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SuperChems™ Overview

Summary

Process Safety Office™ SuperChems™ component is an industry-recognized versatile software tool that provides an integrated platform for pressure relief and flare systems (PRFS) evaluation and design. Features and benefits include:

- Single tool for simple and complex flow dynamics, pressure relief systems and vent containment design, chemical reactivity management, quantitative risk analysis (QRA), and consequence analysis
- Single tool platform enhances execution efficiency (less data transfer across different modeling tools) and reduces errors
- Wizards for beginning and non-expert users
- Piping isometrics made simple with Microsoft™ Visio interface

Process Safety Office™ SuperChems™ component offers a variety of well-validated models for single- and/or multi-phase reacting flow, dispersion analysis, droplet dynamics, and fire and explosion dynamics. All models in SuperChems™ are true multi-component models with support for petroleum fractions and mixture toxicity.

This software overcomes shortcomings of simple relief design techniques often leading to over-design, and more importantly, sometimes leading to under-design.

SuperChems™ is available for free to universities and local, state, and federal government agencies to further enhance graduates' curriculum, as well as offer a skill set advantage when entering the workforce.

History

SuperChems™ is used worldwide. Developed in 1989, it is used by leading operating companies, insurance agencies, universities, and government agencies. In 2002, the American Institute of Chemical Engineers (AIChE)/Design Institute for Emergency Relief Systems (DIERS) selected it to replace SAFIRE™. Another version of SuperChems™, called SuperChems™ Lite was released and included in the second edition of the Center for Chemical Process Safety (CCPS) Guidelines for Pressure Relief and Effluent Handling Systems.

Expert Testimony

- Recognized by the state of New Jersey's Department of Environmental Protection (DEP) and the state of California's South Coast Air Quality Management District (SCAQMD)
- Recognized and accepted as a peer-reviewed model by federal courts in the states of Louisiana and Texas

American Institute of Chemical Engineers

AIChE/DIERS Preferred Software

AIChE/DIERS recommends Process Safety Office™ SuperChems™ component as the premium software solution to its members.

SuperChems™ Technical Steering Committee

The SuperChems™ Technical Steering Committee was formed in 2002, under the auspices of the AIChE/DIERS User's Group. The primary objective of this advisory group is to advance and maintain Process Safety Office™ SuperChems™ component as the gold standard for pressure relief and flare systems design and evaluation. Committee members hail from respected organizations, such as Bayer CropScience, Shell Global Solutions, Merck and Company, ioMosaic Corporation, Monsanto Company, and ChevronPhillips Chemical.

Center for Chemical Process Safety (CCPS), Guidelines for Pressure Relief and Effluent Handling Systems, Second Edition

SuperChems™ Lite is included in this release.

Platform Integration

Process Safety Office™ SuperChems™ component is the only platform that integrates consequence and risk analysis, chemical reactivity management, and relief and flare systems evaluation and design.

Pressure Relief and Flare Systems

- Pressure relief design for multiphase reacting systems
- Flare systems hydraulics and vibration risk identification
- Headers (two-phase, gas, and liquid)
- Piping networks (two-phase, gas, and liquid)
- Cyclone and separator design
- Vent containment design
- Deflagration venting and dynamics (gas, dust, and hybrid systems)
- DIERS technology

Consequence Analysis and Fluid Flow

- Source-term estimation for sub-cooled, liquid, gas, and two-phase
- Dispersion analysis including heavy gas, two-phase jets, and aerosol formation, breakup, and evaporation

- Fire modeling
- Explosion dynamics including shock dynamics

Chemical Reactivity

- Experimental data analysis and reduction
- Reaction kinetics and dynamics
- Reactivity expert
- Thermal Explosion Theory (1D and 2D)

Productivity Tools and Utilities

- Comprehensive thermo-physical properties package and databanks
- Comprehensive vapor liquid equilibrium (VLE) package and databanks

Quantitative Risk Analysis

- Fixed facilities QRA
- Individual and societal risk estimates
- Pipeline risk
- Risk-based inspection per API-581

Facility Siting

- Identify structures at risk
- Calculate maximum foreseeable loss (MFL)

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Case Study: Complex Flare Network Analysis Using Process Safety Office™ SuperChems™

The Client

The client was a large oil refinery with a very complex flare network that had been modified numerous times over the lifetime of the facility. It had six separate flares, three main headers, and hundreds of relief devices that discharged into the system. As the flare system was modified over the years, multiple cross-connection points were added between the headers in an effort to balance the flow rates through the headers with minimal piping changes.

The Challenge

The problem was that the system had become so complex that the tools the refinery was using to evaluate the flows through the flare network could not adequately model the system. The refinery had been using two other well-known commercial flare network software packages to evaluate changes or additions to the flare network, but these programs were not able to properly converge with all of the complexities of the network. Management no longer had confidence that the model results reflected the actual network performance and therefore, could not be sure the system would perform properly in the event of a global relief scenario at the facility.

The ioMosaic Approach

The client requested that ioMosaic develop an accurate model of the flare network and evaluate the performance during a total refinery power failure scenario. They also wanted a model that could be utilized in the future to evaluate changes or additions to the flare network.

ioMosaic constructed a model of the flare network in their software package, SuperChems™. The backbone of the model included drawing piping isometrics in SuperChems™ for all of the relief devices, headers and flares involved in a total refinery power outage based on the actual field piping isometrics provided by the client. All of the relief devices associated with this scenario were also modeled using the valve details provided by the client.

Once the physical details of the flare network had been entered into the program, the network was divided into sections to assist with the complex calculations. Points where the flows could cross between headers were identified as Nodes. Some of these Nodes had relief devices providing flow into the Node and others were only potential crossover points between the different headers, but no new flow was added. For each Node where relief devices provide flow into the Node, the relief devices were grouped together. The network ended up with 11 groups of relief devices and 20 network Nodes as shown in Figure 1. The Groups of relief devices ranged from just 1 relief device up to 19 devices in each group.

A back-pressure curve was generated for each relief device using the specific characteristics of the relief valve and the chemical components flowing through it. Next a back-pressure curve was generated for each Group of relief devices. This provided an initial look at how the relief devices would perform when multiple devices were flowing simultaneously.

Next all of the network Nodes were defined with interconnecting piping isometrics and information about where flow could come from and go to for each node. In many instances, flow could go either direction through a cross-over pipe connecting two headers depending on what the pressure was at each of the connecting Nodes. The other software packages ran into trouble without a defined flow path through each of these connection points. However, it wasn't possible to confirm the flow direction until the pressures were identified.

Once all of the Nodes were defined, the software generated the equivalent of backpressure curves at multiple temperatures and pressures for each Node, called Flow Maps. These Flow Maps were used by SuperChems™ to converge the network solution. The software provided temperatures and pressures for each Node and the flows through the network, including which direction the flow was going through each of the network cross-over connections.

The final step in the analysis was to review each of the groups of relief devices and determine how much flow could pass through each device with the back-pressure at the first network Node as determined above. These relief device flow rates could then be compared to the required flow rates for this particular relief scenario to determine if the relief device and network piping could meet the demand.

Once the model was developed, modifications to the network could be easily examined. If safeguards are present which eliminate the relief load from a particular device, that device can be disabled by a single click. Changes to the type of relief device (conventional, bellows or pilot) can be easily examined. The output from SuperChems™ indentifies the pressure drops through each segment of piping allowing the user to quickly determine which sections of piping should be modified to achieve the greatest performance improvement within the network.

Based on the changes that are made, SuperChems™ can re-evaluate the flows through the network. In some cases, if flows are removed from certain groups, then the pressure drops and flow might reverse direction through one of the cross-over connections. SuperChems™ can identify these changes in flow direction and provide a new solution to the flow network.

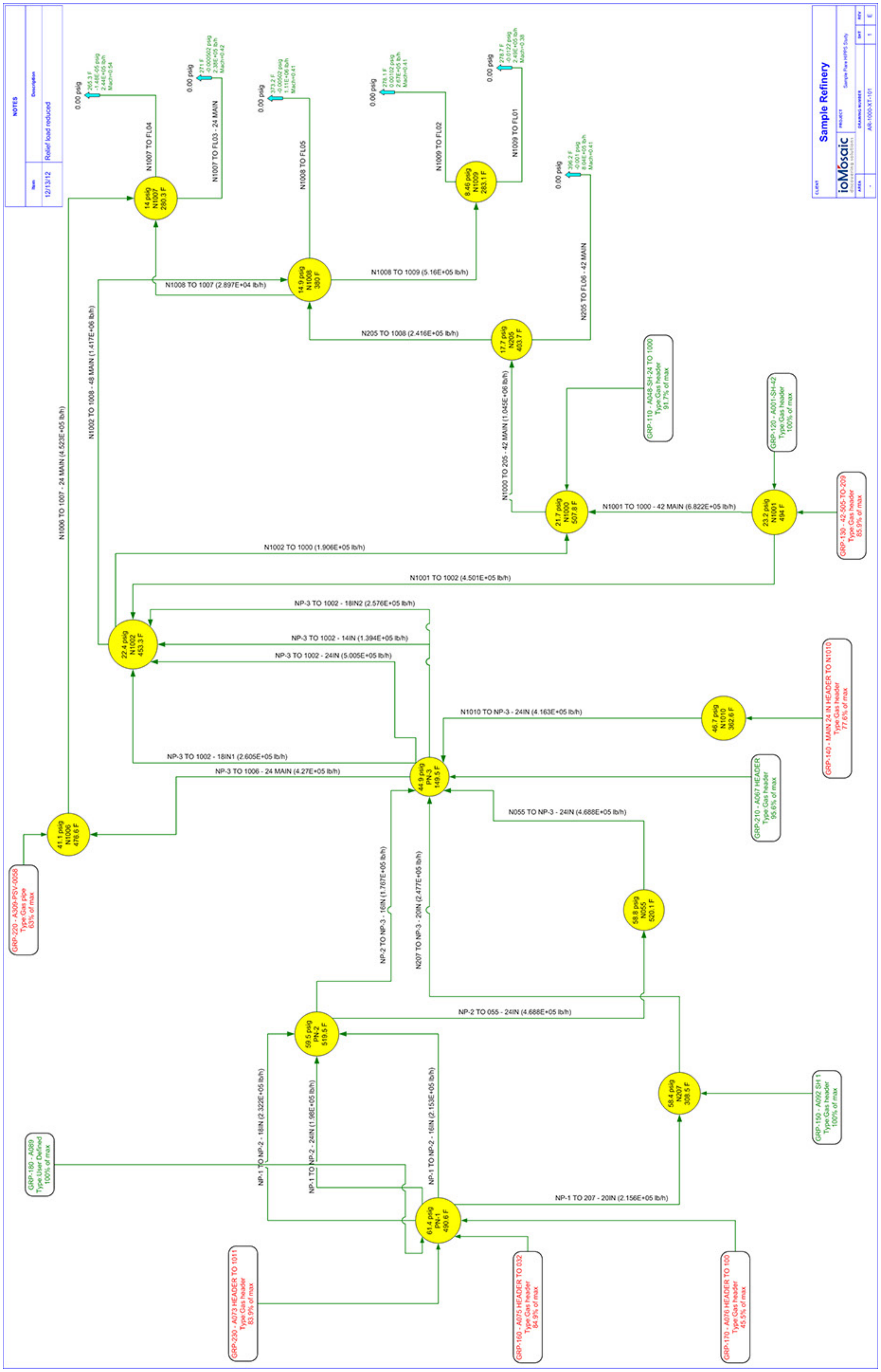

Figure 1 – Simplified Network Node Diagram

The Result

This SuperChems™ flow network model provided some good insight to the dynamics of the flare system. It was able to highlight some valves which were undersized, regardless of the piping configuration and flows throughout the network. It identified several relief valves which would not provide any flow because the back-pressures in that section of the flare network would be higher than the inlet pressure for the relief device.

The model was used to evaluate the effectiveness of various safeguards to reduce the flow rates during this total refinery power failure scenario. The model was also useful in identifying some valves which would benefit from changing from a balanced-bellows style to a pilot device. It also pointed out some bottlenecks in the piping system, which needed to be modified to allow proper flows through all of the relief devices upstream.

In summary, SuperChems™ was able to produce a dynamic model of a complex flare network where all other software packages came up short. Once developed, the model is easily modified to stay current with changes to the system.