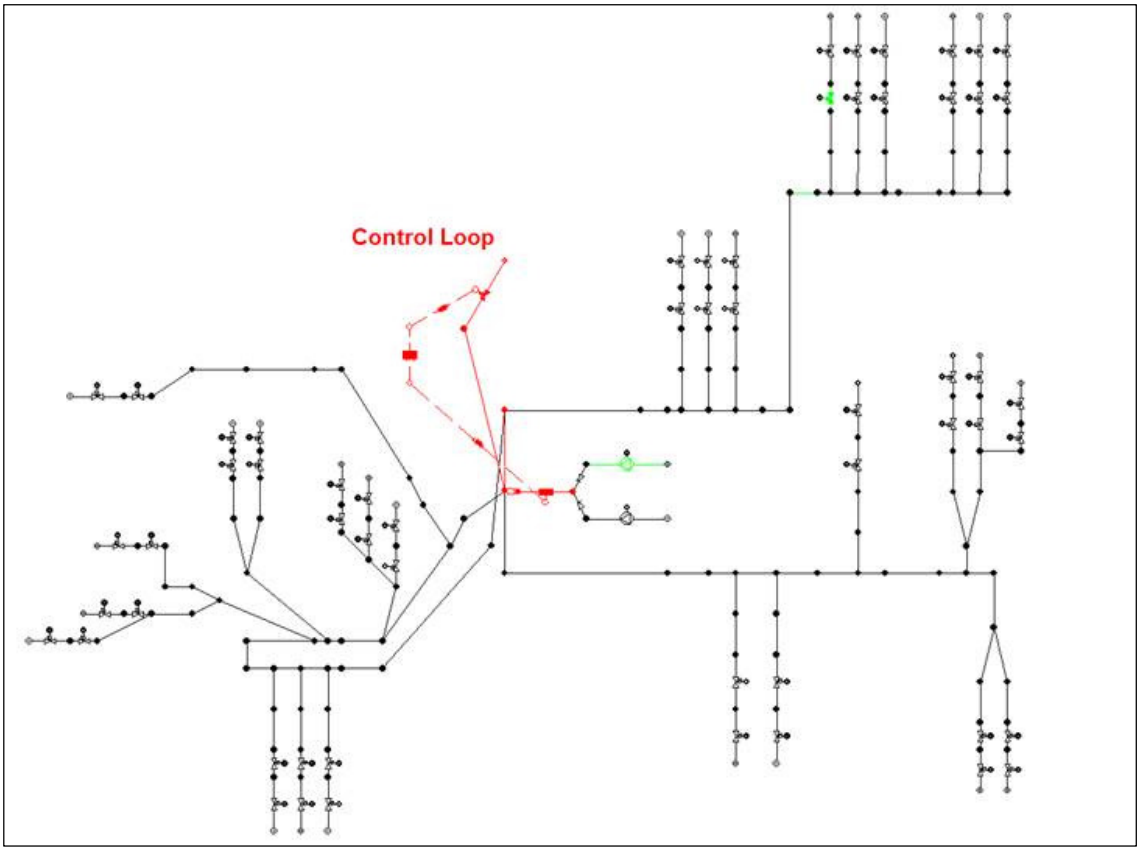
Application Bulletin – Oil & Gas Industry
PIPENET® Transient Module Case Study

MODELLING CONTROL LOOPS IN A WATER INJECTION SYSTEM

BACKGROUND

An engineering company can be requested to conduct a study into the controllability of a water injection system as well as pressure surge analysis. PIPENET Transient Module can perform both water hammer calculations and control systems modelling together, which saves a lot of engineers' time and effort as they do not need to develop multiple models and conduct simulations using various software tools.

The schematic below shows a water injection system with a control loop for the overboard dump valve. For the sake of clarity, the control loop has been highlighted in red.



Some salient features of the simulation as performed by the PIPENET user are as follows:

1. All the block valves at the top of the injection wells closed simultaneously and rapidly. The valves can be closed in a prescribed sequence as well – depending on the case and the engineer's preference.

2. Pressure transients tend to be extremely fast. For this reason, the dynamics of items such as the flow transmitter have been taken into account by the user. In particular the following components form part of the control loop:

(i) A flow sensor. It is also possible to use pressure or differential pressure sensors.

(ii) A transfer function (specified to be first order) which models the dynamics of the flow transmitter. In effect the flow sensor and the transfer function together model the signal from the physical flow transmitter.

(iii) A PID controller. In this model the user has considered proportional and integral terms.

(iv) A second transfer function which models the dynamics of the control valve. This represents the response of the control valve to the signal it receives from the PID controller.

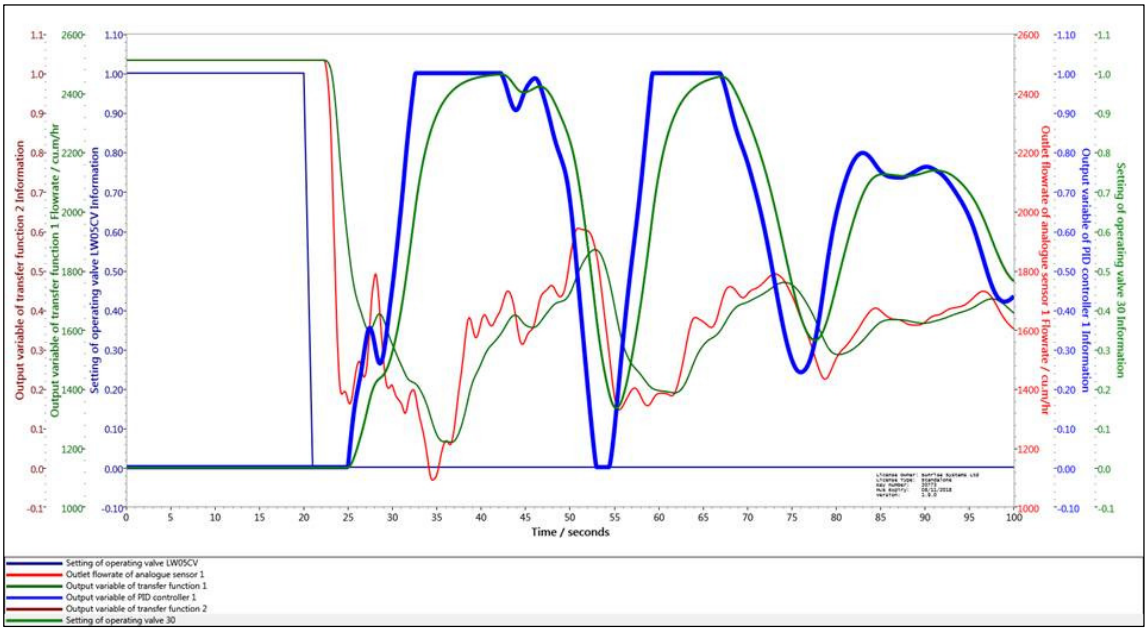
(v) The control valve itself. There are many different ways to model the control valve itself.

Three simulations have been performed. The first scenario is with the control loop as designed. The other two scenarios predict what is likely to happen if the gain was increased.

SCENARIO 1 – Control Loop as Designed

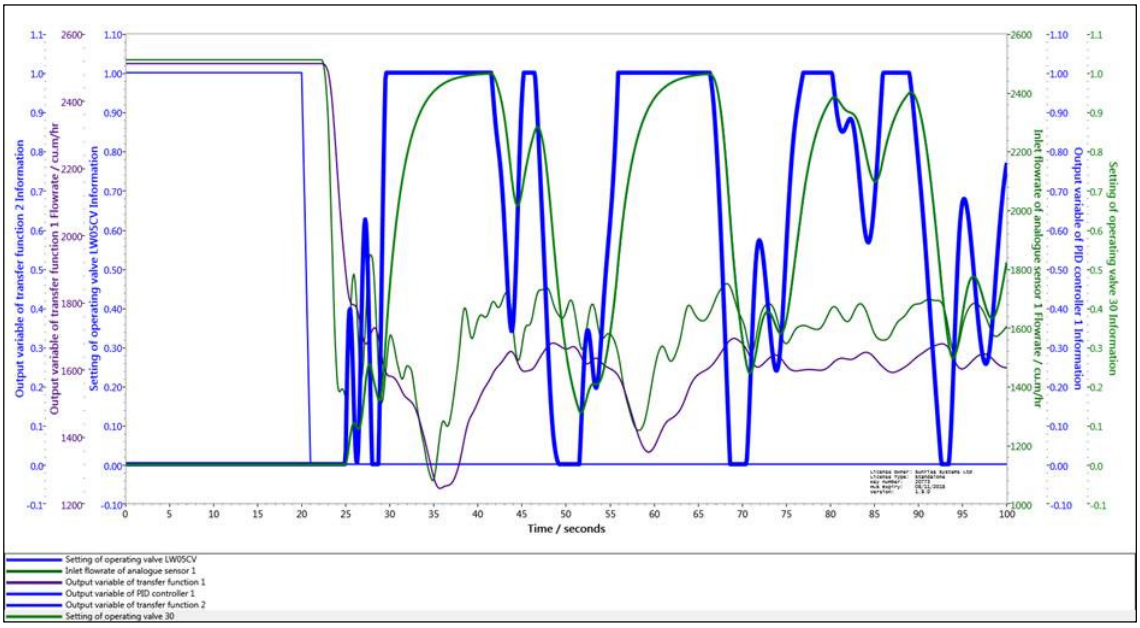
In this control loop gain = -0.00159, reset time = 2. The results are shown on the graph below.

For convenience, the output of the PID controller has been marked as a thick blue line in all three cases.



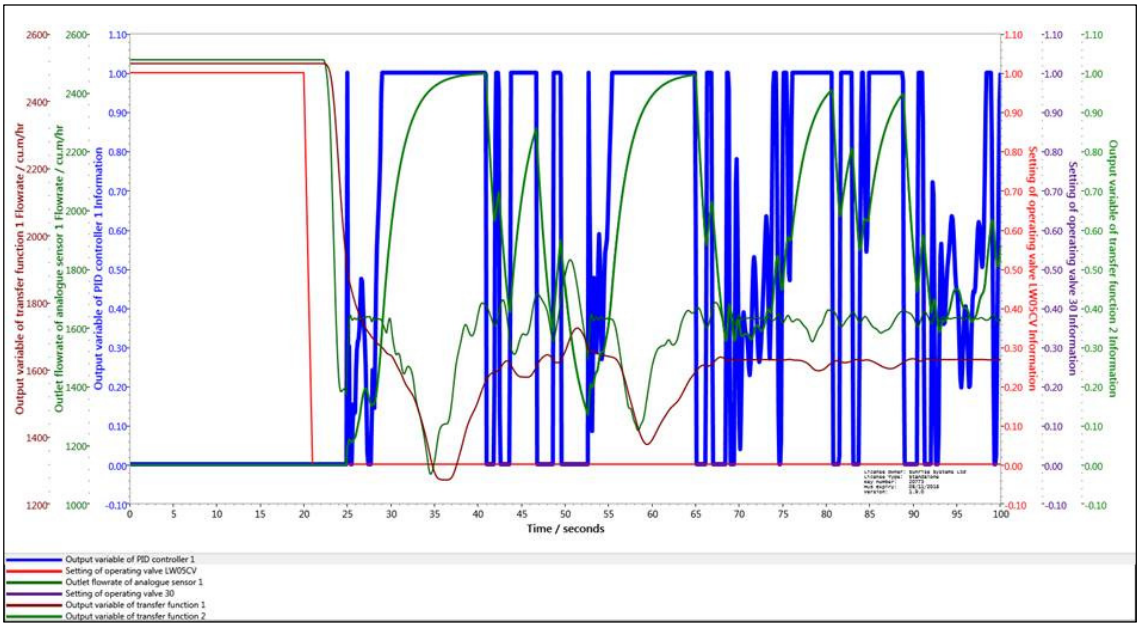
SCENARIO 2 – Gain Increased to -0.01

In this scenario gain was increased to -0.01. Reset time = 2.



SCENARIO 3 – Gain Increased to -0.5

This time the gain was increased to -0.5. Reset time = 2.



CONCLUSIONS

We have seen that PIPENET Transient Module can be successfully used to model control loops together with conducting pressure surge analysis.

If you have any questions about this case study, or any other of PIPENET's capabilities, please email us at Pipenet@sunrise-sys.com.

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