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Is it necessary to consider heat exchanger for sizing PSVs at external fire?

MyoungGun Jeon

포스코엔지니어링 대리

Hello, everyone.

Do I have to consider heat exchanger when I calculate relief load of PSVs at downstream vessel?

In my past experience, only portion of the vessel which is wetted by its internal liquid and is equal to or less than 7.6 m above the flame source were considered to determine the amount of vapor generation. Or unwetted surface of vessel was used to calculate relief load for KO drum

I am afraid that fire relief loads from heat exchanger are very small so chattering can occur at PSVs at downstream vessel if I consider heat exchanger as a source of relief gas.

Answers with standard or codes would be highly appreciated.

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Saeid Rahimi Mofrad

Senior Specialty Process Engineer at Fluor

Hello,

the heat exchanger and vessel can have a common relief valve if you prove that relief path from heat exchanger to the vessel is available during fire. you need to ensure that there is no element in the path that can limit the flow or fail (such a control valve) during fire to obstruct the flow.

for relief valve chattering during heat exchanger fire (which is most probably because the vessel relief valve is too large for heat exchanger load), you can not do much (for each relief valve in a plant, there is usually a low flow relief case). But considering the low possibility of fire, it may be an acceptance risk. Furthermore, the vessel and heat exchanger are presumably very close, they are most probably in the same fire zone and the combined fire relief load from both equipment may reduce the risk of chattering.

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MyoungGun Jeon

포스코엔지니어링 대리

Thank you for your answer.

MyoungGun

Unfortunately, actual heat exchanger location is far from downstream vessel and there is no isolation valve.

It seems that external fire scenario should be considered for each item. Since wetted area of heat exchanger is much smaller than that of vessel, relief loads from heat exchanger in fire are also small.

My client requested me to apply multiple PSVs to avoid chattering due to comparatively small relief loads.

There is no requirement of installing multiple PSVs in API. However I found that approximately 25% of PSV relief capacity make spring loaded PSV open once it pops under any circumstances

in API. Can I use this?

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Wilfredo

Wilfredo Garcia

Process Specialist at Ecopetrol

Hello sir,

API accepts multiple PSVs installation. In this particular case, you have two options:

- 1.- Add a small PSV in the vessel for fire case at heat exchanger
- 2.- Install a PSV in the heat exchanger

Cheers,

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Saeid Rahimi Mofrad

Senior Specialty Process Engineer at Fluor

Refer to API-520 5.4.3.4 Supplemental-device Installation:

5.4.3.4.1 A supplemental-device installation provides relieving capacity for an additional hazard created by exposure to fire or other unexpected sources of external heat.

5.4.3.4.2 Supplemental devices are used only in addition to devices sized for operating (non-fire) contingencies.

5.4.3.4.3 The set pressure of the supplemental device is 110 % of the vessel's design pressure.

Therefore, you can have a small relief valve sized for fire case on the heat exchanger set at 110% of system design pressure where there is a large one on the vessel set at 100% of system design pressure.

Having said that, increasing the number of relief valves just because it may chatter at low flow is not realistic. Most of the relief rate calculations are based on lots of conservative assumptions (such as non-favorable action of control system to reduce the relief load, maximum heat input to the system, valve fully open, etc) which most probably in reality won't happen as bad as we think, therefore the relief valve size will be most likely too big for service anyway. This means that even if there is a single applicable scenario, there is a risk of chattering. The higher number of applicable cases to the system, the higher chance of having a large difference between the relief load of different cases. These reasons along with the remote possibility of fire in the plant completely overrules the need for extra relief valve for likely chattering the relief valve during fire.

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Rupalkumar

Rupalkumar Buch

Principal Process Engineer at Jacobs Engineering India Pvt.Ltd.,

Agreed completely with Saeid. There is wide a spread conservative approach for PSV sizing, which is normally be a highly conservative one, like if you size a PSV for one governing case, that's very high then other applicable cases, the PSV will do chatter if it releases on non-governing cases, and if the governing is fire, this normally happens. While in your case you are worried about PSV chattering in fire case, which is the rarest possibility, I think we can avoid providing the extra PSV..

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Naser

Naser Fallah

Senior Project Engineer at Nargan

Hi,

Focusing on OP issue, if the concern is limited to PSV chatter in just fire case it will result in no problem, but if the range of required relieving rates for various contingencies is so wide that included other cases with small (mostly lower than 25% of the maximum relief load) relief load, then you have to consider multiple PSVs with staggering set pressures for sequential operation to avoid chattering...

Best Regards

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kyoumars

kyoumars rahimi
Deputy of Process Engineering Manager

Dears,

I agree with Saeid, you can consider Heat exchanger and vessel as a block (without any valving between exchanger and vessel) and calculate system relief load at fire condition.

for more information, we consider fire case PSV for refrigerant kettle type heat exchanger (tube rupture case to be calculate if it is valid for exchanger).

Thx

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👍 [Minwook Kim](#), [Mahmoud Aghaei](#) like this



Mahmoud

Mahmoud Aghaei
Piping & Plant Department Manager at Tehran Raymand

Dear Mr. Jeon.

As you said heat exchanger is located far from down stream of vessel, so it seems you have to put a block valve on connected line because of isolation and maintenance philosophy. In this case heat exchanger needs to a separate PSV close to heat exchanger to meet 3% pressure drop at downstream of mention PSV. Let say sorry to discuss on this very proficient subject.

Best Regards,
M.Aghaei

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Shaun

Shaun Nateghi
Senior Process Engineer, CPEng MIEAust, RPEQ, NPER

Hi

Referring to Saeid's comment above regarding provision of supplemental valve on the HX, I reckon it won't address chattering in fire relief; Because the relief during fire is going to be through the big valve having less set pressure rather than the small one set at 110%. Supplemental (as the name suggests) valves are meant to cater for cases in which fire relief load is greater than non-fire cases and to take care of the ADDITIONAL load imposed by external fire (See API-520 as copied in Saied's comment above).

Correct me if I'm wrong.

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Shaun

Saeid Rahimi Mofrad
Senior Specialty Process Engineer at Fluor

Shaun,

You are right about the purpose of supplemental relief valve in API and the fact that the arrangement I proposed above does not prevent chattering. Thank you for that.

it will resolve the chattering issue, if you read it as "you can have a small relief valve sized for fire case on the heat exchanger set at 100% of system design pressure where there is a large one on the vessel set at 110% of system design pressure." The next stage is to use the correct accumulations (over-pressures) for these valves not to exceed the Maximum Accumulated Pressure (121% of design pressure) according to the code requirement.

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Shaun

Shaun Nateghi
Senior Process Engineer, CPEng MIEAust, RPEQ, NPER

Thanks for your feedback Saeid.

Regarding your latter proposed arrangement, I agree that it'll alleviate chattering as you and Naser mentioned before. In this case however, since the second valve is considered as "additional" valve rather than "supplemental", the set pressure should be 105% rather than 110% according to API. In addition, maximum accumulation (over-pressure) of 121% could be taken only for the first valve and only in fire case.

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Saeid Rahimi Mofrad
Senior Specialty Process Engineer at Fluor

I agree that calling the second valve "additional" (rather than "supplemental") seems more appropriate for this case but in general the setting proposed by API (having 5% margin between first, additional and supplemental valves which are set respectively at 100%, 105% and 110% of design pressure) is just to have some consistency across the board. But in reality nothing prevents you to have different setting as long as Maximum Accumulated Pressure meets the code requirement.

In this case if we assume that the system design pressure is 100 barg, the Maximum Accumulated Pressure is 121barg (which is fixed - 121% of design pressure for fire case as per code) but the overpressure for these valves serving system during fire is as follows:
first valve set at 100 barg --> overpressure is 21 barg
additional valve set at 105 barg --> overpressure is 16 barg
supplemental valve set at 110 barg --> overpressure is 11 barg

Don't get caught by names, if you notice in above example I have used three relief valves to handle the fire load. It is not usual to see this configuration that but if somebody uses it due to any reason, you can not call it wrong because it is inline with the standard, meets the code requirement and more importantly fully protects the system!

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