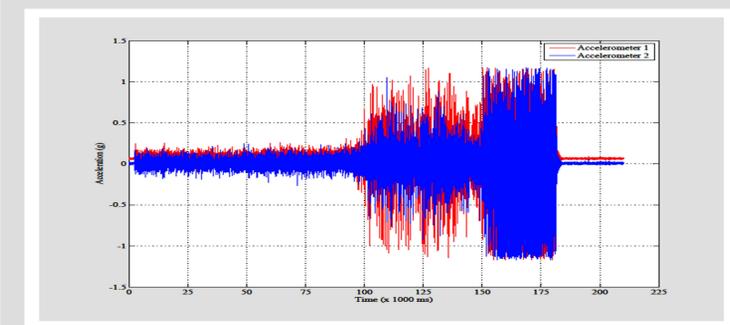


Fig. 2 Pipeline accelerometer data during a 0.5 Hz unplugging

ACKNOWLEDGEMENTS

This research was supported by the U.S. Department of Energy through the DOE-FIU Science and Technology Workforce Development Program. Special thanks to:

- Leonel Lagos, Ph.D. (FIU)
- Jairo Crespo, B.S. (FIU)
- Amer Awwad, P.E. (FIU)



Applied Research Center