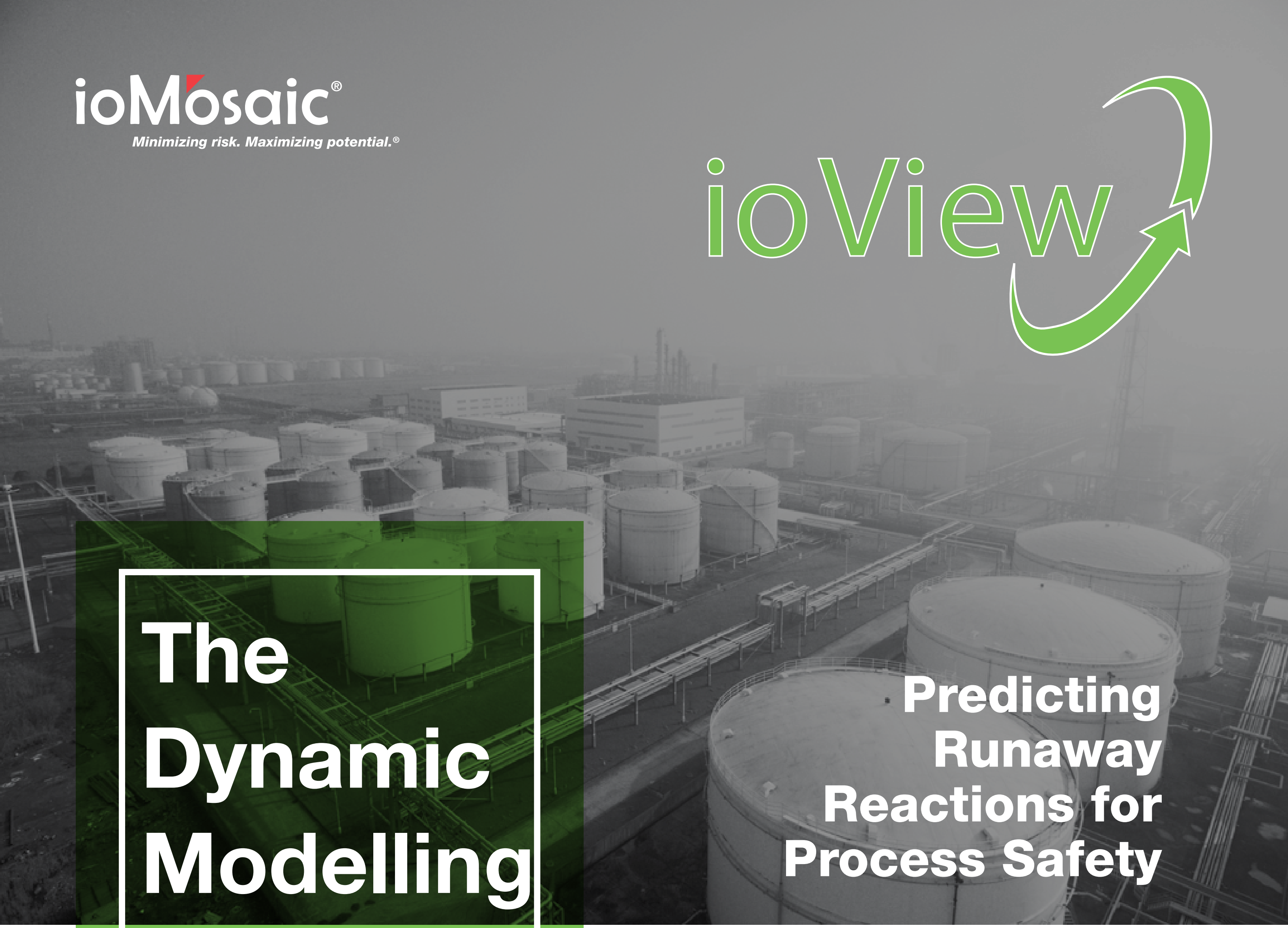

ioMosaic®

Minimizing risk. Maximizing potential.®

ioView

The Dynamic Modelling Issue

Methods, Tools, and Resources

Predicting Runaway Reactions for Process Safety

By James Close, John Barker and
G. A. Melhem, Ph.D., FAIChE

Deconstructing Runaway Reactions Using Dynamic Modelling

ioMosaic presents a case study on a vapor leak involving a polymerization runaway reaction in May 2020 at an industrial facility in India, sadly leading to several deaths and several hundred injuries. We developed a dynamic model of the incident, which evaluated the effectiveness of monomer inhibitors. We used our model to deconstruct the potential causes that we then compared with actual incident reports. Our article concludes that mixing can lead to hot thermally stratified layers and hence poor

We, therefore, assumed that effective refrigeration unit was lost, or the tank was thermally stratified, on Day 40.

cooling in monomer storage tanks, where inhibitor is not mixed effectively to suppress the polymerization reaction. These factors were all found to have contributed to the incident.

The following is an abridged version of an article published in The Chemical Engineer magazine April 2021 edition.

Incident Introduction

A vapor leak involving a polymerization runaway reaction occurred in May 2020 at the LG Polymers Pvt Ltd in R. R. Venkatapurm, Vizakhapatnam district, India. The plant had been closed as part of a national lockdown to prevent the spread of COVID-19. One of the styrene monomer tanks, whilst inhibited, was involved in a runaway reaction spread of COVID-19. One of the styrene monomer tanks, whilst inhibited, was involved in a runaway reaction with several fatalities and many hundreds of hospitalisations.

Reaction Modelling

The suspected runaway reaction scenario was modelled using Process Safety Office® SuperChems™. Using experimental data, depletion models can be developed for the inhibition of the styrene and applied to ioMosaic's qualified styrene thermal polymerization kinetic model. This method can be applied to different kinetic models and scaled-up to simulate real life events.

To model the effects of solar radiation and heat transfer, the tank was divided into segments. This allowed us to accurately model the impact of hot days and the heat loss occurring during the night. Note that the top of the tank and walls show significant change in temperature because they are not in contact with the liquid contents.

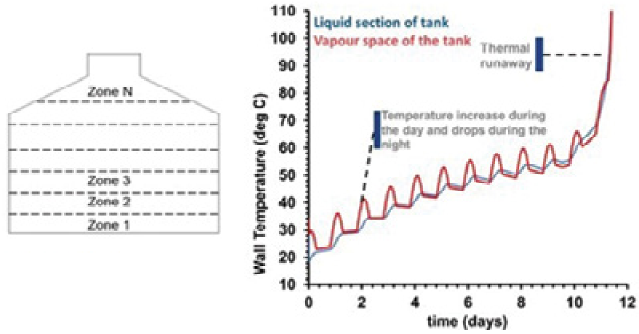

Figure 1: Wall heat transfer dynamic - model predicted duration till runaway
Source: Process Safety Office® SuperChems™

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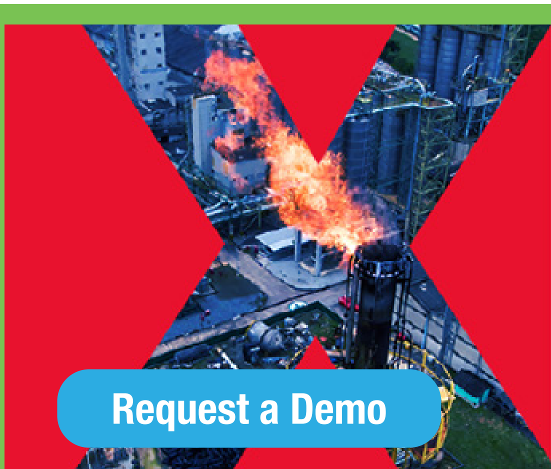

White Paper: Properly Calculate Relief Systems Steady and Dynamic Reaction Forces

Challenges associated with PRV stability issues are not unique for many industries. The 3% rule and simplified API force balance start to become ineffective when the stability is being calculated for complex piping (manifolds), liquids (fluid hammer) and complex mixtures. In Process Safety Office® SuperChems™, using the 1D Dynamics model, we can utilize more sophisticated models to improve accuracy when modelling PRV stability and reaction force on piping.

▸ Click Here To View

5 Advantages of SuperChems™ for Quantitative Risk Assessment (QRAs)

Process Safety Office® SuperChems™ has all the functionality necessary to conduct a QRA and can be used for calculating risk for fixed facilities, pipelines, or transportation routes. Here are five advantages of using SuperChems™ for your QRAs.

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Pressure Relief and Flare System Design - Basic

Gain a thorough understanding of the main issues, concepts, and methodologies with pressure relief and flare systems design.

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September 14-16, 2021

Master techniques for addressing relief sizing for various scenarios, relief piping system design, flare header modeling and consequence modeling.

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September 21 & 28, 2021

Gain a thorough understanding of the essentials of leading PHA/HAZOPs using industry methodologies such as HAZOP, FMEA, What-If, Checklist, and more.

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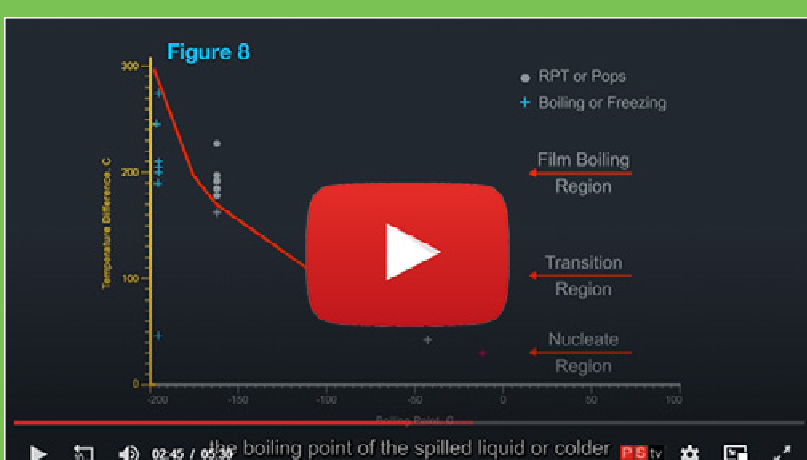

PStv® White Paper Video on RPT and 1D Dynamics

Rapid Phase Transitions are also referred to as physical explosions, which involve the rapid expansion of a high pressure metastable fluid to ambient pressure. Watch this video to learn about predicting RPTs in Heat Exchangers using the 1D Dynamics Modelling within Process Safety Office® SuperChems™ v10.0.

Click Here To Watch