Buletin Teknol. Tanaman, Bil.12, Tambahan.1 (2015): 17-24

The feasibility of using a tank for various products

Sadegh Jozian, Mahdi Ghoharrokhi

Abstract

One of the most important things that proposed in industrial units is using one atmospheric tank for different products. In other words, can we transfer lighter products with different fish point, in a tank that designed with identified Gas oil and Fish point? Or can we keep heavier materials in the tanks that are made for lighter one?

Do the designing of initial tank is competence with new product? Do the degrees of SET should change for PSVs or PCVs?

PSV: pressure relief valve

PCV: pressure control valve

In this project, sizing of PSVs conducted by ASPEN FLARE NET software in the process scenarios and firing.

Key words: Fighting Fire systems , NFPA15, PIPE NET software

Introduction

Safety has great importance in refinery and petrochemical processes and unites . Thus the international standards such as API-ASME-NFPA-ISA, etc., policy and design principles, utilization, repair, inspection and other common activities in oil, gas and petrochemical industries can be specified and these standards and guidelines will follow the entire world. In this regard, it should be considered the following point: key of safety at every stage of oil operations, processes and products is the trained operators who know work well. figures show that about 66 percent of fires are result of the error in following the proper operating guidelines .These guidelines in refinery operating units have been entirely proper and transparent and to be available if required and also all facilities and equipment must be evaluated to understand and control the potential risks. Meanwhile these guidelines must be investigated within a reasonable time to ensure that whether they are updated or not . Operators should be passed the periodic training to fully realize and understand these guidelines, this caused the refinery and installations act safely and will not be anything to worry about. [1] .In oil, gas and petrochemical refineries because of different reasons such as process problems and fire, pressure inside the atmospheric tanks and under pressure will increase. So if the appropriate measures are not taken, it will be a very dangerous incident . In this chapter , we examine the reasons for increasing the pressure in the tanks, principals and concepts of pressure relief devices, in terms of performance, (devices can re-close and devices without this ability) according to the following standards .Compliance with these standards, we can reduce the pressure inside the tank to reach normal conditions and to avoid the accidents. To estimate and calculate output of discharge pressure machines, according to fire scenarios and processes, by using Aspen Flare Net software, in the form of an example with a full description , we will perform the sizing of pressure relief valve .

Research Methodology

The required output to drain from the device under pressure to return the pressure back to normal and allowable range is said the necessary capacity. This connection is made by the projects without any certain relations and formulas. The basis of discharge output is explained in the fifth paragraph the API - STD - 521 standards. All calculations and actions should be based on informed judgment and good engineering.

Sizing

Selection and sizing of the pressure relief device must be done based on standard requirements API - RP - 520,of fourth part. Sizing will be different according to the type of fluid.

Discharge phase

Sizing for critical fluids
- Single phase discharge
  - Vapor
    - Gas
    - Vapor
  - Liquid
- Two phases discharge

Pressure relief valves on the gas or vapor services are under fluid critical conditions under operations. They are sized due to the relations 2 to 4 . Each of relationships may needs to obtain the effective surface discharge (A) from the discharge rate when the discharge valve has performed. With this relation , a or the low level can obtain. But this is not the standard size , then the size can be determined by using the size standard table . Table 1 , Standard API - STD - 526 is used for this activity , in this table , all of pressure relief valves are shown with English letters [2].

$$A = \frac{W}{ckd\ P_1\ kb}\sqrt{\frac{TZ}{M}} \quad 2$$

$$A = \frac{V\sqrt{TZM}}{6.32\ ckd\ P_1\ kb} \quad 3$$

$$A = \frac{V\sqrt{TZG}}{1.175\ ckd\ P_1\ kb} \quad 4$$

A :discharge valve level
W :discharge rate
V :discharge rate
T :temperature of discharge, gas or inlet
Z :compressibility factor for deviation of real gas

Table 1: types of pressure relief valve and effective orifice area

orifice type or psv	**(in^2)effective orifice area**
D	**.11**
E	**.196**
F	**.307**
G	**.503**
H	**.785**
J	**1.287**
K	**1.838**
L	**2.583**
M	**3.60**
N	**4.34**
P	**6.38**
Q	**11.05**
R	**16**
T	**26**

2.1.2 Sizing discharge in the gas phase

Pressure release valve has used when there is only gas phase. Based on the standard API - RP - 520 part 4 will be sizing. Sizing relations divided into two categories based on whether fluid is critical or not. Critical pressure must be checked based on the following equation [3] :

$$P_{CF} = P_1 = \left[\frac{2}{K+1}\right]^{K/K-1}$$

P_{CF} : Critical pressure in psi bottleneck

P_1 : discharge pressure

Sizing discharge in the liquid phase: for when there is only one liquid. Special guideline must be considered for drainage systems . The below relation is used only for non-flushable fluids:

$$A = \frac{Q}{38\ kd\ kw\ kv}\sqrt{\frac{G}{P_1 - P_2}}$$

A : valve drain level
Q: flow rate in gallons per minute
KD: the effective coefficient of discharge that obtained from the valve manufacturer
KW: The initial size can be estimate using 65 discharge coefficient
Correction coefficient is result of the output pressure in the pressure relief device. If this is atmospheric pressure. Then kW = 1.
For Balance valves, a correction factor extracted of fig 31 of standard API520, but for common valves is not necessary.
KV: The correction factor of the viscosity extracted of the figure 32 in the standard API RP 520.
P1: discharge pressure (psia) which is total determined pressure in addition to the allowable pressure.
P2: output pressure of pressure relief device. (Psia)

For example, the required rate of hydrocarbon vapor (w) to discharge is the 53500 pounds per hour because of

operational problems. Molecular weight hydrocarbon vapor (a mixture of pentane and Butane is 65
627R0 discharge temperature and the drain valve is set on 75 pounds per square inch gauge , actually it is the design pressure and behind pressure is considered zero. Aggregation is ten percent. Then discharge pressure is P_1=75x1.1+14.7=27.2 psia , the calculated compressibility factor is 84 (if there was not , it will be considered as 1)
Critical behind pressure (from Table 8 standard API RP 520 part1) 97.2 × .59 = 57.3 and k = cp / CV from Table 8 , $k = \frac{cp}{cv}$=1.09 and c = 326 are derived from table. Correction factor due to the behind pressure is considered 1.0 kb
Size of pressure relief valve is obtained from relation 2 as follows [4]:

$$A = \frac{53500}{326 \times .975 \times 97.2}\sqrt{\frac{627 \times .84}{65}} = 4.93 \text{ square inch}$$

Estimate output rate of pressure relief valve or other safety machines
After defining the reasons for the increase in pressure in all possible scenarios (process scenarios and fire scenarios) the output rate of individual pressure relief valve or other safety machines is calculated.
In Aspen flare net software, the drain valve pressure, safety valve, control valve or any safety device which reduces the pressure with the material leaves the operating system, is called source. Design and sizing of Source or pressure relief devices is done on condition that the maximum flow rate passed form it. If the maximum output rate of the Source is related to the fire scenario, it is recommended that two separate relief valves are installed on the device, one of them on fire scenarios and other based on operational or process problems will be sized because the probability of fire is less than process problems. And by putting these two separate valves, we can prevent the opening of big drain valve because of the removal of a large amount of material. Since the maximum rate of fire scenarios, so the greatest rate of process scenario is lower than fire scenario. As a result , the valve size will be smaller than the first valve. Metal grid design must define different scenarios and reasons for increased pressure. output rates of each Source is calculated for each individual scenario .The sum of output rate for each Source or pressure discharge devices of each scenario represent total rate for scenario . Thus for each scenario , the output rate of each Source and then total flow rate is defined . Metal grid design is done based on scenario that the total rate of that scenario is more than other scenarios [5].2.1.2 Calculation of output rate from any source on the basis of process failures .There is no relation and a formula to calculate the output rate of each source in the scenario of process failures, the flow rate must be calculated based on practical experience and process experience . For example , power outage or process failures and other problems caused to out of service the cooling pump , in this conditions, the output vapor out of the top of distillation tower cannot become liquid in cooler. So the vapor aggregation can increase pressure and backflow is about 10 min . In this case , the outlet rate of pressure discharge valve is equal to the outlet rate of vapor from the top of distillation tower and input to the cooler .Thus the evaporation of materials is considered due to increased pressure (at constant volume) [6].

Calculation of output rate of valves in fire scenarios
Increasing pressure on operating machines and opening the control valves, discharge or safety valves is based on two reasons:
1. Operational and process errors and faults
2. Fires in operational units
For sizing the pressure relief valve, it must be determined the pass flow rate from them . To calculate the pass flow rate from valves in process failures scenarios, there is no relation or formula.
And the certain flow rate can calculate by type of process, the operating machines, and designer experience. (API-STD-521, paragraph V), but a fire scenario in operational units, and there is a formula to calculate the rate of discharge valves. The heat absorbed by the fire will compute at first.
1- If there is only steam into the tank, according to the value of Q , the increased vapor pressure can be determined.
2. If there is only fluid into the tank, heat will increase the fluid volume, but due to the constant volume of operating system, there is no possibility to increase the volume, thus pressure is increased. And when fire has continued, the liquid will evaporate and the resulted vapor will increase the pressure speed.
3. If there is fluid in addition to vapor into the tank, due to the relation Q = mλ , and given Q and λ , the value of m or vapor rate produced of liquid inside the container can be calculated .
In other words, the processes of the liquid evaporation and gas expansion occurred concurrently. Suppose a fire scenario is defined for the two-phase tank , the fluid in the tank will evaporate ,the liquid volume is low and steam pressure increased but low volume due to evaporation of liquid is lower than a required amount of steam . In the two-phase vapor-liquid systems, fire scenario will simultaneously perform the processes of evaporation of a liquid and increasing the gas phase pressure [7].

Calculation of heat absorbed by each operating system
The heat absorbed by the system in the fire scenario can be considered in two cases:
1. If the liquid can be drained out of the tank and to prevent the accumulation of flammable liquids into the tank:
In this case, the heat absorbed by the device is calculated using the relationship Q = 21000 FA ^ (. 82) that Q is total heat absorbed by $\frac{\text{Btu}}{\text{H}}$ and A is wet surface in terms $FT^2$of & F environmental parameters that depends on the insulation thickness . This parameter can be seen in the following table according to the thickness of the insulation [8].

Table 2: Environmental parameter F, to get the absorbed heat

environmental parameter F	insulation thickness	environmental parameter F	insulation thickness
1	(bare surface) 0	.15	**2 in**
03	1 in	.075	**4 in**

If the insulation thickness is not known , F = .3 value is recommended.

B) If there is walls or barriers around the tank and cannot be evacuated liquid, In this case, the heat absorbed by the tank is determined of the relation $Q = 34500 F A^{82}$) or calculation of the following table.

Table 3: The heat absorbed by the tank when the fluid cannot be drained.

Q	insulation thickness	Q	insulation thickness
2000	bare surface 0in	6000	**2 in**
1000	1 in	3000	**4 in**

Calculate the heat flow rate out of the tank on fire scenarios

The effects of fire and energy absorption in devices caused that if there is liquid inside it (fluid in pressure and temperature lower than the critical temperature and pressure) the absorbed heat will turn liquid into steam. And if there is a gas or vapor inside the tank (fluid temperature and pressure above the critical temperature and pressure), the absorbed energy causes the expansion (rising pressure.) So to calculate the heat flow rate out of the tank on fire scenarios, various scenarios must be considered.

1. The fluid in temperature and pressure is lower than the critical temperature and pressure into the tank.

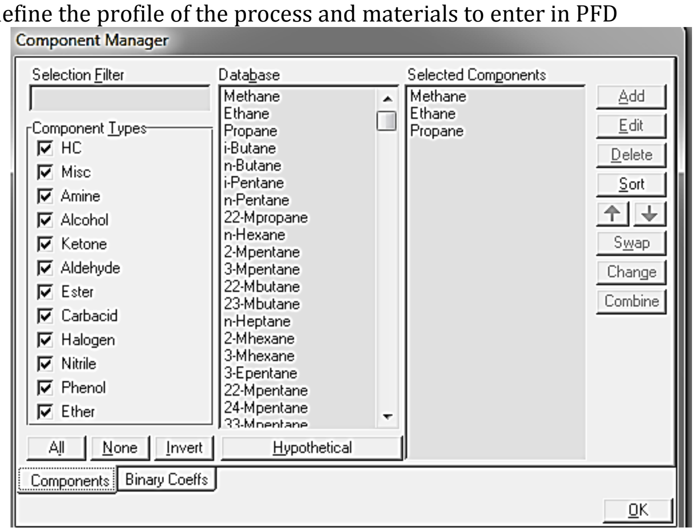
In this case, the heat absorption can turns the amount of liquid into vapor that to calculate the steam flow rate and the size of the proper discharge valve, therefore the equation $Q = m \times \lambda$ used to compute the produced steam quantity that Q is the absorbed energy by device in terms of $\frac{BTU}{h}$ and λ is the latent heat of vaporization of the fluid inside the tank that the thermodynamic parameters calculated in inlet pressure valve placed inside the tank. And m steam rate is based on $\frac{lb}{hr}$. Given the considerable difference between sensible heat and latent heat of vaporization based on sensible heat standard is not considered in calculations and it is supposed that the liquid inside the tank is in the boiling point.B) fluid is in temperature and pressure above the critical temperature and pressure in the tank .If the discharge pressure condition is closer or above than the critical point, the latent heat of evaporation is rather zero. Thus the absorbed heat consumed to increase the gas pressure into the tank. In other words, the output vapor rate out of discharge valve depends on the speed of liquid pressure increasing and energy absorption in the case, fire will increase the temperature of tank wall and the fluid and therefore increases the pressure inside the tank. When the valve is opened, some amount of vapor in the tank will discharge. This decreases the pressure inside the tank, but because of the material discharge from the tank, the wall temperature increased rapidly [9]. (According to the equation $Q = mcp\ \Delta T$ and constant Q and cp and also reduce the amount of m, the value of ΔT increases.)

Results and Analysis

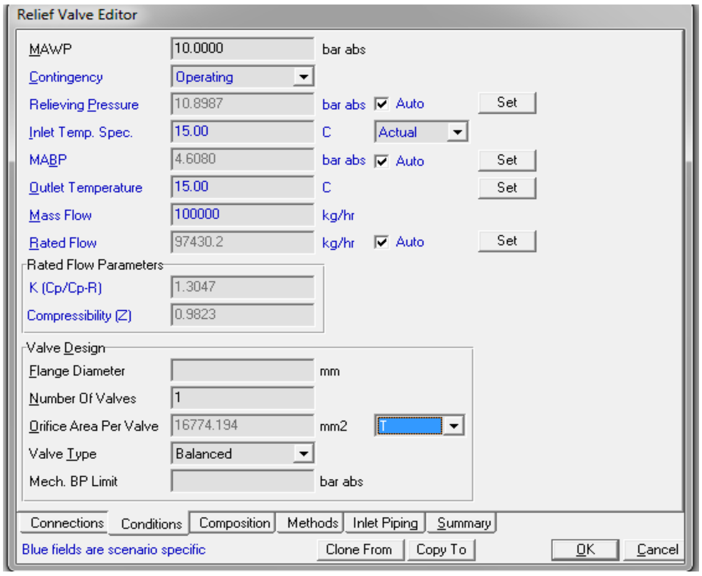
Sizing pressure release valve using Aspen flare net software

Gas stream contains methane, ethane and propane out from a pressure relief valve and psv is balanced type. Output rate of pressure relief valves is 100000 kg / h and 25 the molecular weight, we intend to perform the sizing of psv using Aspen flare net software:

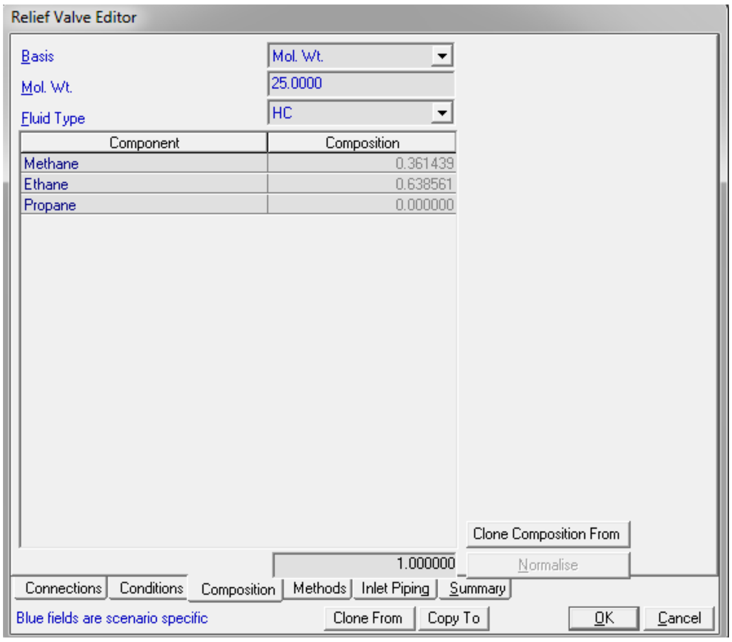
Open the app, we define the profile of the process and materials to enter in PFD



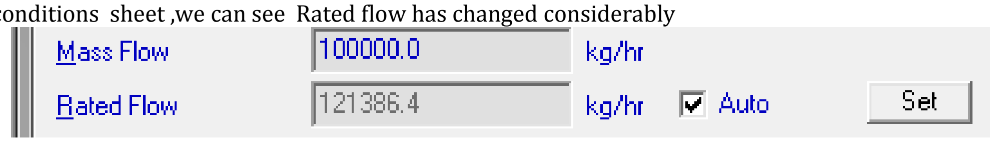
In PDf page and the toolbar, we select pressure release valve. In conditions Sheet , we marked the rate as 100000 kg / hr and a T- orifice type and all auto.



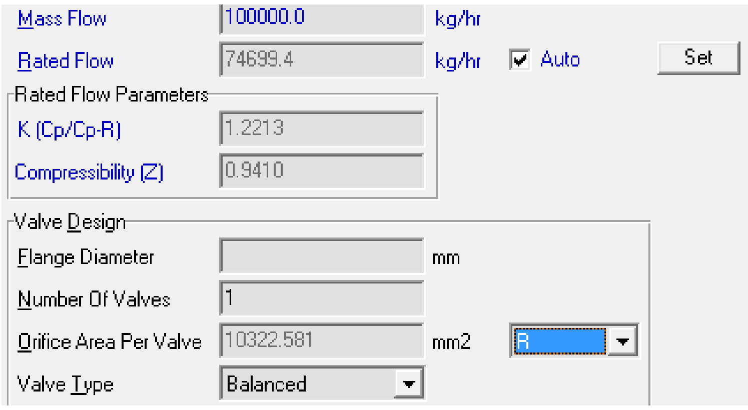
The greatest levels to choose and Rated flow orifice of the mass flow is also lower. So this case has no physical meaning, but this calculation is based on the molecular mass of software if the molecular mass of the exhaust gas is 25.



we return to conditions sheet ,we can see Rated flow has changed considerably



Rated flow is much higher than the mass flow. Select the type of small orifices and it continues until Rated flow is much higher than Mass flow and Rated flow for orifice is one size smaller than (Type R) than mass flow.



So the same type T is true. To view summary information, the pressure relief valve must be selected from the view menu, Data Options software and then source.

Type	Inlet Pressure (bar abs)	Inlet Temp. Spec. (C)	Allowable Backpressure (bar abs)	Outlet Temperature (C)	Mass Flow (kg/hr)	Rated Mass Flow (kg/hr)	Outlet Flange Diameter (mm)	Valves	Relief Valve Type	Orifice Area (mm2)
Relief Valve	10.89868	15.00	4.60795	15.00	100000.0	121386.4		1	Balanced	16774.194

Orifice	Back Pres. Limit (bar abs)	Outlet Fittings Loss Method	Inlet Length (m)	Inlet Elevation Change (m)	Inlet Material	Inlet Roughness (mm)	Inlet Nominal Diameter	Inlet Schedule	Inlet Internal Diameter (mm)	Inlet Pipe Class	Inlet Fittings Loss A
T		Calculated	0.00	0.00	Carbon Steel	0.04572	12 inch	40	303.225	No	0.000

In continuing, we will be discussed definitions of **i**nhalation and exhalation systems (steam outlet and air inlet) of atmospheric storage tanks and also reasons for the increase of pressure in the tanks:

Reasons for the increase or decrease of pressure in atmospheric storage tanks

1. Send a liquid into the tank or drainage of fluid from the tank

tank inhale is result of fluid drainage out of the tank. In other words, the height of the liquid is low after the liquid out of tank, then temperature and pressure have reduced. That's why moving air or gas into the tank .exhale of tank is result of the liquid moving into the tank, which increases the pressure inside the tank. Entering liquid into the tank, there is two-phase liquid feed (flash). In other words, with the introduction of liquid feed into the tank and two-phase, the pressure will increase. Two phase feed that is near or above the boiling point of the tank pressure will be very important.

2. Climate changes:

Due to lower ambient temperature or changes like the wind and condensate vapors precipitation inside the tank , it would be contracted and caused to the inhale of tank . Also, due to increased ambient temperature (climate change) the vapors expanded and liquids evaporate. Which caused to the exhalation of tank (exit of vapor?????)

3. Exposure of fire exposure:

When fire is occurred around the tank , the heat of fire is absorbed , so the liquids into the tank will evaporate and the evaporations will expanded that caused to the tank exhale

4. Installation mistakes and devices failures:

5- pressure transfer Blow off:

transfer the fluids of other tanks (tanks are placed behind the truck or pickup) that can help with pressure of the suppliers tanks (trucks or vans) with a gas such as nitrogen. In other words, by injecting nitrogen, the pressure inside the trucks or vans will increase , and liquid will sent to the main tank and receiver automatically and more rapid . Finally transfer will face with fluctuation because of entering gas out of the liquid nozzle of receiving tank which this is based on the pressure before it and the free space of liquid height . Nitrogen with liquid move into the main tank, if the pressure of main tank is high before the entering the nitrogen and the height of liquid is high (low vapor space) this nitrogen can increase the pressure . This additional gas volume may be important to increase the pressure . It is the worst thing that (the controller) is transmitted to the receiving tank to fill it up , so there is very little space for pressure fluctuations.

A similar situation can also happen during the cleaning the line that a follower and gas driving device after pigging (a device that gives off the waste) is present. This reason of increased pressure is said transfer Blow off pressure.

6. Inlet pad and purge

To preserve the contents of tank against the pollutants and to keep an inflammable environment into the tank and also to reduce the vapors out of tank , some inert gases such as nitrogen are used. When a valuable light material is evaporated in the hot region like Asaloyel , it is possible to loss the products because of evaporation . Thus we use the nitrogen gas that is placed above the valuable material .When the valuable matter is evaporated instead of the matter moving out , the nitrogen gas will be out because it is above of it , and when there is low temperature and tank pressure , the same nitrogen will enter into the tank. Inlet pad systems and the rivet equipped with Regulator exist into the tank to keep the pressure inside the tank . If these Regulators be corrupted , this causes to entry gas will into the tank with unlimited rate . If the control valve on the nitrogen is opened, inlet gas flow rate increases. If the flow control valve on the inlet gas is closed , inlet gas flow rate is reduced. So the deterioration of output pressure regulators (Back Pressure) may increase the pressure.

7. Heat transfer devices (outside the tank):

Steam, hot water or hot oil can warm fluid commonly used for tanks that its contents should be kept at high temperature. If the temperature control valve or sense of control systems is failed, may increase the steam flow . So liquids stored inside the tank will evaporate. (Evaporation of the stored liquid occurred in the tank.) As a result, the pressure rises inside the tank. If the tank is empty and is kept at high temperatures, when the feed enters , it will heavily evaporate. If the tank temperature control systems is in the steam range (above the liquid level) , it will sense the temperature of steam. The temperature of the liquid, due to the heating coils is more than the steam temperature, so due to placing on the steam , it will sent signal that show low temperature, while the liquid temperature is high, filling in these circumstances caused to evaporate a large feed . This high evaporation of feed as soon as the tank wall is cool and liquid level covered with Sensors , will be stopped .

8-devices of Transmission of heat (in the tank):

If the cooling and heating devices into the tank are failed and the contents of the tank exposed the cooler and heater fluid . (For example, when heating coils have holes, the contents of the tank are exposed to the cooling and heating fluid, or when heating devices are failed, the flow of heat transfer will face problems , so the pressure inside the tank is reduced.

9- Failure of utility devices

10. A change in the input stream to the tank:

11. A change in the input stream to the tank, as a result of an increase in heat input, can be due to increased pressure in the tank.

12. chemical reaction:

The contents of some tanks may be exposed to the chemical reaction, so the heat and steam will be generated. Add water to acid or acid consumed in the tank caused to produce the steam or evaporation of hydrocarbons, in other words, the vapor is produced and the reaction will be out of control.

13. The fluid overflow from the tank:

. The fluid overflow, with accurate design (such as when the liquid height increases), control systems and instrumentation, such as the level Switch and operational procedures which close the operating operators of inlet valve to the tank must be prevented and controlled. Systems and tools for determining liquid level will stop the filling operation independently.

14- Changes in atmospheric pressure:

Increase or decrease in air pressure and atmospheric pressure can cause the vacuum or pressure increasing in tank.

15- Steam out: If the tank is filled with steam and the tank is non-insulated and non-insulated. its temperature is more than the environment, so gives heat to the environment and there is the possibility of condensing.

So when the steam enters heat to the environment , it may be actually cooled and condensed and the condensation rate and speed is more of (steam out) . When the steam cools and condenses inside the tank, the internal pressure decreased and may be the tank is vacuumed and be crumpled , to avoid this condition, open the tank valve to cool the tank slowly , this cooling avoided the tank Vacuum and crumpled. In other words, by opening the valve, the air penetrates inside , and the condensing rate will be compensated , and finally this will compensate the interior pressure.

Discharge route of pressure and vacuum

The most important issue about the discharge of vapor in atmospheric storage tanks is that the steam discharge will be done in one of two modes:

1- Pressure vacuum valve

2- Open vent

In other words, evacuation route for pressure and vacuum must be equipped to PV Valve or OPEN Vent with or without Flame arrester machine

Fluid stored in the tank for atmospheric, standards stressed that it should be stored in a tank with PV Valve, the fluid or hydrocarbons cannot be saved in the Open Vent tank.

So to store and handle materials , it should note the following points:

1. Atmospheric storage tanks containing crude oil or petroleum products which its flash point below 100 degrees Fahrenheit or even there is heavy fluid and its temperatures higher than the flash point , it must have PV Valve.

2. Because the flame speed is less than the speed of vapor pass through the PV Valve , so the Flame arrester is not necessary.

3. Open Vent and flame arrester used for tanks with oil products, which its flash point is below 100 ° F, it may be used instead of PV Valve.

Hence, light materials of atmospheric storage tanks should have PV Valve. Otherwise Open Vent, along with Flame arrester used

In the following cases, we use the Open vent without flame arrester:

4. For the flash point of petroleum products equal to or greater than 100 degrees Fahrenheit, and as long as the content is not hot and fluid temperature remains below the flash point.

5. The tank is heated to the temperature of the oil or petroleum products below the flash point

6. to store products with a capacity of less than 59.5 barrels (9.46m ^ 3)

7. to store crude oil with a capacity of less than 3,000 barrels (477m ^ 3)

Conclusions

1. Operating system and storage tanks should be equipped with water spraying system based on guidelines API-RP- 2030 and NFPA15.
2. If you need to use multi-purpose tanks (use of tanks for different materials) . it must be studied properly sized pressure relief devices in harsh operating conditions, and feasibility study with respect to the physical properties of materials, such as flash point, spot welding based on standards NFPA30 and API- STD- 2000.
3. Guidelines of periodic repair and inspection of pressure relief devices and flame-consuming should be done according to the standard, to ensure that they are not blocked.
4. The training of operating personnel carried out based on API- 1200 standard , also different standards of design, repair, inspection be trained to the personnel of engineering department and, it is noted the necessity of any change to them.

5- Fire control systems for tanks are surveyed based on API- RP- 2021. This will prevent the great and widespread accidents involving tanks or greatly reduce the extent of injuries.

7-for multipurpose use of atmospheric storage tanks, it must be considered the pressure and vacuum routs to the discharge for the pv valve or open vent with or without flame arrester . In other words the fluid is stressed to store into the standard atmospheric storage tank must has pv valve, it cannot stored that fluid or hydrocarbons in open vent tanks. (Principles and observance were examined in Chapter Five.)

8. The combustible liquids with flash point F0100 or higher are typically stored in tanks with fixed roof.
9. Fluids with a low flash point of crude oil, polar solvents and flammable liquids contaminated, may be stored in fixed roof tanks. But if the vapor space above the liquid surface and the roof is in the range of combustibility, if any ignition source, an explosion occurs.
10. If the volatile liquid stored in tanks with fixed roof, abundant vapor space of the tank prevent the fire into the tank , but the environmental regulations will not allow us to store flammable liquids in fixed roof tanks . if they stored, they will lose their nature due to evaporation . Thus e liquids with a low flash point should be stored in tanks with floating roof . Due to the safety and fire prevention, floating roof storage tank is superior to fixed roof storage tank , because the occurrence of fire this tank is lower, and in the case of fire, it can be controlled easily (floating roof prevents the evaporation of liquids.)

References

1. AWWA, Welded Steel Tanks for Water Storage
2. CRC, Handbook of Storage Tank Systems. Codes Regulations, and Designs
3. Emission Controls - Product Transfer & Storage
4. Environmental Guidelines, Management of Petroleum Storage Tanks, 318-8
5. National Code of Practice for the Preparation of Material Safety Data Sheets, March 1994.
6. NFPA 25, Standard for Inspection, testing, and maintenance of water –Based fire protection systems, January31, 2002
7. NFPA 72, standard for national fire Alarm code, 2007 Edition
8. NFPA13, Standard for the Installation of sprinkler systems, 2007 Edition
9. NFPA15, Standard for water spray fixed systems for fire protection, second edition, August 2007

Sadegh Jozian, Department Chemical Engineering, Faculty of Engineering, Tehran South Branch, Islamic Azad University, Tehran, Iran
Mahdi Ghoharrokhi,Assistant Professor, Faculty of Engineering, Tehran South Branch, Islamic Azad University, Tehran, Iran