KNIGHTHAWK TECH NOTES

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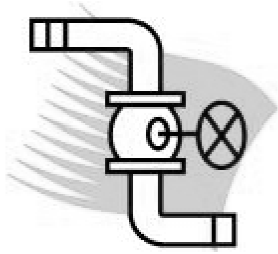
Closed Relief Discharge Systems – Can be Complex

As you are walking out in the plant you look up in the pipe rack and there is the famous set of relief valves that discharge into a header that goes to the flare. You remember the last time they went off. The pipe rack jumped around, supports were damaged, and the knock out drum at the flare header got "knocked out". In your mind you ask the question, "How could this happen?" Good question, because it happens more than you think around the world.

Several issues came up in the example discussed above.

1. High vibration due to the relieving operation.
2. Relief capacity was not met.
3. High amount of liquids were contained in the header system.
4. Slugs caused damage to the system.



The system was designed to API standards and all applicable Codes. For a typical closed system design, a steady state analysis is conducted and the size of the closed system is determined based on the total relieving load anticipated in the system.

The fluid state should be considered as it passes through the relief valve and into the closed systems. The real problem is transient and the temperature of the closed system is also important. Challenges are in liquid or two phase hydrocarbon systems that

are discharging into a closed system. This liquid is flashing across the relief valve and flashing in the closed relief header. The volumetric expansion is so fast that in some cases sonic flow is achieved and we have choked flow. Under those conditions the relieving capacity is reduced and shock waves propagate up and down the header system. The relief system dances around. The bottom line is the closed system should be designed for subsonic conditions that consider the two phase flow conditions that may exist. Complex systems may require a transient analysis to determine the correct response including a temperature sensitivity study. Traditional relief system codes may not consider these complex conditions and the system maybe undersized.

Now let's assume the process size is designed within code and all the conditions discussed above have been addressed. Well, it is not over with. Even the best of the process designs with two phase or single phase liquid hydrocarbon relieving, can cause some pretty remarkable dynamic loads. There are a few things to design for.

1. The normal transient thermal expansion issues that occur during a relieving event.
2. The momentum loading across the bends.
3. The transient "kickdown force" at the relief valve.
4. Anticipated slug loads.
5. If the process suggests sonic flow conditions may occur, then you have to address shock and "ringing effect". Sometimes the branch lines from the relief lines will choke before going into the main header.

This article covers just a few aspects of what can be very challenging designs. Relief designs should be designed by qualified professional engineers for both the process and mechanical design.

Cliff's Notes: KnightHawk has analyzed complex relief systems from two phase hydrocarbon flow, to blow down systems for high pressure condensate. KnightHawk also has conducted failure analysis of failed systems for over 20 years. Let KnightHawk help get you where you need to be.

We hope everyone had a wonderful Labor Day holiday. If you did not it is your fault. I am enjoying the nice cool front that has come into Houston as I write this. Those of you around the world who have not been to Houston would not understand this, but we Houstonians do. We get to sit outside for supper about 5 days per year and last weekend was one of them. Football has started and I hope your team wins, unless of course they play LSU. My son has started football in high school. Already a broken thumb…

Take care and God Bless,

Cliff Knight
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KnightHawk Project Update

- CFD of PSV System – Petrochemical
- 19 MW Diesel Engine Failures – Power
- Combustion CFD Analysis – Power
- Liquid Ring Compressor Failures – Oil & Gas
- Equipment Hydrotesting – Oil & Gas
- Clamping Connector Analysis – Petrochemical
- Duct Work Redsign – Petrochemical
- Critical Pipe Stress – Petrochemical
- Vertical Cast Transporter Failure – Nuclear Power
- Reactor Head Damage Repair – Petrochemical
- Transient Fluid Dynamics – Petrochemical
- Knockout Drum FFS – Petrochemical
- Gear Pump Failure Analysis – Petrochemical
- Transfer Line Exchanger – Petrochemical
- Brittle Fracture Analysis – Petrochemical
- Fit for Service Analysis – Petrochemical
- Tensile Testing – Manufacturing
- Pump Vibration Analysis – Petrochemical
- Very High Pressure Vessel Code Analysis – Petrochemical
- Gas Pipeline Coupling Failure – Oil & Gas
- Reciprocating Compressor Re-Design – Petrochemical
- Compressor Skid Pipe Stress – Petrochemical
- Pump Vibration Analysis – Petrochemical
- Corrosion Analysis – Gas Pipeline
- Gasifier Equipment Design – Power
- High Temperature Molten Salt Tank Design – Green Energy