Pressure Relief Valve Stability
Effects and Implications

Presentation by Marie Clark
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AGENDA


  - What is PRV Instability
  - Types of PRV Instability
  - Causes of Instability
  - Ways to Address Instability
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- Senior Process Engineer with 20 years’ industry experience
- Registered Professional Engineer in the State of Texas
- 10+ years of experience analyzing complex pressure relief and effluent handling systems for multiple types of assets
- Experience spans from offshore/onshore production, midstream processing, refining to specialty chemical facilities
- Most recently she has been supporting capital project efforts as a relief systems SME
- Active member of API’s Standards Subcommittees related to relief systems
- Houston Livestock Show and Rodeo Committee Member
What is Pressure Relief Valve Instability

Relief valve instability generally refers to the operation of a relief valve during a relieving event. Though relief valve sizing and pressure drops are performed assuming “steady state” flow, in reality, the flowrate through the relief valve is rarely steady state.

Pressure at the inlet of the relief valve is often dynamic during the overpressure event.
Types of Pressure Relief Valve Instability

Three main types of dynamic responses (instability) to variable flow conditions:

- **Cycling**: The opening and closing of a relief device at relatively low frequency.
- **Flutter**: The rapid reciprocating motion of the movable parts of the relief valve due to system dynamics.
- **Chatter**: The opening and closing of a relief valve at a high frequency.
Types of Pressure Relief Valve Instability

Three main types of dynamic responses (instability) to variable flow conditions

- **Cycling**
  - The opening and closing of a relief device at relatively low frequency
  - Most often occurs when the relief rate is small compared to the capacity of the relief valve
  - At opening, the valve flows more than what the system can provide causing the pressure to drop and the valve to reseat
  - Once closed, system pressure builds to the PRV set pressure and the cycle repeats
  - The frequency of cycling is a function of the upstream system's ability to keep the valve open and is lower than the natural frequency of the PRV
  - Usually does not cause detrimental damage to the valve
  - May affect reseating of the valve and cause wear over time
Types of Pressure Relief Valve Instability

Three main types of dynamic responses (instability) to variable flow conditions

Flutter

The rapid reciprocating motion of the movable parts of the relief valve due to system dynamics

- Disk does not contact the relief valve seat but reciprocates close to the natural frequency of the valve
- May lead to rapid wearing of the relief valve movable parts in contact with stationary parts
- Higher probability of the relief valve getting stuck open and potential capacity reduction
Types of Pressure Relief Valve Instability
Three main types of dynamic responses (instability) to variable flow conditions

Chatter
The opening and closing of a relief valve at a high frequency

- Possibility of valve seat damage and/or mechanical failure due to rapid hammering of the disk onto the seat
- May result in loss of containment from pressure pulsation or impact loading from hammering of the valve
- Can cause significant reduction in flow capacity
- More severe during liquid relief
Causes of Instability

There are a number of factors that may contribute to relief valve instability

Excessive inlet pressure loss

- Pressure acting on the valve disk is reduced by an amount equal to the inlet pressure drop
- If large enough, valve inlet pressure may fall below reseat pressure causing the PRV to close then reopen immediately

Excessive built up backpressure

- Built-up backpressure on a conventional valve forces the valve closed, then reopens immediately.
- Instability results from the rapid repetition of this cycle
Oversized pressure relief devices

Improper valve selection

Acoustic interaction
Ways to Address Instability

- Limit Inlet pressure loss
- Use multiple PRVs with staggered set pressures
- Modulating Pilot-operated relief valves
- Restricted lift relief valves
- Engineering Analysis
Our next episode, scheduled for June 11th, will be about:

How to use a tool to improve your asset health predictability and promote faster workflow processes.

Let's Work Together!

Thank you for listening!