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Blocked discharge PSV requirement on Centrifugal Compressor Discharge

Sampath Kumar R
Upstream Process Engineer at Technip

Dear Friends,

I happened to notice installation of PSV (designed for blocked discharge scenario) at Centrifugal Compressor's discharge. Generally discharge piping / system of Centrifugal Compressors shall be higher than the maximum pressure developed by the compressor (Maximum pressure corresponds to the maximum speed of the compressor at reduced flow i.e. towards surge line).

However, even if the discharge piping is being designed for maximum pressure generated by the compressor, most of the centrifugal compressor discharge will have PSV (designed for blocked discharge scenario) and we will not go in detail as it is vendor package.

Can we avoid PSV at Compressor discharge if the discharge piping is designed for the maximum pressure generated by the compressor?

Kind Regards

Sampath Kumar R

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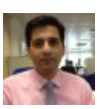

Saeid R. Mofrad
Principal Process Engineer at Petrofac (P.E.)
Top Contributor

A process equipment is assumed to be fully protected if either of the following methods is used:

'1. Designing the system for the maximum pressure attained in service during normal operating, upset, startup and shut down conditions. This pressure in most cases is extremely high, unpredictable or not economically feasible to design for. That is why second approach is usually being followed.

'2. Designing the system for a pressure (called design pressure) which is calculated by adding some margin to maximum operating pressure and providing a relief valve set at or below calculated pressure.

Centrifugal pumps are usually designed based on first category whereas reciprocating pumps' protection is achieved through second method.
The same rule is applied to compressor or any other system.

Under particular conditions, HIPPS also can be an alternative to the second method.

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Mojtaba Habibi
Process Engineer at Petroleum Engineering and Development Company (PEDEC)
Top Contributor

Mojtaba

Here is the response I have received for the similar query from Mr.Philip Leckner who is very experienced at presure relief system design:

"No, the full pressure rated design, now officially part of ASME Section VIII, Div. 1 (see paragraph UG-140) is for any pressure containing equipment that falls within ASME scope. Pump and compressor casings usually do not fall within ASME but vessels of course do. If you can justify that no external source of pressure on a piece of equipment can exceed that equipment's MAWP, then you have the option of not installing a pressure relief device.

To justify this, you would have to go through the exact same scenario analysis as you would if you were going to install a PSV. You would then need to notify the vendor that you intend to invoke this option. You also need to notify the governing authority that you intend to invoke this option and they must give prior approval before the equipment item can be built. Of course, I'm talking about the U.S., other countries might be different.

So in a nut shell, I would just put the relief device in and forget about trying to invoke this option, it just isn't worth the time to wait for prior approval."

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Mojtaba Habibi
Process Engineer at Petroleum Engineering and Development Company (PEDEC)
Top Contributor

Mojtaba

Here is the response I have received for the similar query from process leader of french reputable company who is experienced at design of compressor stations:

"Regarding the PSV downstream of a centrifugal compressor, I tend to agree with you. However a PSV may be required anyway:

- if the compressor is driven by a gas turbine, over speed should be considered;

- increase of the gas molecular weight above the design range may be considered.

Then it sometimes is a Company rule to install a PSV downstream of all centrifugal compressors."

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Stuart

Stuart Williamson
Dynamic Simulation Consultant at CB&I

I think this discussion is very similar to one we had a number of months back about non-slam check valves at a compressor discharge, as that discussion digressed on to discharge relief valves.
When considering the maximum discharge pressure you need to start from the maximum suction pressure (some would use the suction high pressure trip and others the suction PSV setting).
You may also need to account for the highest molecular weight (as stated above), and the lowest suction temperature.
Whilst in reality the compressor driver may not physically be capable of delivering this mass density at the suction (due to power limitations), some may consider that this again has to be ignored (e,g, on an electrical drive, the maximum torque can be much higher than the rated torque)
Allowing for all the above and at the maximum head (surge line) at the maximum speed, you may end up with quite a high pressure value. As per the discussions above, in general a compressor will have discharge PSVs or HIPS protection (which replaces the PSVs).
I have seen system designs that have PSV's around the anti-surge valve (to limit any discharge relief rate), but this only relieves to the suction, which can require careful consideration of what then happens / is required at the compressor suction.

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Vinay

Vinay Singhal
Process Engineering Manager at McDermott International Inc.

Stuart, I read your above reply as well as the earlier discussions regarding provision of non-slam check valve on compressor discharge. You mentioned above that an electrical drive (fixed speed) can have a maximum torque much higher than the rated torque. What is of interest is that you and other estemmed members use the word "torque" instead of "power". As I understand:
Power = Torque x 2 Pi x rotation speed; or
Power (hP) = torque (lbf.ft) x 2 Pi x RPM / 33,000
Therefore, is it possible that during motor start, since the speed is less, corresponding torque is high, but the maximum power delivered by the motor do not exceed its rate power. Point of interest is how much power is made available to the Compressor and what would be its corresponding delivered discharge head at maximum power (assuming fixed suction pressure).

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Stuart

Stuart Williamson
Dynamic Simulation Consultant at CB&I

Vinay
Depending on the units your equation is pretty much correct.
What I was referring to was if if you look at the torque speed curve for a fixed speed motor, the peak torque (which occurs around 95-98% speed) can be up to say 2 times the rated torque. Hence if during normal operation, the compressor suction density (i.e. pressure) were to increase, and the gas compression power increased accordingly, the fixed speed motor can potentially deliver much more power than the rated power. This is why typically this sort of configuration has a motor maximum current (i.e. power) protection system which will for example close a suctin throttle valve.
So the point being made here is that the PSV calculation should not necessarily be limited by the rated power of the motor, as in the short term this could potentially be exceeded.

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