‘Smarter’ Pump Stations for Pipelines

Overview
The pump station simulation we created uses SIMATIC in TIA Portal Step 7 and a PLC controller to simulate a four pump station for a pipeline. Our simulation provides the user with an intuitive HMI to control pump and valve operations. The user is given real time data on viscosity, flow rate, density, temperature, and efficiency. These values are sent to an optimization team to improve overall system efficiency.

Objectives
To design and test a program using TIA Portal Step 7 PLC programming and WinCC HMI software in order to:
- Simulate a pump station and pipeline.
- Provide a user interface to manipulate and control operating parameters to display real-time centrifugal pump operating curves.
- Simulate different efficiencies for each pump for multiple operating conditions and viscosities.

Approach
- Customer needs and/or requirements were provided by the sponsor.
- The first phase was responsible for designing a single centrifugal pump whereas this phase was responsible for designing a pump station with 4 pumps and 50 miles of subsequent pipeline.
- The primary output to be controlled was flow. To find flow in this simulation, we had to assume that the viscosities of the fluid would remain constant. Each equation was also worked out numerous times to ensure accurate results and appropriate units.
- Integration testing was regularly performed, where both the simulation and optimization teams used PLCs to communicate. Inputs and outputs were continually monitored.
- To confirm the values attained in the simulation, we also worked in MATLAB to produce the results. Static testing was conducted in both MATLAB and the TIA Portal to compare values.

Outcomes
- Designed, programmed and tested a number of subroutines to be vetted by Siemens in order to create a standardized pump station control system.
- A scheme was developed to measure each pump's efficiency for a variety of operating conditions and to then optimize the pump station at that efficiency.
- The results of this project would save millions of dollars over the course of a pipeline’s lifetime.