Chemwork

The Basis for Fire Depressuring Calculations

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

Dears,

This is with regards to paper titled " Effect of Different Parameters on Depressuring Calculation Results" published on www.chemwork.org/board.html

My questions are:

1. Page 2, Initial temperature section mentions that "maximum operating temperature is normally used as initial temperature for fire depressuring"

How the effect of heat exchangers should be implemented on this initial temperature? Is it assumed that heat exchanges are stopped?

2. Page 2, depressuring time section:

For sectionalized process sections which involves equipment and piping (for example compressor loops), usually the piping section has lower thickness. Should the effect of piping thickness be included for setting the depressuring time? If so what is the procedure?

3. Page 3, Heat input model:

For vessels containing liquid pool fire model of API 521 has been recommended and for totally dry systems jet fire heat load which is advised by API 521 has been recommended.

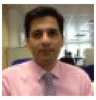
I think regardless of this fact that either the vessel is dry or containing liquid, both of 2 fire cases (pool fire and jet fire) should be used for fire calculations. Fire case either as pool or jet model is external issue and may not be related to the content of the vessel.

4. Page 3, PV Section mentions that "PV of zero may be appropriate for fire case"

Could you please explain why this value should be used?

All The Best,
Mojtaba

Comments



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

'1. On detection of fire, all feed streams, pressure sources (pump, compressor, etc) and heat sources (such as heaters, rebiloer, etc) are stopped then depressuring is started. Maximum operating temperature is normally used as starting temperature which is reasonable considering that depressuring is supposed to be started once fire is detected. However rational choice for fire case can be the temperature (T) corresponding to the starting pressure using Pop/Top = P/T.

'2. The ideal depressuring system should protect all parts of system during fire and prevent rupture. However, the fact is that it may not be realistic and achievable in reality because of all uncertainties involved.

There are methods to calculate the stress of all system objects in the fire (when the temperature is increasing by time) to make sure that equipment stress is always lower than rupture stress, but the outcome of these kinds of studies are not always to prevent rupture. If calculation indicates process equipment/piping rupture, then it needs to be evaluated whether this causes unacceptable consequence or not. This is normally related to nature, pressure and quantity of released fluid as well as consequence of rupture (as I explained in another post). Read more on http://www.scandpower.com/Images/Guideline%20for%20protection%20of%20Pressurised%20Systems%20Exposed%20to%20Fire_r1_tcm191-203082.pdf

API-521 states that “since the consequences of vessel rupture are normally larger than for a pipe rupture, pipe rupture can be more acceptable than a vessel rupture. “ That is why depressuring criteria usually addresses preventing vessel rupture as a final objective and defines the depressuring time based on vessel thickness (not pipe).

'3. You are right, pool and jet fires are applicable to all equipment irrespective of number of phases inside vessel. In heat input model section, I mentioned that:

• For vessel containing liquid, ”API-521 fire” equation (q = 43.2 F Aw^0.82) is appropriate.
• For totally dry systems, “Fire” equation (q = C1 + C2 time + C3 (C4 – Vessel Temp) +….) is usually used. For this purpose, constant heat input can be defined by setting C1 = Q A and C2 = C3 = C4 = C5 = 0 where Q (fire heat flux) range as advised by API is 80 to 100kW/m2. Refer to discussion made on fire heat flux in technical note “Fire Heat Flux to Un-Wetted Vessel”, where the adequacy of this equation is discussed.

There is no talk about type of fire in this paragraph. My point is that using “API-521 fire” model for unwetted (gas filled) vessels as it is defined in Hysys depressuring tool through Q = C1 x C3 (Wetted Area@ time =t)^C2 will basically result in no heat input because heat input rate is defined as a function of wetted area.

'4. PV term is approximately isentropic efficiency.

• 100% indicates isentropic process
• 0% indicates isenthalpic process

There is no published value for PV in fire case but we agree that the main purpose of fire depressuring study is to obtain the maximum depressuring rate and specify required the size of orifice. Keeping this in mind, using PV=0% in fire case is conservative approach (though the effect in not considerable).

The effect of PV on the fire peak depressing rate and orifice CV has been given in table 1 of the same article you are referring to. In that particular case, increasing PV from 0% to 50% causes CV reduction from 16.25 to 16.1 (less than 1%).

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Huy

Huy Tran Vo Minh
Process Engineer at Chiyoda Corporation

Dear Saeid Rahimi Mofrad!

I' m now calculating Blowdown for a system with only gas. Your comment is very useful for me. However, I have something confusing.
My system is totally dry, as you advise, "Fire" equation is used,with C2-C5 =0, While C1 = 100.A. How about A? Is it total area of my vessel? I'm so confusing because I have not seen anyone used this equation for blowdownd calculation.

Please help me.! Thank you so much.

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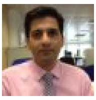

Saeid R. Mofrad
Principal Process Engineer at Petrofac (P.E.)
Top Contributor

Dear Huy,

A is the exposed surface area of the vessel within 7.6 m (25 ft) of grade or any other surface at which a major fire could be sustained, such as a solid platform.

If you use “Fire API-521” method (Q = 43.2 F Aw^0.82, which is available in Hysys depressuring tool) to define the fire heat input to an unwetted vessel, the net heat input will be zero as wetted area of the vessel (Aw) is equal to zero.

Q = 100A for unwetted vessel has been rused in past, however, it may result in a highly oversized depressuring facilities for your system depending on the system operating pressure.

You can improve this equation if you are ready to undertake some heat transfer calculations. Please read more about it on:
http://www.chemwork.org/PDF/board/Fire%20Heat%20Flux%20to%20Un-Wetted%20Vessel.pdf

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Huy

Huy Tran Vo Minh
Process Engineer at Chiyoda Corporation

Dear Mr. Saeid Rahimi Mofrad,
Thank you very much for your response.!!!

I read a project, in which vessel contains nature gas only designed by Worley Parsons, they only design in adiabatic case, and do not care about fire case. They explained that the vessel is dry gas vessel, so do not need to calculate blowdown in fire case. And I read API 521 section 5.15.1.2.2, it is said that, heat input from wall vessel to contained fluid in un-wetted vessel is not as significant as wetted vessel. So, I think it is the reason why Worley Parsons consider fire and adiabatic cases are the same.

I also realized that simulation with HYSYS dynamics depressuring utility in adiabatic and fire case for unwetted. But our customers say that lowest valve outlet temperature in fire case must be much higher than adiabatic case. I think the customer 's concept is right if the vessel have initial liquid, because I try changing initial composition by add more propan, butan and set about 0.1 m3 initial liquid volume in HYSYS - dynamic depressuring (other parameters keep unchanged) , the result immediately become different, lowest temperature in fire case many times higher than adiabatic case.

So, should I explain with our customer that fire case and adiabatic case are same if our vessels contain only gas.?

Best regards!!!

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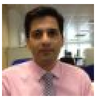

Saeid R. Mofrad
Principal Process Engineer at Petrofac (P.E.)
Top Contributor

Dear Minh,

What I am sure is that both fire and adiabatic cases are applicable if three is a pressure vessel in your system. I can not answer your question unless I see the simulation file done by WP.

If you are only concerned about valve outlet temperature, adiabatic case is definitely the governing case. Depressuring calculation is such a complex study that making a general conclusion applicable to all cases seems impossible so I can not confirm that your observation on wetted and unwanted vessels are valid for all systems.

Fire and adiabatic cases are definitely different because:
1. heat input model which is used for fire is different from adiabatic case
2. heat loss model which is used for fire is different from adiabatic case
3. the sizing criteria (final pressure, depressing time of 15.0 minutes) which is used for fire is different from adiabatic case
4. .....

I suggest you getting in touch with an experienced process engineer in your company before taking a any action..

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Waqas Manzoor likes this

Tran Duy

Tran Duy Hai
Process Engineer at VIETSOVPETRO joint venture

Dears,
I am trying to do depressurizing for fire case. My question is:
* For fire case, I defined that the liquid inventory for equipment is taken up to LAH level of the equipment, but why Hysys often assumes that the liquid volume is 50% of inventory volume? How can I change this parameter?

Please see image below for more detail.
http://www.cheresources.com/invision/uploads/monthly_12_2013/post-214208-0-45777200-

1385977959.jpg

Best regards!

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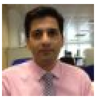

Saeid R. Mofrad
Principal Process Engineer at Petrofac (P.E.)
Top Contributor

Hi Tran,

You can simply enter the Initial Liquid Volume (m3) on the "Connection" tab of Depressuring Utility.

Saeid

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Tran Duy

Tran Duy Hai
Process Engineer at VIETSOVPETRO joint venture

Dear Mr. Saeid,
I did, but when generate the report, Hysys alway shows the liquid volume is 50% inventory volume.

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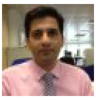

Saeid R. Mofrad
Principal Process Engineer at Petrofac (P.E.)
Top Contributor

What is the Version of Hysys you use? I don’t have this reporting format and problem in V7.2 and 7.3.
Nevertheless, the pdf file you have shared shows the correct "Initial Liquid Volume" - not 50% of total volume. The liquid volume is 50% by default (can be a software bug) which should not be used for the calculation.

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