Could anyone guide me how to calculate latent heat of a multicomponent mixtures ? Any reference material,book will help.

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Roberto

Roberto Paron
Software consultant & contractor at Prode

the Properties of Gases and Liquids by Prausnitz, Poling, O'Connel would be a good starting point but other books can be of interest for specific areas of application.
Databanks (DIPPR etc.) have correlations and data for pure components at saturation temperatures.
For multicomponent mixtures one can calculate latent heat as difference from vapor enthalpy and liquid enthalpy, these (vapor and liquid enthapies) can be estimated from ideal gas enthalpy by adding the departure calculated with a equation of state.
You can (easily) do these calc's with a Process Simulator or in Excel , Matlab etc. with a proper add-in.

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Tariq A. Al-Omari likes this

Evgeny

Evgeny Ivlev
Senior process engineer at Sakhalin Energy

L(mixture)=L1xX1+L2xX2+....
Li-latent heat of component kj/kmol
Xi-mole fraction

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Goddeti

Goddeti Gangaiah
Process Engineer at ADMA-OPCO

one must know the mass fraction each component in the mixture and mafraction is to multiplied by pure component latent heat and then sum them.

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Raheleh

Raheleh Sabounchi
Process Engineer

As you know when a mixture is vapourize,the composition in liquid phase will be changed.in other words mas heat of vaporazation will be varried by time.
in case that vaporazation heat of the components in the mixture is closed to each other it is not very important.but when there is large diffrent between components,this will be a problem.
I have always problem when I want to calculate this parameter for mixture in fire relief load calculation in PSVs .Please let me know your experience for this case if any.

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Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

Dears, to estimate the latent heat of the moisture to designer PSV to avoid overpressure in fire conditions, we can be conservative, if you are not sure about the percentage of each components on time of vaporization, besides the facts of the variation of the composition during the vaporization, as said by Ms. Sabounchi, the critical moment will be on the begginer of the vaporization. Remember that the price of the PSV and all pipe is too small than all system, then it ´s better you make mistake to put one PSV few bigger that necessary than smaller that necessary.
About shatter possibility, this can be avoid if you assembly one other smaller PSV to small overpressure events.

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Dimitrije Dimitrijevic likes this

Roberto

Roberto Paron
Software consultant & contractor at Prode

altough SUM(Hi*Xi) is correct it's difficult to estimate latent heats in multicomponent mixtures as there is not a single point for phase change.
Supposing you know values in the saturation curve (from DIPPR or estimated with Clapeyron, corresponding states etc. see Properties of Gases and Liquids) you can calculate averages (or integrate values) for that component in the mixture.
Alternatively (as suggested in my previous post) one can calculate heats of vaporization as difference from gas and liquid enthalpies, these can be estimated with a EOS or equivalent method (starting from low pressure conditions and calculating departures), errors are usually low for hydrocarbons, may be large for polar fluids (water etc.) depending from selected EOS

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Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

Mr. Roberto, I have used estimative for hydrocarbons, really it’s a good estimative, but for polar fluids, as NaOH in water for example (10%, 20%, etc), do you think that the result is no so good? Or your commented was just for mix of other solutions (no consider water to dilution) ?

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Roberto

Roberto Paron
Software consultant & contractor at Prode

the original post was for a method "to calculate latent heat of a multicomponent mixtures" and the suggested procedure has general application providing there are accurate ways to estimate/calculate vapor and liquid enthalpies, of course for narrow-boiling-mixtures things are more easy, for the specific case you mentioned there are reliable values available in the literature for low pressure range, you can compare estimated values with experimental data.

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Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

Thanks Roberto!

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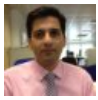

Saeid Rahimi Mofrad
Senior Specialty Process Engineer at Fluor

May be the simplest way is to use software like Hysys. For each multi-component liquid mixture, Hysys gives a property called "mas heat of vaporization" which is nothing but the difference between vapor and liquid enthalpies.
I am not sure if the original post was about fire case but if anybody is interested about fire relief study and variation of process parameters during fire:

See the article titled "designing for pressure release due to a fire - Part 2" on http://www.chemwork.org/paper.html

There is a spreadsheet on http://www.chemwork.org/sprd.html called "Fire Relief Rate Calculation for Wetted Vessels Using Sequential Flashing Method" for the same calculation.

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Lionel Sheikboudhou, Anny del Valle B. like this

Roberto

Roberto Paron
Software consultant & contractor at Prode

the original post was for reference material, book etc. to calculate latent heat of multicomponent mixtures, problem being with wide-boiling mixtures as noted by Raheleh Sabounchi.
I agree that a software may be the simplest way, for example I utilize Prode Properties, see

http://www.prode.com/en/properties.htm

which works directly in Excel, you can calculate the heat of vaporization as difference from gas and liquid enthalpies by putting =StrGH(1)-StrLH(1) in a cell, easy and immediate...

finally, about codes and standards applicable to the design of relief and vent systems, there are different standards in Europe, US etc. so one must be prudent to identify the correct values.

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Hi Saeid,
I have gone through your article you mentioned here. It seems you plotted orifice area vs. wt% vaporized and got peak area for this case study at a certain wt% of vapourization.

Do you take any consideration of vapour temperature limitation(for example CS material has temperature limitation of 400 deg.C above which this fails) for stopping 5wt% vapourization ?

Regards,
Samiran Mukherjee

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Raheleh

Raheleh Sabounchi
Process Engineer

Hi
In case of increasing the temperature more than melting point of CS,you should change the calculation basis for fire case from wet basis to dry basis.
Also in this scenario another protection level like Emergency blow down valve shall be considered for safety regard.
It means that individual PSV is not a sufficient protection for fire case.

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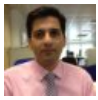

Saeid Rahimi Mofrad
Senior Specialty Process Engineer at Fluor

There is not such limitation on CS application. CS can withstand temperature higher than 400°C. The only point is that mechanical strength of most of steel material start reducing at about 400°C . When the temperature reaches about 800°C ultimate tensile stress (UTS) drops below 20% of the UTS at 20°C. If you heat up the CS plate with gas cooker at home for some time, it will ultimately fail because of thermal decomposition even in atmospheric pressure. The same can happen faster in process vessels because of internal pressure.

That is why the relief valve is not considered as a full protection for systems on fire especially unwetted (gas filled) ones where internal fluid behaves like insulation and causes wall temperature to increase rapidly. In this case, overheating due to fire heat flux (creating hot spot) and subsequently mechanical failure of vessel is most likely to occur long before vessel pressure reaches relief valve set pressure. That is why providing depressuring facility is the most effective overpressure protection system besides water deluge and fire proofing. Depressuring system simply reduces the pressure and keeps the system stress below rupture stress at elevated temperatures and prevent vessel from rupture.

As far as fire relief rate calculation is concerned, you can use the method I have explained to find out the maximum required orifice area. It is applicable up to 100% vaporization without any limitation on temperature (you can use it as far as simulation software can generate the gas and liquid physical properties!).

There is a possibility of thermal cracking of heavy HC components at elevated temperatures and producing light components (generating excess flow) for which relief valve may not be sized (which is out of interest of fire calculations).

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Rodrigo Lopes de Siqueira likes this

Roberto Paron
Software consultant & contractor at Prode

the main problem with PSV systems is that discharging pressure is constant and temperature

Roberto

can increase well above material rating, a common case is
external fire, for example with vessels containing high boiling components but also with vessels containig gas mixtures in certain conditions, there are discussions in API 520 and other standards.
Common simulation is via direct integration method (forcing at each step material and heat balance, difficult being the estimate of heat from external fire), in case the simulation shows that material rating limits are exceeded one can use a rupture disk or a depressuring system (typically a valve plus a RO), also for this case there are discussions in several standards.
In my opinion with external fire case one must be very prudent to evaluate the proper conditions as different standards may apply different rules, hence the warning in my previous post.

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Rodrigo

Rodrigo Lopes de Siqueira
Process Engineer

Dears, I liked so much of each one speeches, it will be wonderful if we could discuss personally. Well, its really fact that HC can coking during the fire situation and it can create another light fluids with other latent heat, besides that, it could occur every kind of changes, it's too difficult to estimate the process during transient state, therefore we have to super estimate the conditions guess a permanent stage and design the PSV. Remember that, as our partner Saeid said, we have to have another overpressure devices protection -"water deluge and fire proofing"- besides that, we have to have a prepared team to fight the fire conditions and we wait that the fire won't keep more than 30 minutes. After every device, we can just pray and thanks God.

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