Evaluation of Asynchronous Pulsing Unit Pipeline Unplugging Technology

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Background

• The US DOE Hanford Site contains High Level Waste (HLW) with diverse composition.
• Transfer pipelines have become clogged with substances that are very difficult to remove.
• Over the past two years Florida International University's Applied Research Center (ARC) has evaluated a method known as Asynchronous Pulsing.
• Asynchronous Pulsing uses high pressure waves to dislodge material in plugged pipelines.

Experimental Setup

• The HPU creates the pressure "behind" each pump's piston, compressing the fluid in the pipeline.
• Each pipeline segment has one 90-degree elbow, three pressure transducers, and an accelerometer.
• The pistons can be cycled back and forth at a given range of frequencies.
• The plugs will be made of different materials in order to simulate different field conditions.

Optimization

• Over the past thirty years, researchers from various disciplines have come together to develop "evolutionary" optimization algorithms (EA's).
• When coupled with powerful engineering software, EA's are capable of automatically generating optimal designs.
• EA's save time and money, and often produce novel solutions.
• Objective: Maximize Pressure at Plug Surface,

$$ P_{\text{plug}} = P_{\text{inlet1}} \cdot P_{\text{inlet2}} \cdot f_{\text{inlet1}} + f_{\text{inlet2}} $$

$$ \exists \left\{ \begin{array}{l}
0 < P_{\text{inlet}} < 300 \text{ psi} \\
 f_{\text{min}} < f_{\text{inlet}} < f_{\text{max}}
\end{array} \right. $$

Future Work

• The Optimizer Program and FLUENT model of the pipeline are in development.
• The Optimizer will run simulations (usually at least 50 iterations) in order to obtain the best possible (and feasible) configuration of inlet pressures and pulsation frequencies.
• The results will be validated in order to gauge the effectiveness of the optimizer.
• The Optimizer can be extended to handle multiple objectives including maximizing pressure at plug surface, and minimizing the number of pulses required.

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