Relief, Blowdown and Flare Modeling

At Avocado Engineering, our professional team of engineers model various operational scenarios of venting and relief of the hydrocarbon fluids via the flare network to minimize the risks of over-pressurizing of the process piping and equipment or to limit the pressure to a safe operational region.

Before the construction of any process that requires relief system and flaring, such as offshore/onshore oil/gas facilities, gas collection and separation areas, biodigestion processing and biomass/biogas operations in the food or waste processing facilities, it is recommended to simulate and model the operation of relief system and flaring under various operational scenarios such as in the emergency modes of operation, start-ups and shut-downs, and during other possible relief conditions at normal operation modes, to ensure that the system is designed at the optimum design conditions and to minimize the associated risks of failure of relief systems in cases of emergency.

We are pleased to work with your engineering teams to synergize the design and to support your design and optimize your equipment sizing under various modeling conditions using specialized softwares and packages such as FLARENET, FLARESIM HYSYS dynamic simulator, PRO/II steady-state process simulator and PHAST.

Avocado Engineering is pleased to provide advice, consultation and simulation in conjunction with your designs done by your process design engineers. Below are some brief explanations on the scopes of our works and services in this range.

Flare Network Design

The relief and blowdown systems are designed to reduce or limit the pressure of the processing facilities safely during an emergency situation or under manual initiation, and thereby prevent equipment rupture due to the overpressurizing. Released hydrocarbon fluids are collected from atmospheric or pressurized equipment and are disposed of via the HP or LP flare system at a safe location.

The relief and blowdown system is part of the overall safety system providing the ultimate protection. All design documentations, including calculations, for the relief and blowdown sizing are required as the input for the flare system design. The flare, relief and blowdown systems start at the equipment being protected and finish at the flare...
tip/vent tips. As part of the flare and relief systems, knockout drums (also called relief drums) are also required to be considered. Knockout drums separate any liquid droplets that are carried over with the gas before the gas is sent to the flare stack for ignition.

Figure 1. An example of the flare network simulation.

A calculation record is prepared for each relief valve within each sectionalized area. The data can then be used as the input for the flare network system design. This includes the Relief Device Summary Tables. Our flare system design engineers incorporate the information into a Flare Load Summary Table, which is the basis of the flare design. The flare design will be based on an assessment of the coincident cases considering all the required overpressure relief and blowdown situations.

All possible causes of overpressure are considered in the sizing of the relief and blowdown valves. Various different emergency cases and operational flaring loads will be reviewed in the flare system design. The data from each sectionalized area will be compiled into a Flare Load Summary table to give the total flare loads possible for each scenario considered.
The flare scenarios to be considered will include blowdown loads, vent valve loads and simultaneous fire relief from all of the equipment within each fire area.

FLARENET is used for sizing of flare network piping. FLARENET enables our engineers to perform steady-state design, rating or debottlenecking of single or multiple flare and vent systems.

The simulator can calculate minimum sizes for new flare systems or evaluate alternatives to remove bottlenecks in existing relief networks. FLARENET can also be used to identify potentially dangerous relief scenarios during the design phase or current operational scenarios. The program can be used to demonstrate regulatory compliance of the flare and vent systems in relation to over pressure and noise regulations.

**Depressurizing and Low Temperature Studies**

Low temperature studies during flow assurance analysis are performed to determine if the methodology specified for a facility is appropriate for the likelihood of the low temperature excursions that may occur. This can be applied to both the new and existing equipment. The study is intended to cover all systems on a facility that might be subjected to low temperatures during any or all of the following scenarios:

- Start-up and repressurization/shutdown
- Normal operation
- Process upsets
- Process control fluctuations
- Draining
- Depressurizing (either in emergency or during maintenance modes)
Any change in the operation that has occurred after the equipment was originally placed into service, which may cause a lower Critical Exposure Temperature (CET) than it was originally designed for, is of special concern.

Blowdown and depressurization of equipment can be modeled using a variety of different simulation methods such as:

- HYSYS Dynamic Model (note that this does not require HYSYS dynamics to run)
- PRO/II Steady State simulator

The choice of depressurizing model is dependent on the system to be depressurized. The HYSYS dynamic depressurizing model allows full specification of the system to be depressurized, including isentropic efficiency, vessel volume and mass, vessel specific heat, initial liquid volume and the heat transfer area (either the total vessel surface area or the wetted area whichever is appropriate), mass of the system in contact with the vapor and liquid, heat transfer model to be used, and so on.

**Pressure-Relief Device Sizing**

A pressure-relief device protects process equipment from the hazards of high (or low) pressure in a process. It operates by opening at a designated pressure and ejecting mass from the process. The ejected mass contains energy and the removal of the energy reduces the process pressure.

The API Standard 520, Part 1 and API Standard 521 are the most widely used standards for sizing relief devices and relief load calculation in the chemical process industries.

The objective of the relief sizing calculation is to determine the required relief area for the relief device. Almost every relief device installation has its own unique design issues and special considerations that will impact the relief sizing calculations.
Flare Location Study

The scope of this study is to assess the radiation, dispersion and noise impact of hydrocarbon and toxic gas releases arising from the flare and to establish a distance required between the plant and flare based on the specified criteria.

Radiation and noise calculations are performed by FLARESIM. FLARESIM, developed by Softbits is a sophisticated flare simulation/design software. It models thermal radiation and noise footprints generated by flare systems for offshore platforms, gas plants, refineries and chemical plants, and predicts the temperature of the exposed surfaces within range. Flaresim can provide a full 3D flame-shape analysis with flexibility in the location and orientation of multiple stacks, and rapid evaluation of flare systems under different wind speeds and directions. Flaresim can also size stack or boom length to meet specific radiation, noise or surface temperature limits at the defined receptor points.

PHAST (Process Hazard Analysis Software Tool) is used to model the flash fire, dispersion of SO₂ as a toxic product of combustion and in addition, the dispersion of H₂S for the case of unignited releases. PHAST has the ability to simulate the progress of a potential incident from the initial release to far-field dispersion including modeling of pool spreading and evaporation, and flammable and toxic effects including explosions and fires.

In summary, Avocado Engineering is pleased to provide advice, consultation and simulation packages for any process design that requires the relief and flare analysis and simulations.

We look forward to hearing from you.

Yours sincerely,

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