Case study

Oil & Gas analysis

Fully coupled process and flare system dynamic modelling saves tens of millions of dollars in plant modification expenditure

As part of an asset integrity test programme on an Oil & Gas processing facility, conventional steady-state analysis identified potential safety issues that if confirmed would require expensive modifications to the facility's flare system. Accurate assessment using the gFLARE® dynamic modelling methodology demonstrated that these modifications were not needed, saving the operator tens of millions of dollars in capital expenditure.

Hazard analysis identifies flare capacity concerns

At an oil & gas processing facility, producing 75 MBD of oil and over 230 MMSCFD of natural gas, a process hazard review identified a number of problems requiring further investigation. The facility's flare system was of particular concern. The flare system has over 200 valves including 25 blowdown valves, and 3 flare tips. Six of the blowdown valves are staged (meaning that the flow through the valve is regulated based on the pressure in the downstream flare tailpipe).

The hazard review identified a number of actions relating to the flare system's capacity for a full plant blowdown under a number of credible scenarios (e.g. pressure regulator failure) that would require further investigation. An initial flare system assessment using steady-state calculations identified the following concerns:

- Potential flare overpressure during full plant blowdown
- Acoustic and flow-induced vibration due to excessive tailpipe velocities
- Pipe material embrittlement, as the cold gas entering the flare system was found to be colder than the temperature rating of the flare piping

Reliance on this steady-state based analysis would have necessitated expensive modifications: the operator would need to significantly increase flare system capacity, make adjustments to blowdown valve sizes and replace carbon steel pipe segments with stainless steel equivalent piping.

It was felt that due to the hugely transient nature of process blowdown that these threats may not be credible, and so a rigorous study centred on dynamic model-based analysis was commissioned.

PSE Oil & Gas builds a fully coupled process and flare system model

A fully coupled dynamic process and flare system model was constructed in PSE's gFLARE® Advanced Process Modelling software and configured to assess full plant blowdown scenarios. A number of 'what-if' scenarios of interest were assessed using the model to explore all credible scenarios:

- Analyse the effects of changes to valve travel stops, valve capacity and failure of the blowdown staging controllers
- Consider the impact of flare tips and bursting discs on flare system performance

- Explore the impact of process conditions on the blowdown operation
- Determine the benefits of staggering blowdown operations

Dynamic analysis reveals significantly lower KO drum pressures

In contrast to the initial steady-state analysis, the detailed gFLARE model enabled the operator to verify that the behaviour of the flare system during plant blowdown was safe under all likely scenarios.

A key finding of the study was that the initial steady-state analysis was overly pessimistic: it did not give credit for the fast reduction in blowdown rates when traded against the time to "pack" (pressurise) the flare system nor could it accurately model the impact of the blowdown controllers or consider the fact that low pressure sources would not depressurise at the beginning of the blowdown operation.

A steady-state methodology assumes that the material entering the flare system leaves the system instantaneously. In reality, the large flare system volume must be pressurised before significant flows are seen at the flare tip by which point the flows into the system have decreased.

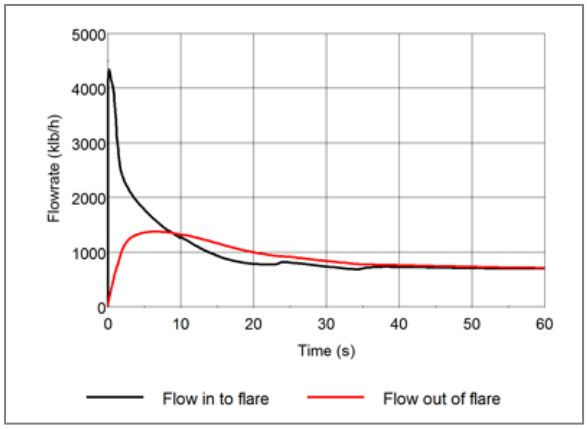

Fig. 1 Peak flow through KO drum (klb/hour)

Steady-state analysis gives an unrealistic KO drum pressure greater than 200 psig (i.e. greater than some source pressures). By contrast, modelling the actual transient flare system behaviour shows significantly reduced KO drum pressures (<50psig).

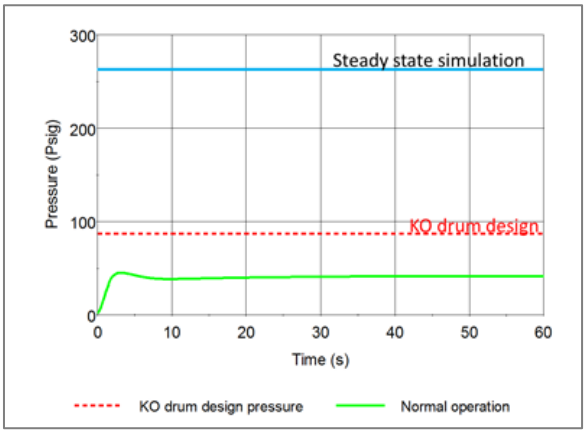

Fig. 2 Peak KO drum pressure (psig)

Dynamic analysis saves tens of millions of dollars

The operator was considering making extensive and costly modifications to their facility in order to solve the safety issues highlighted by the initial steady-state calculations. Closer investigation using PSE's gFLARE® dynamic modelling methodology revealed that an expensive flare system upgrade was not required; saving the operator tens of millions of dollars in capital expenditure and avoiding the need for a prolonged shutdown to make the modifications.