Cautions When Using Full-Bore Relief Devices

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Common Applications

Although full-bore relief devices are not "common", the most common place that full-bore devices have been seen is in natural gas pipelines, where they are sized for full flow in the event of a blocked outlet. They have been found installed on multi-stage gas compressor systems, as well as on low pressure/ large relief load systems such as the FCC Fractionator. Full-bore devices are not typically installed as part of the initial design, but are considered after the equipment and nozzles are already specified or built, and aren't large enough for a standard PSV to have adequate capacity.

Potential Issues

With full-bore relief devices, it is extremely difficult to meet the 3% rule, especially if installed on a flange with the same nominal pipe diameter. The below paragraph considers the inlet pipe flange to be the same nominal diameter as the PSV inlet flange. It is not expected to see full-bore devices connected to flanges with larger nominal diameters, because the limitation in available nozzles was most likely the reason for resorting to a full-bore device.

If pilot is "self-regulating", where it senses the pressure at the PSV immediate inlet, then at a minimum the entrance loss will be considered if the PSV is mounted directly on the vessel/pipeline flange. If a sharp edged entrance (K = 0.5) is considered, the inlet pressure drop is typically around 7-11% of the set pressure. If a slightly rounded entrance (K = 0.25) is considered, the inlet pressure drop is still typically greater than 3%. For these valves, the 3% rule can still be met by ensuring that the entrance is rounded enough for the pressure drop to fall below that point. API 520 pt II §4.2.2 already states rounding the entrance as a method for meeting the 3% rule.

This of course does not consider any inlet piping or fittings other than the entrance. If a full-bore device is installed on any significant length of inlet pipe, it should be equipped with a remote sensing pilot. API 520 pt II §4.2.2 currently references §4.2.3 for using remote sensing pilots if 3% rule isn't met with a certain piping configuration.

API RP 520 pt II §4.2.3.1
"Although remote sensing may eliminate valve chatter or permit a modulating pilot-operated pressure-relief valve to achieve full lift at the required overpressure, any pressure drop in the inlet pipe will reduce the relieving capacity"

Although this statement brings to attention that the user should correct the relieving capacity to account for inlet pressure drop, it may not be clear that the inlet piping, and not the relief valve, could be limiting the relieving capacity. Choking in the inlet piping is possible when full-bore relief devices are installed. This also makes the PSV nameplate capacity not an accurate representation of the relieving capacity.

Caution should also be used for liquid relief cases, where the inlet pressure drop results in flashing in the inlet line rather than across the PSV. Therefore, a different PSV sizing method would need to be used. Although it seems unlikely, if a natural gas liquid is flashing in the PSV inlet line, would the temperature drop below the design conditions of the PSV?

For new system design, specifying a full-bore device could hinder expansion and increased throughput, as there is no room increasing the PSV orifice size.

Considerations

It is in the opinion of this author that full-bore relief devices should not be considered as part of designing new systems. For existing systems, full-bore relief devices could adequately be used as cheaper alternative to replacing a vessel nozzle. However, the user should be fully aware of the affects that the inlet piping will have on the relief capacity. If not installed directly on the protected vessel, full-bore devices will most likely have to be equipped with a remote sensing pilot ties in somewhere upstream of the inlet pipe entrance. If the PSV is not remote sensing and it is installed directly on the protected equipment, the entrance loss will be considered.