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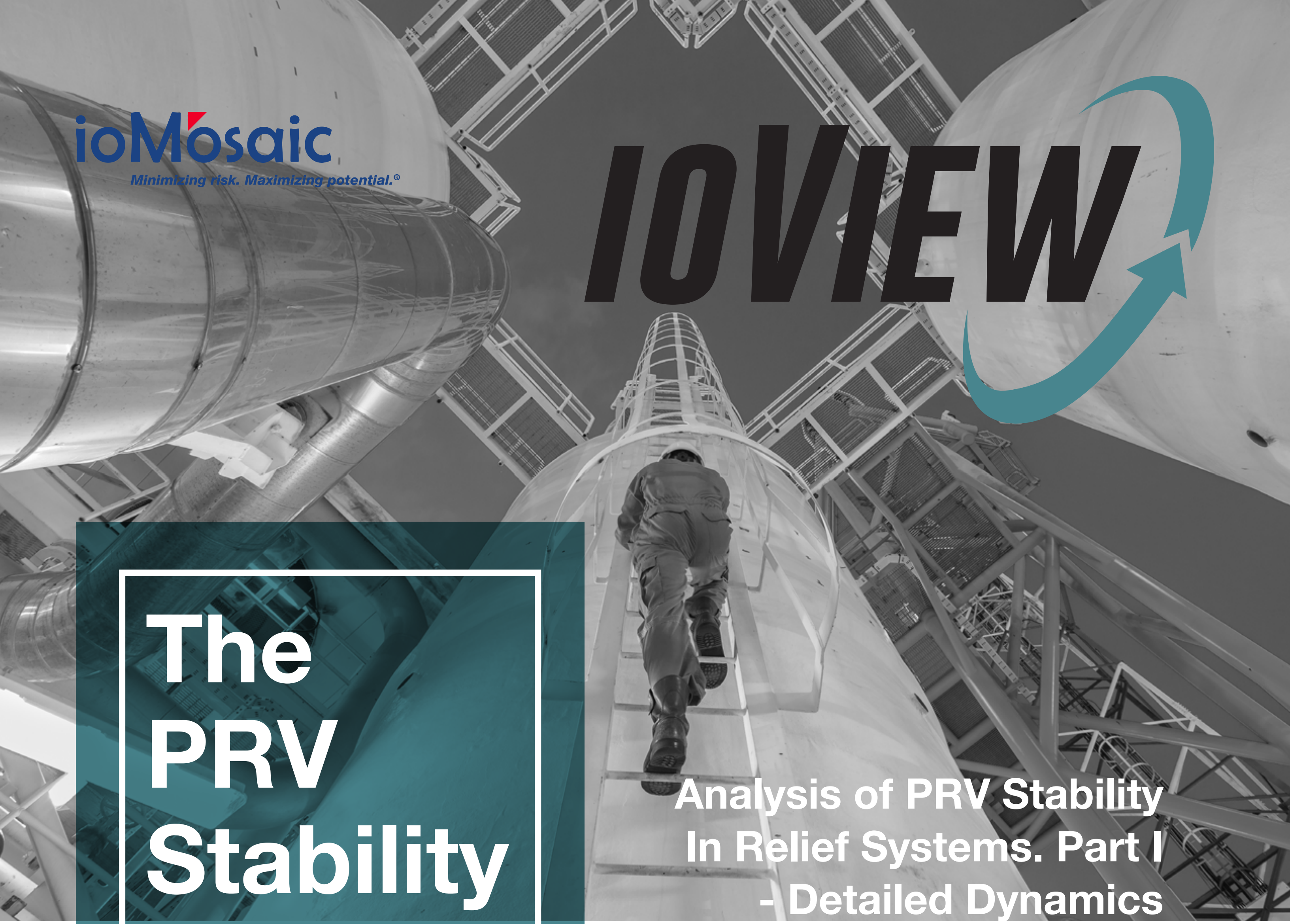


The PRV Stability Issue

Methods, Tools, and Resources

Analysis of PRV Stability In Relief Systems. Part I - Detailed Dynamics

By Georges A. Melhem, Ph.D.

Challenges associated with PRV stability issues for existing installations are not unique to any particular segment of the chemical process industry. This is an industry wide problem that has received a lot of attention from both OSHA and industry associations such as API, ACC, and AFPM. A consistent definition of what constitutes an Engineering Analysis is currently being proposed by API/ACC/AFPM for inclusion in the upcoming revision to API 520.

API, AFPM, and ACC are diligently working on the development of tools and recommended guidance on how to perform an Engineering Analysis to assess PRV stability for existing installations where the 3 % is exceeded. A consistent methodology is emerging that has a solid mathematical foundation and is installation specific.

“The issue of PRV stability is a complex one and has been the subject of active research in the last few decades.”

PRV Stability, an Industry Wide Issue

We do not currently have sufficient evidence to confirm that existing PRV installations with excessive inlet pressure loss that is more than 3 % and less than the valve blowdown (where the reduced flow capacity is still sufficient) present an increased level of risk that is high enough to warrant physical changes to the installations. Physical changes to existing systems may actually increase the risk while modifications are being implemented and there is no assurance that such costly modifications will actually reduce the risk for all installations where the inlet pressure loss exceeds 3 %.

The issue of PRV stability is a complex one and has been the subject of active research in the last few decades. There is wide spread agreement among lead researchers that the 3 % rule is not sufficient to guarantee PRV stability. Numerous companies and organizations have been working diligently to develop and implement both screening and detailed modeling tools/methods to assess PRV stability. The list includes ioMosaic, Chiyoda, Darby/API, DIERS/AIChE, and Pentair to name a few.

Common Threads

While the individual modeling details may differ between the various organizations, common threads are emerging that are clearly signaling that a solution may already exist but is in need of disciplined validation. It is clear that PRV stability is a dynamics problem which requires an understanding and coupling of the dynamics of the following components:

A- Pressure Source or Vessel/Equipment

B- Inlet Line

C- PRV

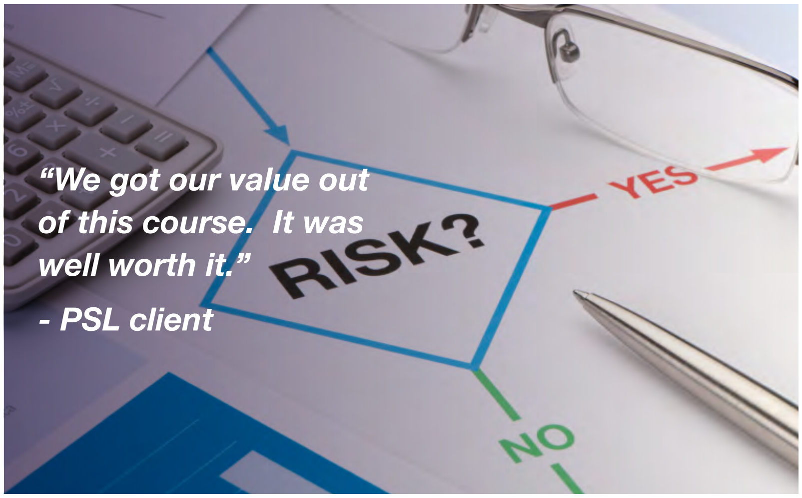
D- Discharge Line

Although all four components are equally important, the interaction of pressure wave phenomena in the inlet line with the valve disk motion is critical. How these four components are coupled together is also very important.

The dynamics of the pressure source are well understood, even for multiphase, reacting flows. We have developed commercial computer codes in wide use where the vessel dynamics have been benchmarked and heavily validated against test data and incident data.

The dynamics of flow in relief lines have also been well understood and researched in the literature, including numerical schemes for the solution of shock tube problems and waterhammer problems. The waterhammer problem encountered in rapid or sudden valve closure for example is very similar to our PRV stability problem. One dimensional solutions with gradual flow area changes should be sufficient to provide us with enough information about pressure wave interaction with the PRV disk. The one dimensional solutions are also practical for two-phase flow. We have developed numerous codes for the solution of waterhammer problems and explosions/shocks in one dimensional geometries. These solutions are also well validated and benchmarked. Note that it is possible to use simplified methods to assess the total pressure drop attributed to pressure waves for simple piping geometries.

▸ Click here to continue reading and access the entire four part series



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