For Overpressure Protection in SRU's, Lots of Things are Changing...

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Old school overpressure protection was provided by the exclusion block valves and an open path to the atmosphere via an incinerator or blowing through the liquid seals into the sulfur pit. A typical Claus Plant with a Scot Tail Gas treater is shown in the diagram below.

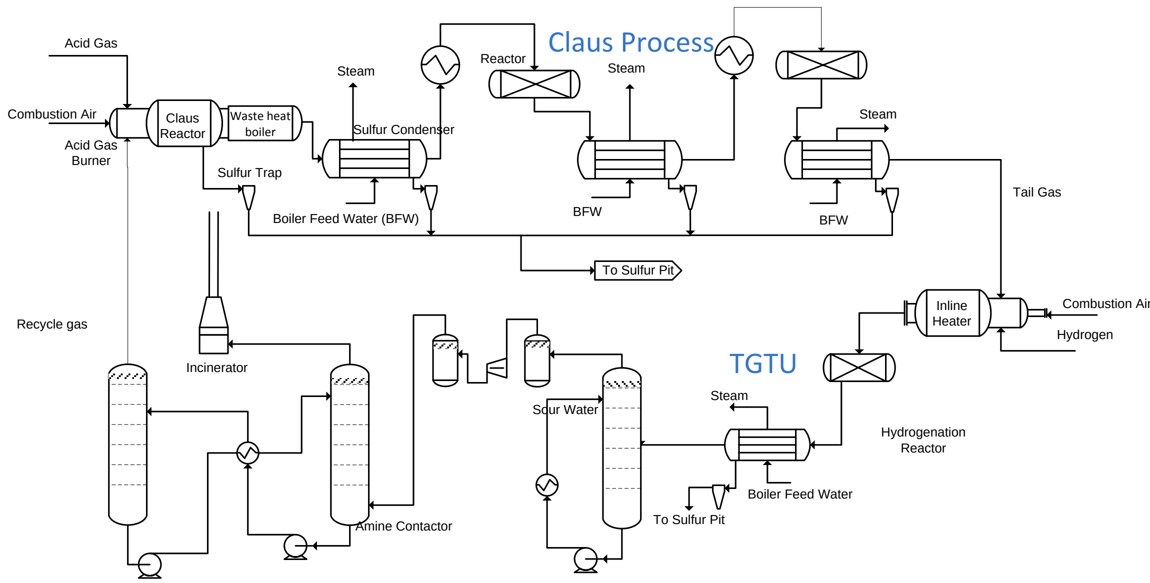

Figure 1: Simplified Claus Process with Scot Tail Gas Treater

The EPA has now intervened with consent decrees with most major refiners and the normal discharge of the exhaust gas from the process to the atmosphere via the incinerator is no longer viable (they now go through a tail gas treating unit which can "block" the outlet with block valves or liquid head). There are rumors that certain facilities are going to be required to install traps in the sulfur seals that do not allow gases to pass through them (similar to a steam trap, but for sulfur). These two steps eliminate the overpressure protection for "old" SRUs. Note that wherever the emergency vent gas goes, the gas is extremely toxic, can, and has killed people. For that reason, venting via the sulfur pit is probably a bad idea as sulfur pits tends to be a buried low pressure tank with a low allowable pressure.

Here is a relatively detailed list of how Smith & Burgess LLC evaluates overpressure protection for these systems.

Problems Related to Relief Devices

1. Installation of a relief device upstream of the Primary Reaction Furnace (Claus Reactor) may be acceptable ***only*** if the maximum discharge pressure of the combustion air blower is less than the set pressure of the relief device. If the blower can put up more pressure than the set pressure (and you have to check on a cold day) the possibility exists that the air will flow backwards through the burner into the inlet line and melt everything (best case) or result in an internal explosion (worse case). ***This has happened!***
2. Pressure Relief Valves downstream of the first condenser are generally not recommended (or useful) due to the complexity associated with ensuring that they do not plug (solid sulfur or NH4HS deposition). Experts agree that plugged relief devices are close to worthless. One could steam trace and purge the relief device inlet lines; however, this complexity definitely lowers

the availability of the system (not to mention the corrosion concerns associated with H2S / NH4 below about 250 °F). ***Normal block valves do not stand a chance in this service so why would a relief device.***

3. Putting anything downstream of the first condenser causes a problem because many times the blocked outlet has been caused by collapsed reactor beds or plugged sulfur condensers. ***Again this happens.***
4. PSVs also have another challenge. Say the systems normally operates between 10 and 12 psig (operating pressure is directly related to the capacity so this pressure is creeping up) with a safety shutdown system at about 12.5 psig. On older systems, the equipment is designed for about 15 psig (generally 14.8/9 so they don't have to comply with Section VIII) and the sulfur seals blow in the 14-15 psig range. ASME Section VIII M-11 (c) recommends a minimum of 5 psi difference between the set pressure and the operating pressure for relief devices. That aside, relief devices require 10% on the inlet so they don't leak, have a +/- 3% for the set pressure tolerance, and require about ~8% to open. Either way, relief devices in general will not operate well between the constraints of the operating pressure and blowing vapor through the sulfur seals.
5. Rupture disks have been installed in low pressure services in the past, but tended to fail at pressures of 5 psig when set at 15 psig. This results in operational concerns and increased downtime for the unit and is generally not a viable solution.

Smith & Burgess LLC is working with a rupture pin manufacturer to see if rupture pin technology can meet the service requirements for installation just after the first sulfur condenser venting directly into the incinerator. They can be specified with a piston that is flush to the pipe wall and sized in such a way that the maximum pressure is the set pressure. Current tolerances are +/- 0.5 psi on the set pressure, so it may work. I am hoping that these devices will work like an HIPS system (without all of the pain and the ASME Section VIII endorsement for PRDs). I know that block valves are being replaced with flush pistons and virtually eliminating deposition and corrosion concerns (no dead space).

Once the means of overpressure protection has been decided, the next question is the ASME VII requirement for venting the relieved vapors to a safe location. The disposition of the relieved vapors can raise almost as many questions as the determination of overpressure protection method.

Venting disposition – The following discussion is for a rupture pin or ESD that opens after the first condenser and lets the flow out to somewhere. *Upstream generally of this location presents a problem (hot air into the flare or other location) and downstream of the first condenser is much more likely to encounter blockage.*

1. Venting the stream from the first condenser to an incinerator is generally a problem as it defeats the safety instrumented protection against flameout then re-ignition. This is primarily a problem if the stream is flammable (and they usually are until the very end). Should the venting event snuff the flame, then the possibility exists that the flammable stream will ignite somewhere in the piping between the burner and the incinerator outlet (*internal explosion*).
2. Venting the stream to the flare is also not advisable as the system will frequently have shut-down logic which could isolated the acid gas but not the blower and blow air into the flare header. After passing through the inlet furnace, reactor, waste heat boiler and 1st sulfur condenser, the air will still be above 600°F and injecting even small quantities of high temperature air into a flare header is not a good idea. (see above).

3. Similarly, venting through the sulfur pits has the problem of over-pressuring the sulfur pit and/or poor dispersion. Not to mention that if the facility is forced to isolate the sulfur pit with the SulTraps, this option is gone!
4. Seemingly the best option is a dedicated vent stack that is high enough to prevent unacceptable concentrations of H2S at grade or nearby elevated structures.

General Concerns

1. The location of the relief protection must account for all the aforementioned problems.
2. SIL-III systems are generally extremely costly to install and maintain due to the number of feeds to the system (may be over 10 that can overpressure a single SRU train).
3. Relief protection, should it be provided, will have to act above the existing shutdown system but below the MAWP or sulfur seal pressure.
4. Back flowing acid gas through the inlet of the blower is ***very*** bad and has actually killed workers in the past in Europe. Any system should not stop the blower but isolate the air inlet from the process and all the anti-surge control system to divert the discharge to atmosphere. We should also check the blower and ensure that there is some means to stop the backflow of acid gas.