

# ioMOSAIC STATEMENT OF QUALIFICATION

## EMERGENCY RELIEF EFFLUENT HANDLING SYSTEM DESIGN

### OVERVIEW

Quite often, sizing the relief device and effluent piping for reactive systems is only part of the solution. When the reactive systems release involves toxic or flammable reactants, decomposition products, or two-phase flow, it is unacceptable to let the untreated material discharge into the atmosphere. Allowing entrained liquid to exit with the vapor will result in aerosols producing vapor clouds that take longer to disperse. If the venting is through a flare and the liquid is combustible, flaming balls of liquid can drop to the ground. Another issue is the continuation of the initiating runaway reaction in the effluent piping. This significantly affects the fluid dynamics as well as prolonging the generation of undesirable reaction products.

When these conditions are encountered, a properly designed emergency relief system needs to consider separation and/or treatment of effluent streams to protect personnel and the environment. This may involve the use of gas/liquid separators, reaction quench tanks, passive scrubbers, and vent or flare stacks. In the past, designing relief systems typically involved the sizing of individual relief devices, followed by determination of the inlet and exit losses. Finally the collection headers were sized for the worst-case, common-cause release scenario. Quite often this results in iterative computations before an optimum solutions that meet all the design requirements.

### SERVICES

ioMosaic Corporation's state-of-the-science software SuperChems, can perform sizing calculations on multiple relief devices with associated inlet and outlet piping, and simultaneously account for header, separator, and flare stack pressure drop. If required, SuperChems can also calculate the dispersion or radiation effects due to venting or flaring. During the same simulation, the software also performs the sizing calculations for specified effluent handling equipment such as



cyclones or API separators and quench tanks. By utilizing this software, our experienced staff can achieve a high level of productivity and reduce the cost of designing or revalidating effluent handling systems.

Our software tools are the industry standard for performing pressure relief design. In July of 2002, the AIChE Design Institute for Emergency Relief Systems selected our relief design software (SuperChems) as a replacement for the SAFIRE computer code. SuperChems Expert has been the subject of many publications and has been used successfully by several major chemical companies.

SuperChems Expert is a sophisticated computer code that is capable of handling all the modeling requirements of pressure relief and effluent handling design, including the rating of two-phase headers and interlinked vessels.

No special modeling efforts are required for different vessel geometries. For relief valves with actual opening curves, SuperChems allows the input of the actual opening curve. For relief valves where there are available actual lift characteristics as a function of overpressure and backpressure, those curves can also be used.

SuperChems Expert can handle, for example, the



dynamics of a vessel under fire exposure that is venting to another vessel, which also may be under fire exposure, and will handle the effects of reaction and backpressure buildup and their impact on the relief capacity and behavior of both vessels.

Two-phase headers in SuperChems Expert can handle multiple inlets consisting of two-phase, and/or gas, and/or liquid flows. Reactions are also tracked in the header. We can also take the results all the way to the flare tip, and estimate the radiation footprints from a combined loading of several vessels venting into the header simultaneously.

During venting, the reaction forces imposed on the venting vessel and downstream equipment can be substantial. SuperChems calculates the maximum reaction force experienced during the venting event. Through strategic alliances with other companies, we can evaluate the adequacy of support structures and header piping using finite element analysis and computational fluid dynamics.

### SELECTED STUDY EXPERIENCE

The following are selected examples of ioMosaic assignments that involved effluent handling system design.

#### **LD Polyethylene Reactor Decomposition Containment**

We assisted an engineering design contractor with the evaluation of the structural integrity of their proposed design of an ethylene decomposition effluent containment system for an LD polyethylene reactor operating at 30,000 psig. The results of the SuperChems analysis indicated that the containment system would be subjected to severe loads during an ethylene decomposition event. The evaluation identified reaction force and internal stress issues for the reactor support structure and several piping components that needed to be addressed in the final design.

#### **Herbicide Plant Effluent Handling Systems**

ioMosaic Corporation professionals designed a multiple effluent handling system for a major agricultural chemicals company. The manufacturing process involved many reactors and raw material handling vessels in which a water-induced decomposition reaction was possible. One of the decomposition reaction by-products was hydrogen chloride. Due to the number of vessels involved and the physical layout, multiple effluent handling systems were required. The effluent handling system included collection headers, several com-

mon cyclone separators, a passive vapor scrubber and common vent stack. Using SuperChems, we computed time-dependent flows for each affected vessel, selected worst-case discharges for the separator designs, and designed the scrubber and stack for worst common-cause release event.

### ABOUT US

ioMosaic Corporation is a leading provider of safety and risk technology consulting services and software solutions.

#### **ioMosaic's Consulting Services:**

- ◆ *Auditing*
- ◆ *Calorimetry, Reactivity, and Large-Scale Testing*
- ◆ *Due Diligence Support*
- ◆ *Effluent Handling Design*
- ◆ *Facility Siting*
- ◆ *Fire and Explosion Dynamics*
- ◆ *Incident Investigation and Litigation Support*
- ◆ *Pipeline Safety*
- ◆ *Pressure Relief Design*
- ◆ *Process Engineering Design and Support*
- ◆ *Process Hazards Analysis*
- ◆ *Risk Management Program Development*
- ◆ *Quantitative Risk Assessments*
- ◆ *Software*
- ◆ *Structural Dynamics*
- ◆ *Training*

At ioMosaic, we are helping our clients discover practical and cost effective solutions to safety, risk, and business challenges.

### CONTACT US

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