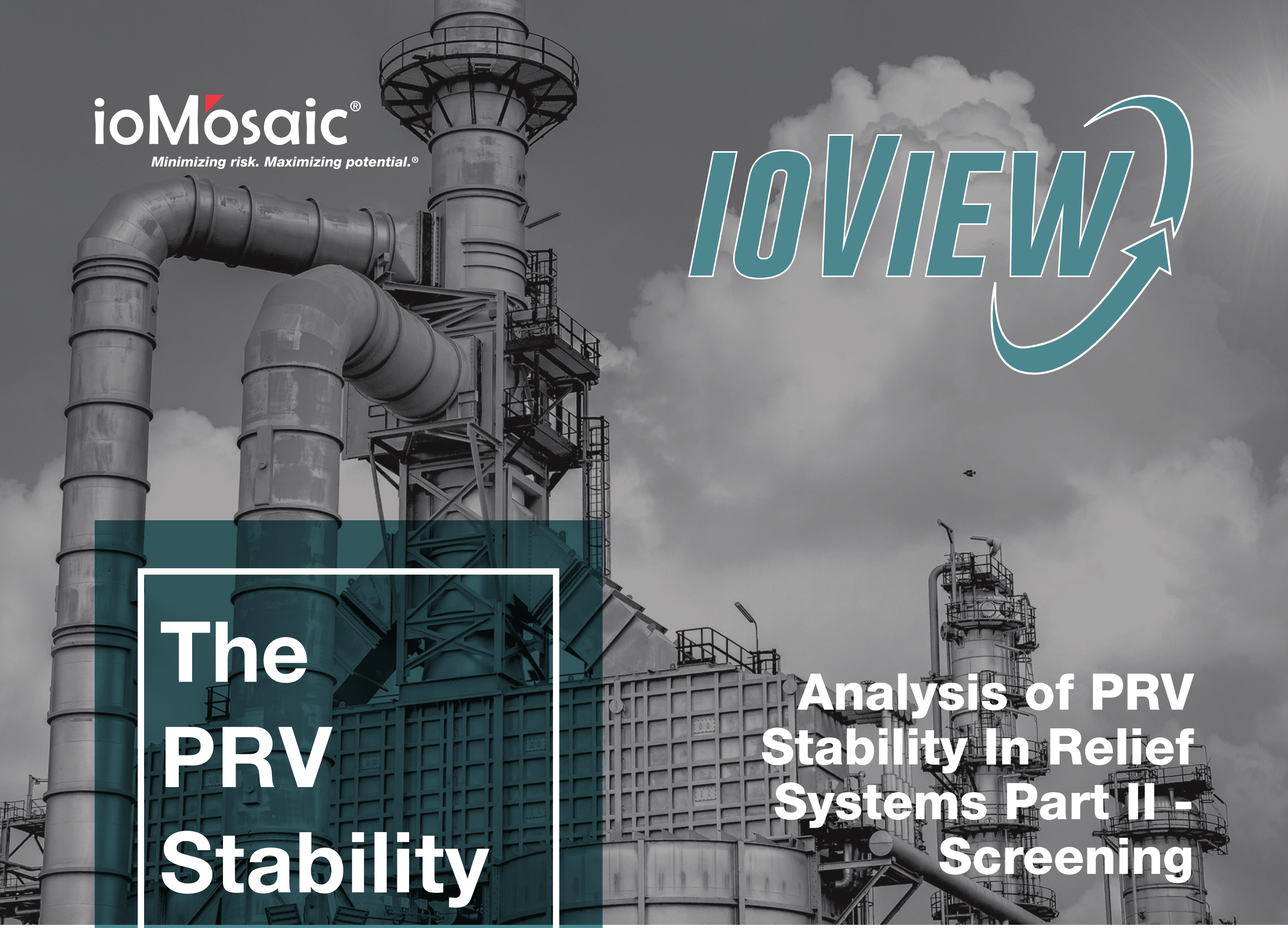

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IOVIEW

The PRV Stability Issue

Methods, Tools, and Resources

Analysis of PRV Stability In Relief Systems Part II - Screening

By G. A. Melhem, Ph.D., FAIChE

Abstract

In part I of this paper we established a detailed dynamics methodology for the modeling of PRV stability. We demonstrated that (a) the irrecoverable inlet pressure loss due to friction has essentially no impact on PRV stability, (b) PRV instability is caused by the coupling of PRV disk motion with the pressure wave caused by excessive acoustic pressure drop (1/4 wave) during PRV opening/closing, (c) the instability does not amplify, and (d) liquid systems are the most likely to cause damage to piping and piping components.

In order to apply the simple screening model we need to establish the speed of sound in the inlet line, the PRV opening and closing times, and the acoustic pressure drop associated with PRV opening/closing.

In this paper we provide a simplified model for the assessment of PRV stability where the inlet line geometry is simple and/or where the inlet line acoustic length can be established. This simplified model has also been proposed in the 3rd ballot of API-520 part II.

Simple Model Parameters

PRV stability is heavily influenced by the inlet and discharge piping configuration. Excessive inlet pressure loss or backpressure can cause PRV chatter and/or flutter. As the PRV starts to open, the pressure upstream of the PRV starts to decrease due to sudden expansion. This gives rise to an expansion wave that will travel upstream. As the expansion wave reaches the pressure source (Vessel) upstream, it reflects and travels back towards the PRV as a compression wave. The largest upstream pressure fluctuations are expected to occur during fast opening or closing of the PRV. The interaction of the pressure wave and valve opening/closing can cause instability. Note that during the opening of the PRV, a delay is typically observed in backpressure buildup because of the time needed to fill body-bowl and the discharge piping. Body-bowl choking and backpressure can influence the force balance on the disk and as a result can cause instability.

In order to apply the simple screening model we need to establish the speed of sound in the inlet line, the PRV opening and closing times, and the acoustic pressure drop associated with PRV opening/closing.

Speed of Sound Estimates

The speed of sound values used in the estimation of wave travel time can be subject to uncertainty. This is most important for liquids and two-phase systems. The piping flexibility can lower the value of the speed of sound. The presence of small amounts of entrained gas in liquids can also reduce the speed of sound. Adding a small amount of gas to a liquid, say 0.01% by weight can lower the speed of sound for the two-phase mixture by as much as a factor of two. Note that the two-phase speed of sound depends on the

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The U.S. Chemical Safety and Hazard Investigation Board Released A Factual Update

Incident Summary

On November 27, 2019, a major loss of containment event occurred, resulting in multiple fires and explosions at the TPC Group (TPC) Port Neches Operations (PNO) facility in Port Neches, TX. Read the factual update on this incident for important safety lessons for your facility.

Popcorn Polymer

From September 6, 2019 through the date of the incident (at least 82 days), the final fractionator A to B transfer pump was out of service. The suction piping into this pump was open to the process during this period but with no flow through it, and was therefore a "dead leg." As discussed above, this is the piping segment that workers in the unit observed to have ruptured.

Popcorn polymer was known to form in the South Unit before the incident. Figure 12 shows a heat exchanger bundle pulled from one of the methyl acetylene removal tower reboilers on or around September 10, 2019. A TPC employee also noted that the emergency pressure-relief valve on this bundle "was plugged solid with popcorn and polymer." Figure 13 shows multiple locations where the TPC PNO facility has experienced polymer fouling problems since July 2019.

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