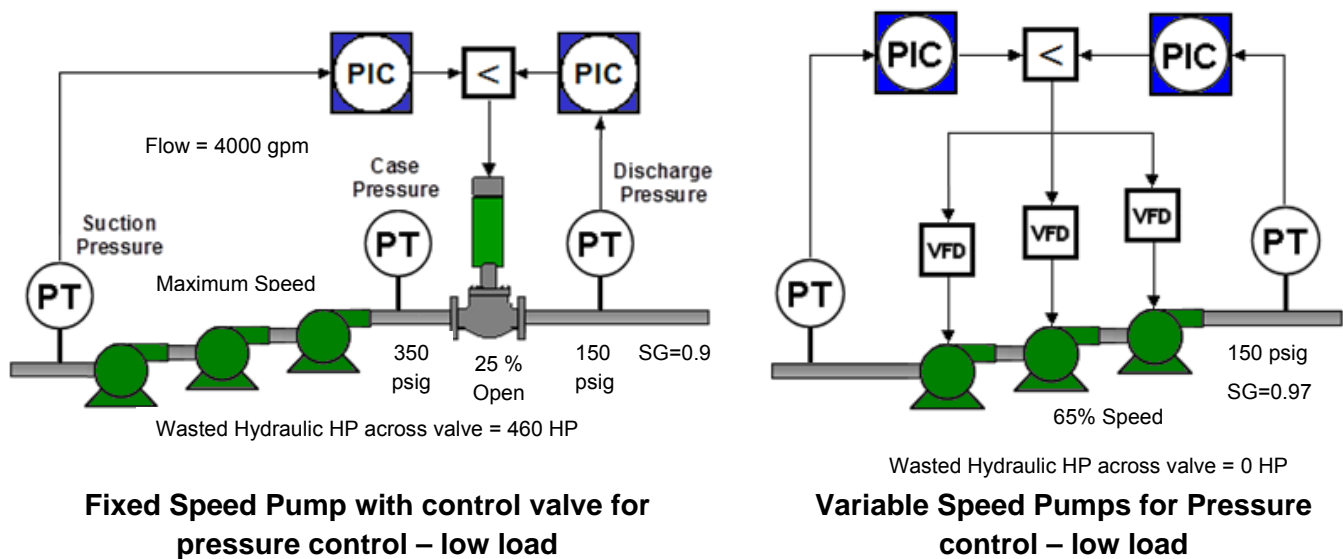


Pipeline VFD Pressure Control Optimization

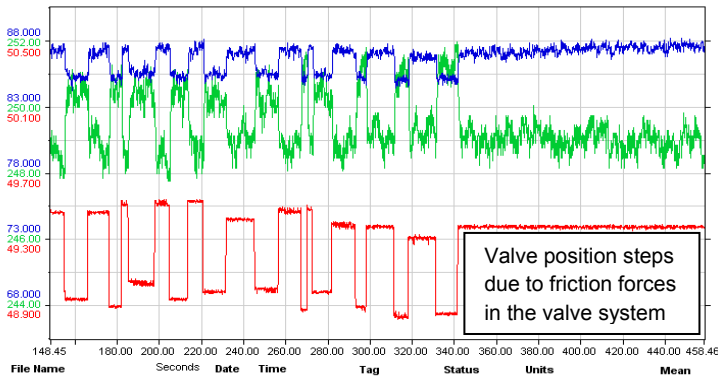
There has been a significant increase in the application of VFD's for pipeline pressure control over the past several years. Why has this occurred? The most common answer is energy savings. With a VFD the pump speed is adjusted so that the pump adds only enough hydraulic energy to match the load required. Conversely, a constant speed pump, using a control valve for pressure control, adds an excess of hydraulic energy that is dissipated across the valve. The wasted energy across the control valve can be substantial, particularly at low load conditions, as shown in the example below.



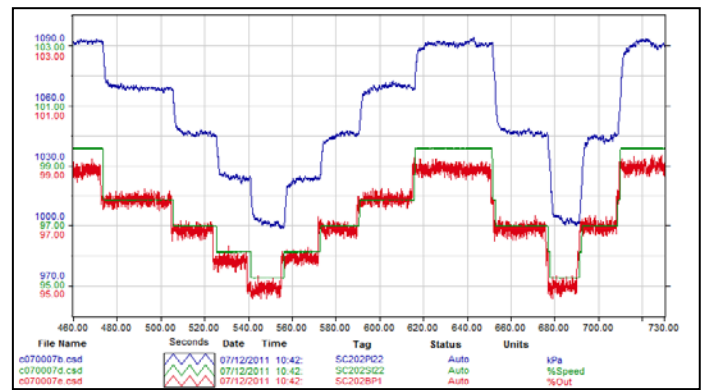
A less common answer is the potential for improved control performance. From the control perspective the VFD has several inherent advantages versus a fixed speed pump / valve combination.

- The VFD is invulnerable to the problems of backlash and stiction
- The VFD pressure loop process gain is typically more linear. With a fixed speed pump / control valve combination, there is often a 'low gain' region as the valve opens above 50%.
- The pressure loop dynamics are often faster.

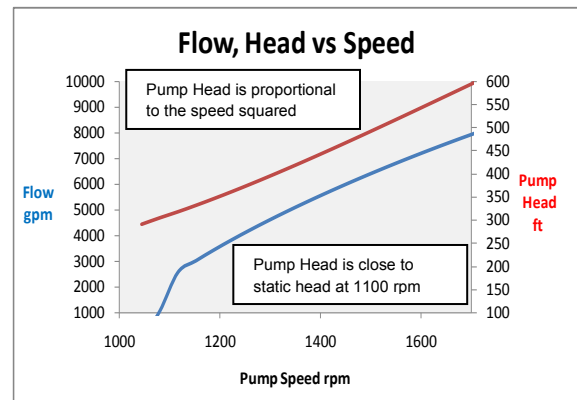
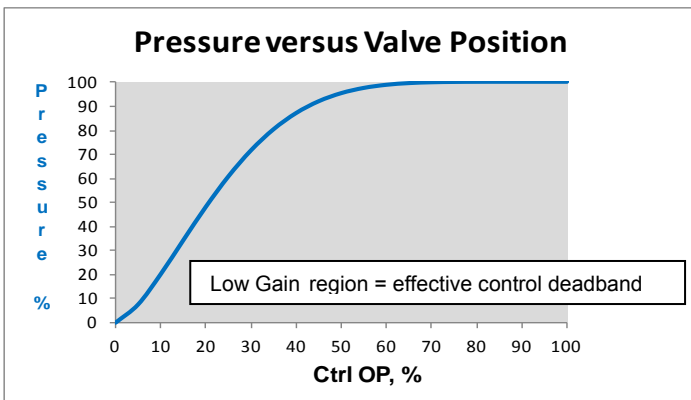
These inherent advantages can/often do result in superior control resolution and faster response to upsets. The control benefits are often just as important to overall pipeline performance as the energy savings.



Pressure cycle caused by Control Valve Stiction



VFD open loop step tests showing a fast, relatively linear pressure response



The left plot shows the typical 'Low Gain' region above 50% Valve Position. The right plot shows the relatively linear relationship between pump speed and pressure

Pressure control with VFD's still has significant challenges and work is required to fully realize the potential.

- The pressure controller process gain increases with pump speed because the pump head is proportional to the *speed squared*. This non-linearity is sometimes important enough to require an output linearization strategy.
- The process gain increases with the number of pumps in operation and the controller tuning needs to be adjusted accordingly.
- In pipeline systems with high static head the pressure loop process gain will be zero until the pump head is greater than the static head. A low limit is required to ensure that pump speed cannot fall below this minimum value.
- The VFD ramp rate is sometimes unnecessarily slow, resulting in unnecessarily slow pressure loop dynamics – and requiring slower tuning.

ProNamics has optimized VFD pressure controls on many pipeline applications. We would be pleased to discuss your pipeline VFD application. Please give us a call at 604-898-1376 / 604-922-9524 or contact us at www.pronamicscontrol.com.