We used the calculation of PSV for two phase liquid/vapor relief (API 520 Part 1 annex C) for equipment protection yielding big sizes of PSVs. What experience exists with this method?

Germán Snaider
Ingeniero de procesos en FLUOR DANIEL SOUTH AMERICA LTD

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Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

Mr. German, we used to discovered what will be the composition of gas and liquid on pressure and temperature at downstream , then we size the PSV for each composition and after we add the area of each orifice to get the total orifice and the PSV. Important to require to manufacturer a SRV (used as PSV and PRV).
I wait to help you, best regards.

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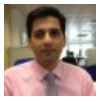

Saeid Rahimi Mofrad
Senior Specialty Process Engineer at Fluor

I guess you are referring to APP C of 8th edition of API-520 (December 2008), two phase relief valve sizing had been discussed in APP D of earlier version (Jan 2000).

I have sized many relief valves using numerical solution of isentropic nozzle and the modified version of omega method presented in this appendix but i did not face any unexpected or extraordinary sizes. for high liquid fraction, relief valve size will be even relatively small.

I can do it quickly if you provide me with required input data. Refer to the following spreadsheets on my website (www.chemwork.org/sprd.html) to see the inputs required:

- PSV Sizing (Two Phase - HEM Method Numerical Solution)
- PSV Sizing (Two Phase - Omega Method)

Regards
Saeid

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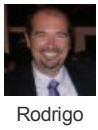

Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

Mr. Saeid, I'd like to know your opinion if the methodology showed above by me reports result so different if compared at your methods, could you tell me?

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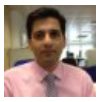

Saeid Rahimi Mofrad
Senior Specialty Process Engineer at Fluor

Dear Rodrigo,

Two phase flow in the relief valve nozzle can be formed in different ways:

1- Two phase mixture enters RV and liquid flashes

2- Two phase mixture with non-condensable gas enters RV and liquid flashes

3- Two phase mixture with/without non-condensable gas enters RV and liquid does not flash

4- Single phase liquid enters RV and flashes

Method mentioned by you, (sizing liquid and vapor orifices separately and selecting an orifice equal/bigger than summation of vapor and liquid orifices), will overestimate RV orifice in some of these cases and underestimate in some other. But the main point is that this method lacks the sound theoretical basis and validated experimental data.

Despite its origin dating back to the 1950's and its popularity over the years, this method is regarded as obsolete. That is why, it was removed from API and replaced with new methods since Jan 2000 (7th edition).

Regards
Saeid

Delete • August 30, 2011

Ed

Ed Kitchen
PSM Technical Speicalist at Digital Solutions Technology, Inc

Saeid is right on track.

You are also welcome to use for free the Mach II Digital Engineer at www.digitalsolutions.org and download the software, install and request user ID and passcode. The software uses both the algebraic Omega method and the more rigorous HEM method of numerical integration of the Vdp intergral to determine the maxium flux, Gmax at the choke. This method works for all states, gas, liquid, and two-phase mixture. What is great about the program is that you can follow the fluid as it flows in the inlet and outlet pipiing and is being depressurized and begins to expand and possibly flash. The results you can see both in a numerical integration table and also graphically where you will be able to looks to the physical properties of the fluid at each integration step. The API method uses a version of the Omega method but has limitations. It does not take into account viscosity, and is an aalgebraic approximation of the more rigorous numerical integration method of HEM. It also does not take into account slip or non-equilibruim into the model. Also you want to include flow regime modeling into the equation. What type of flow model do you want to consider. If you choose the more conservative homogeneous model then you will get a larger relief oriifce then if you have some disengagment between the vessel and the nozzel. Other flow regimes that may be considered are bubbly or chur-trurbulent which is the less conservative, You can play with the Mach II and determine how selection slip, non-equibrimum, or selection different flow regime models with effect the sizing of the orifice. The the API Omega method you do not have this type of flexibility. Also with this method used in API it does not show you how to calculate the inlet and outlet pressue drop with is required to meet the ASME code. However using the numerical integration method the inlet and outlet pressure drop are detemined automatically by just subtracting the pressue at Gmax from the the relief pressure for the inlet and from the back-pressue for the outlet piping.

Enjoy!

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Germán

Germán Snaider
Ingeniero de procesos en FLUOR DANIEL SOUTH AMERICA LTD

Hello everyone, thanks very much for your help!

I was talking about API 520,Part 1, Appendix C (as Saeid said).

I have to say that i have worked with a client that asked us to use the method of " Sum of areas" (as well as Rodrigo has explained) that is, calculating liquid relief, then vapor relief, and suming the required areas. But that was asked by a particular client.

Nowadays, we are using the two phase relief method of API 520, P1, AppC.
We found that in the last projects, the method of sum of areas yields a lesser required area than the 2 fase method, for the PSV (PRV).
I`ve performed some cases to get some sensibility, and i found that from a GOR of 400, the required area is approx. 2 times higher (i begin with 120.000 SCMD of gas and 10m3/d of liquid

and then i increased the liquid flow rate to 2500 m3/d).
Talking about the Gas oil ratio, we have many different cases.

So, we are trying to define a criteria and assess our clients about safety relief requirements.

I will find a representative example an i give it to you Saeid.

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Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

I had thought that the method of " Sum of areas liquid and gas" was conservative, are you sure that it's not warranted ? On time, I'd like to know what does mean "RV" on the write by Mr. Saeid and what does mean "GOR" on the write by Mr. Snaider, Could you answer me?
Another question is, does the API RP 520 part 1 avoid this method ?
Thanks for you attencion.

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Ed

Ed Kitchen
PSM Technical Speicalist at Digital Solutions Technology, Inc

Adding the liquid and vapor portion is not a valid technique and is not considered conservative. As a matter of fact the resson it was removed is that sizing using this method was grossly undersizing valves as much as ten times! Do not use this method. As Saeid has discussed it has been long removed from API. To get the lastest research and methodology you should use DIERS methodology (Design Institute of Emergency Relief System) a sub-group under AIChE. They have been the true leader in this two-phase relief design. API is using some of the DIERS methodology. The most reliable method is the rigorous HEM numerical integration. There are also some good articles on the comparison of various methods and their strengths and weaknesses. Send me you e-mail and I can send some articles to you.

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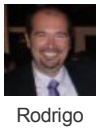

Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

Thanks Mr Kitchen, I´ll study that to learn one more thing, I´ll wait for you e-mail.

Like • Reply privately • Flag as inappropriate • September 2, 2011

Ed

Ed Kitchen
PSM Technical Speicalist at Digital Solutions Technology, Inc

Did you send me your e-mail address? I have sent them to Saied so you can also get them from him. Or you can send your e-mail and I can send to you

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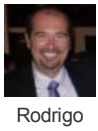

Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

I had sent my adress for you as message, look at your message, it´s there, thanks.

Like • Reply privately • Flag as inappropriate • September 7, 2011

Germán

Germán Snaider
Ingeniero de procesos en FLUOR DANIEL SOUTH AMERICA LTD

Well, the main cases could be two scenarios of :
a) 100.000 SCMd of gas and 900 m3/d of liquid (50% W.C.)
b) 170.000SCMd of gas and 2300 m3/d of liquid (70% W.c.)

HC: is 80% methane, no H2S or CO2 reported,
viscosidad a): 1467cP
viscocidad b): 0,9 cP
ºAPI : aprox. 32
gas MW: 18.1

I obtained:
a) 4 P 6
b) 6 Q 8
for full flow of gas and liquid, with API 520 Part1, Normal boiling point < 150ºF.

What do you think?

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Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

I'm sorry Mr. Snaider, but I don't know what is SCMd, could you explain me? To get best precision it would be to know the value of k (cp/cv) and Z (isontropic factor).

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Germán

Germán Snaider
Ingeniero de procesos en FLUOR DANIEL SOUTH AMERICA LTD

SCMD: Standard cubic meters per day.
k = 1,28
Z = 0,9967

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Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

Sorry Mr. Snaider, I had tried to solve the question but I need to know some other informations, could you send me the list below?
Design pressure, operation pressure, back pressure, relief temperature and what it will be the over pressure allowed.
I am waiting for you complementation for me try solver.
Thanks.

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Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

I guess that value just as test, please, check it.

═══════ DADOS DE PROCESSO ═══════

Identificação - PSV- MR Snaider
Tipo de fluido - desconhecido
Estado Físico - LïQUIDO+GåS
Diâmetro da linha/equipamento - desconhecido
Critério de dimensionamento - BLOQUEIO INDEVIDO
Vazäo Gás/Vapor Requerida - 4166.7000 Nm3/h
Vazäo Líquida Requerida - 37.5000 Nm3/h
Pressão de operação - 8.0000 kgf/cm2 MAN
Pressão de ajuste - 10.0000 kgf/cm2 MAN
Contrapressão variável (máx.) - 1.0000 kgf/cm2 MAN
Sobrepressão (%) - 10.0000
Densidade Rel @ Alívio - 0.8650
Viscosidade Absoluta - 1467.0000 cps
Temperatura de Alívio - 40.0000 GRAUS C
Temperatura de Projeto - 60.0000 GRAUS C
Peso molecular - 18.0000
Fator de Compressibilidade - 0.9967
Coeficiente isoentrópico - 1.2800

═══════ P. S. V. ═══════

Area Calculada (Líquido) : 0.154874 pol²
Area Calculada (Gás) : 0.716178 pol²
Area total calculada : 0.871052 pol²
Orifício da Válvula tipo : ORIFICIO J
Corpo e Castelo : ACO CARBONO
Mola : ACO CARBONO
Tamanho da Válvula : 2 X 3
Classe de pressão : 150# X 150#

═══════ FATORES DE CORREÇÃO ═══

Parte líquida :
Correção Devido à Sobrepressão (Kp) - 0.6022
Correção Devido à Contrapressão (Kw) - 1.0000
Correção Devido à Viscosidade (Ku) - 0.5847
Número de Reynolds (Re) - 96.9216
Coeficiente de Descarga (Kd) - 0.6200
Parte Gasosa :
Correção Devido à Contrapressão (Kb) - 1.0000

Constante do Gás/Vapor (C) - 345.0836
Coeficiente de Descarga (Kd) - 0.9750

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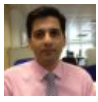

Saeid Rahimi Mofrad
Senior Specialty Process Engineer at Fluor

Germán,

The data you have provided is not enough to size the relief valve. Since mixture NBP range is less than 150ºF, one of the following methods can be equally used:

* Numerical solution of HEM method

* Omega method using fluid properties at single point

* Omega method using fluid properties at two points

You can find the data required for each method through the spreadsheet files I have uploaded in below links:

http://www.mediafire.com/?f9fo5xnyson5h7c,
http://www.mediafire.com/?185duzs1e9w2848,
http://www.mediafire.com/?5xeqwdgl4fn5hry,

Green cells are input data. You can print any of them and write the data for the relief valve you want to size. I will do the sizing for you and share the results.

I sized a sample relief valve using above methods (refer to the links). All of them produce same results (orifice area =7.3-7.4 in2). Then I checked the size of relief valve using old API method (summation of liquid and vapor orifice) the required area is about 3.7 in2. simply 50% underestimation!!

Delete • September 22, 2011

Germán

Germán Snaider
Ingeniero de procesos en FLUOR DANIEL SOUTH AMERICA LTD

Well Saeid, i had aproximately the same results that you got.
the links you posted gives error, so i couldn`t download the spreadsheets.

Rodrigo, i have seen your answers, and with the method of sum of areas i got aprox the same result as you on gas relief, but i got a higher area required for liquid relief. So the total area result i get is higher.

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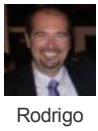

Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

Germán, would you have any idea about what the difference between my method and your method? Another doubt, where could I find some article about the calculus method to design the orifice for fluids on 2 phase, liquid and gas? Could you have send me some software or equation/method to use for that case? Thanks

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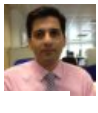

Saeid Rahimi Mofrad
Senior Specialty Process Engineer at Fluor

German,
i guess you misunderstood. The data you have given in previous posts are not enough to size the PSV, for example relieving pressure and many other parameters are not known.(see data required for each method in the links)
i have done sample calculation to compare the result of old and new API methods which shows 50% undersized PSV using old method. it is nothing to do with your PSV.
links are working as far as i try.

Rodrigo,
you don't need article, get the latest revision of API-520 and refer to APP.C

Delete • September 23, 2011

Rodrigo Lopes de Siqueira likes this

Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

Saeid, could you send me some software by e-mail to use for that case? It will be so large to send? Thanks

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Evgeny

Evgeny Ivlev
Senior process engineer at Sakhalin Energy

Dear all,

could you give me an example of case when both liq&gas will flow through PSV?
I really can not find such application
Thanks

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Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

Dear, that can occurred with LPG, because the fluids is liquid on high pressure and it will be at 2 phase when it will be discharged to flare or vessel on low pressure. I wait to help you.

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