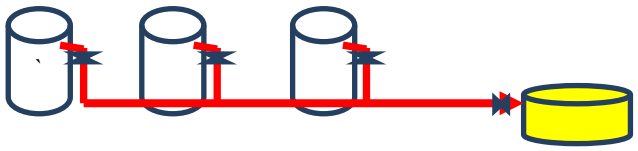
Covey Consuting Pty Ltd

Serving the industry since 1989

NOT YOUR EVERYDAY WATER HAMMER!

COVEY CASE STUDY

The client had a series of three batch pressure reactors that periodically discharged liquid under moderate pressure through a common, long line to a receiving tank.



Usually everything went well, but on occasions there would be severe hammering in the line as discharge started. Usually this was no more than worrying and required no more than restoring pipes to their proper location. Occasionally things were worse, but the standard fixes (altering valve stroking rates etc.) did not seem to help.

One day the hammer was so severe that it knocked a piece of equipment off it's base & Covey Consulting was asked to determine what was going wrong.

There were several possible reasons for the behaviour, but one early clue was that all of the really severe incidents had been when the reactor furthest from the receiving tank was discharging.

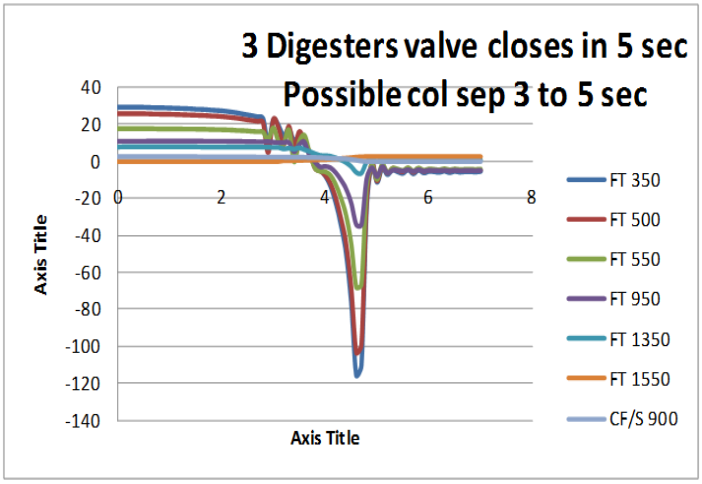
We set up a full hydraulic model of the system and then analysed the transient flow behaviour in it

Classic water hammer – T*his did not seem to be appropriate here, because the problem was on the start of flow, not when it stopped, and slowing the valve rate did not have much effect.*

Flashing – *The liquid in the reactor was hot and under pressure. If it flashed as it discharged the resulting two-phase flow can cause hammering. However, the liquid was not hot enough for this to be significant.*

Bore flow – *The rush of flow into an empty pipe can cause hammering, particularly at constrictions and bends. Unfortunately, this type of flow cannot be properly analysed with the current state of the art. Consideration of piping configuration showed that hammer from this cause was possible and it could be reduced by replacing elbows with large radius bends but subsequent analysis showed that bore flow was not really the problem*

Column separation –*This is most usually seen when flow stops, particularly when it is an upstream valve that closes. In this case the decelerating liquid column is 'stretched', a vapour pocket is formed and then the column closes again with a hammer. The situation is difficult to analyse fully, but the techniques used showed that column separation could occur in conjunction with mass oscillation.*



PO Box 99 Kew East VIC 3102
Tel: (03) 9859 4290
Fax: (03) 9859 4630
www.coveyconsulting.com.au

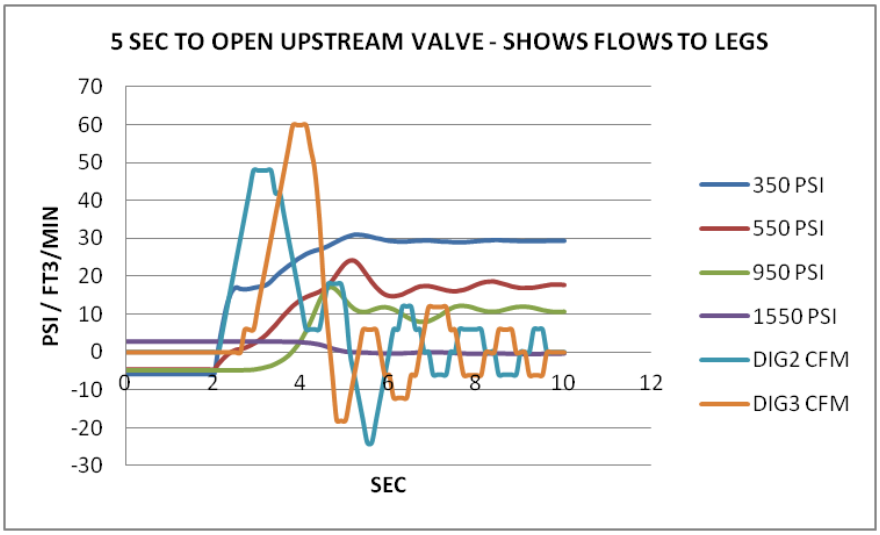
Covey Consuting Pty Ltd

Serving the industry since 1989

NOT YOUR EVERYDAY WATER HAMMER!

COVEY CASE STUDY

Mass oscillation – *If there is an element that can act as a surge tank, it can fill and empty and induce pressure and flow surges. In this case the falling legs from the reactors can drain empty, and those not being discharged can act as surge tanks for the flow from the discharging reactor. When we analysed the system, we found that the two empty legs can interact and produce a very unstable flow:*



The problem could have been fixed by re-running the horizontal pipe at a higher level to eliminate the drop legs. However, in this case it was easier to place non-return valves at the bottom of each leg. This converted the unstable flow shown above to the very stable flow shown below: