Tube Rupture Scenario
E-3003

1. Heat Exchanger Data Input

High pressure side	Syngas
Low pressure side	CW
Design Pressure of high-pressure side	99 barg
Design Pressure of low-pressure side	7.5 barg
Operating Pressure	83.7 barg
M	10.07
Cp/Cv	1.37
Z	1
Relieving Temperature	41.8
Tube OD	25.4
Tube Thk.	1.65

2. Check if a PSV is needed

In order to perform this step, do the calculation below:

multiply design pressure of high-pressure side by 10/13:

99 * 10/13 = 76.15 barg

So, design pressure of low-pressure side should be at least 76.15 barg in order not to need a PSV. Here it is 7.5 bars, thereby requiring a PSV.

3. Use the formula below to calculate Relief Load

K_G : 2.93 (Metric), 385 (USC)

K_L : 1.77 (Metric), 2645 (USC)

Vapors $$W_G = K_G\, d^2\, P_1 \sqrt{\frac{M}{zT}}$$

Liquids $$W_L = K_L\, d^2 \sqrt{\rho_L (P_1 - P_2)}$$

W_G	:	gas flow through tube break, kg/hr or lb/hr
W_L	:	liquid flow through tube break, kg/hr or lb/hr
d	:	tube inside diameter, mm or inch
P_1(*)	:	HP side normal pressure, bara or psia (alternatively the HP side design pressure may be considered for P_1, as required by some clients).
P_2(*)	:	relieving pressure of the low pressure side, usually 1.1 x gauge set pressure, bara or psia
M	:	molecular weight
z	:	compressibility factor
T(*)	:	vapor temperature, °K or °R
ρ_L(*)	:	liquid density, kg/m3 or lb/ft3

4. Relief Load Result

Standard	API-521	Topsoe	TCC
Wg	21675 kg/h	19680 kg/h	20309 kg/h

5. Use the formula below to calculate orifice area

Gas or Vapor Relief – Critical flow

In USC units:

$$A = \frac{W}{CK_dP_1K_bK_c}\sqrt{\frac{TZ}{M}}$$

$$A = \frac{V\sqrt{TZM}}{6.32CK_dP_1K_bK_c}$$

$$A = \frac{V\sqrt{TZG_v}}{1.175CK_dP_1K_bK_c}$$

In SI units:

$$A = \frac{W}{CK_dP_1K_bK_c}\sqrt{\frac{TZ}{M}}$$

$$A = \frac{2.676 \times V\sqrt{TZM}}{CK_dP_1K_bK_c}$$

$$A = \frac{14.41 \times V\sqrt{TZG_v}}{CK_dP_1K_bK_c}$$

USC:

$$C = 520\sqrt{k\left(\frac{2}{k+1}\right)^{\frac{(k+1)}{(k-1)}}}$$

SI :

$$C = 0.03948\sqrt{k\left(\frac{2}{k+1}\right)^{\frac{(k+1)}{(k-1)}}}$$

P_1 is the upstream relieving pressure, psia (kPa); this is the set pressure plus the allowable overpressure

K_b is the capacity correction factor due to backpressure

K_c is the combination correction factor for installations with a rupture disk upstream of the PRV equals 1.0 when a rupture disk is not installed. K_c equals 0.9 when a rupture disk is installed in combination with a PRV and the combination does not have a certified value.

T is the relieving temperature of the inlet gas or vapor, °R (°F + 460) [K (°C + 273)]

Z is the compressibility factor for the deviation of the actual gas from a perfect gas, a ratio evaluated at inlet

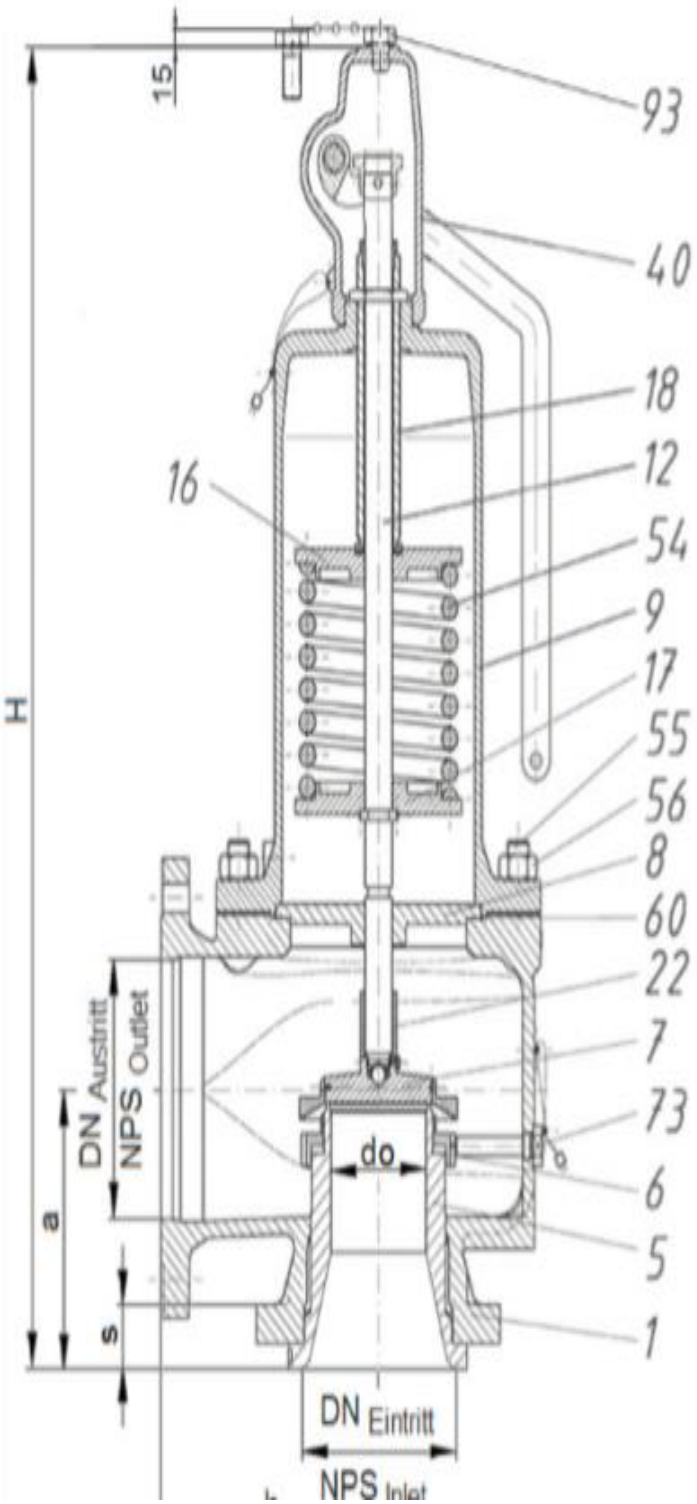
6. Results

Standard	API-521	Topsoe	TCC
Orifice area	50 cm2	45.28 cm2	

Table 14—Spring-loaded Pressure-relief Valves "Q" Orifice [f] (Effective Area = 11.05 in.^{2})

Materials [b]	Valve Size	ASME Flange Class		Maximum Inlet Flange (Set) Pressure Limit [a] (psig)						Outlet Pressure Limit [a] (psig)		Center-to-Face Dimensions (in.)	
				Conventional and Balanced Bellows Valves									
Body/ Bonnet	Inlet by Orifice by Outlet	INLET	OUTLET	−450 °F to −76 °F	−75 °F to −21 °F	−20 °F to 100 °F	450 °F	800 °F	1000 °F	Flange Rating Limit [a] 100 °F	Bellows Rating Limit [a] 100 °F	INLET	OUTLET
Temperature Range Inclusive −20 °F to 800 °F													
Carbon Steel	6Q8	150	150			(165)	(165)	80		(115)	70	9 7/16	9 1/2
	6Q8[c]	300	150			(165)	(165)	(165)		(115)	70	9 7/16	9 1/2
	6Q8	300	150			(300)	(300)	(300)		(115)	115	9 7/16	9 1/2
	6Q8	600	150			(600)	(600)	(600)		(115)	115	9 7/16	9 1/2
Temperature Range Inclusive 801 °F to 1000 °F													
Chrome Molybdenum Steel	6Q8	300	150					(165)	(165)	(115)	115	9 7/16	9 1/2
	6Q8	600	150					(600)	430	(115)	115	9 7/16	9 1/2
Temperature Range Inclusive −450 °F to 1000 °F													
Austenitic Stainless Steel	6Q8	150	150	(165)	(165)	(165)	(165)	80	20	(115)	70	9 7/16	9 1/2
	6Q8[c]	300	150	(165)	(165)	(165)	(165)	(165)	(165)	(115)	70	9 7/16	9 1/2
	6Q8	300	150	(250)	(300)	(300)	(300)	(300)	(300)	(115)	115	9 7/16	9 1/2
	6Q8	600	150	(300)	(600)	(600)	(600)	(600)	(600)	(115)	115	9 7/16	9 1/2

According to table above 6Q8 is selected.Due to low Pb/Pset conventional type can be selected



Specific Valve Data		
Pos	Description	Data
1	Purchase Order No.	A-2-LCN22102-Methanol/HK170414es-1
2	LESER Job No.	20329048
3	LESER Pos.	160
4	Type	5262.6584
5	Orifice	Q
6	Inlet size	NPS 6"
7	Inlet pressure rating	300 lbs ASME B16.5
8	Inlet flange facing	Serr spiral finish, Ra=3,2-6,3
9	Outlet size	NPS 8"
10	Outlet pressure rating	150 lbs ASME B16.5
11	Outlet flange facing	Serr spiral finish, Ra=3,2-6,3
12	d0 [mm]	105,50
13	Set pressure	7,50
14	Pressure unit	bar-g
15	CDTP [bar-g]	7,50
16	Dimension a [mm]	240,00
17	Dimension b [mm]	241,00
18	Dimension s [mm]	57,00
19	Dimension H [mm]	1056,00
20	Weight [kg]	221,00
21	Tag No. 1 + 2	PSV-3143; PSV-3146
22	Tag No. 3 + 4	PSV-3149
23	Tag No. 5 + 6	
24	Tag No. 7 + 8	
25	Tag No. 9 + 10	
26	Tag No. 11+ 12	

List of Parts Main Valve			
Pos	Description	Qty	Material
1	Body	1	1.0619/ WCB/ WCC
5	Nozzle	1	1.4408/ CF8M (stellited)
6	Adjusting ring	1	1.4408/ CF8M
7	Disc AS	1	1.4401/ 1.4404/ 316/ 316L (stellited)
8	Guide AS	1	1.0460/ SA-105
9	Bonnet	1	1.0619/ WCB/ WCC
12	Spindle	1	1.4021/ Chrome Steel
16	Spring Plate	1	1.0460/ SA-105
17	Spring Plate	1	1.0460/ SA-105
18	Adjusting Screw AS	1	1.4104/ 430F + PTFE/ Glas
22	Lift stopper	1	1.4401/ 1.4404/ 316/ 316L
40	Cap/ Lifting Device AS	1	0.7040/ 60-40-18
54	Compression Spring	1	1.8159 (51CrV4) or 1.7102 (54SiCr6) or FDC67 / High temp. Alloy Steel
55	Stud	12	1.4401 / Stainless Steel
56	Hexagon Nut	12	1.4401 / Stainless Steel
60	Gasket	1	Graphit/ 1.4401 / Stainless Steel
73	Lock screw	1	1.4401/ 1.4404/ 316/ 316L
93	Test Gag AS	1	1.4401 / Stainless Steel