Hydraulic Expansion Scenario

E-6003

PSV-6085

1. **Use the formula below to calculate Relief Load**

$$q = \frac{\alpha_V \cdot \phi}{1\,000 d \cdot c}$$

q is the volume flow rate at the flowing temperature, expressed in cubic metres per second;

α_V is the cubic expansion coefficient for the liquid at the expected temperature, expressed in 1/°C;

ϕ is the total heat transfer rate, expressed in watts;

NOTE For heat exchangers, this can be taken as the maximum exchanger duty during operation.

d is the relative density referred to water (d = 1,00 at 15,6 °C), dimensionless;

NOTE Compressibility of the liquid is usually ignored.

c is the specific heat capacity of the trapped fluid, expressed in J/kg·K.

Relief Load Calculation

Parameters	value
av (1/k)	0.000454
duty (watts)	1900000
specific gravity	0.99
c (J/kg.K)	4176
Q (lit/m)	12.51
Q (kg/h)-API521	750
Q (kg/h)-Topsoe	705

2. Calculate orifice area

In USC units:

$$A = \frac{Q}{38 \times K_d K_w K_c K_v \sqrt{\frac{G_l}{P_1 - P_2}}}$$

In SI units:

$$A = \frac{11.78 \times Q}{K_d K_w K_c K_v \sqrt{\frac{G_l}{P_1 - P_2}}}$$

P_1 is the upstream relieving pressure, psig (kPag);

P_2 is the total backpressure, psig (kPag).

K_w is the correction factor due to backpressure; if the backpressure is atmospheric, use a value for K_w of 1.0. Balanced bellows valves in backpressure service will require the correction factor determined from Figure 31. Conventional and pilot-operated valves require no special correction (see 5.3);

K_d is the rated coefficient of discharge that should be obtained from the valve manufacturer; for preliminary sizing, an effective discharge coefficient can be used as follows:

- 0.65, when a PRV is installed with or without a rupture disk in combination,
- 0.62, when a PRV is not installed and sizing is for a rupture disk in accordance with 5.11.1.2.1.

Orifice area calculation

Q	12.51
G	0.99
P1	8.25 barg
P2	0 barg
Kw	1
Kc	0.65
Kd	1
Kv	1

Calculated Orifice Area-API521	**0.078cm2**
Calculated Orifice Area-Topsoe	**0.08cm2**

3. Kv calculation

1. Estimate Kv=1
2. Calculate Orifice area
3. Calculate Reynold's Number according to the following equation:

$$Re = \frac{Q(18{,}800 \times G_l)}{\mu\sqrt{A}}$$

4.Calculate new Kv

$$K_v = \left(0.9935 + \frac{2.878}{Re^{0.5}} + \frac{342.75}{Re^{1.5}}\right)^{-1.0}$$

5. Divide calculated orifice area in step 2 by new Kv
6. Check API-526 for nearest orifice area

Results

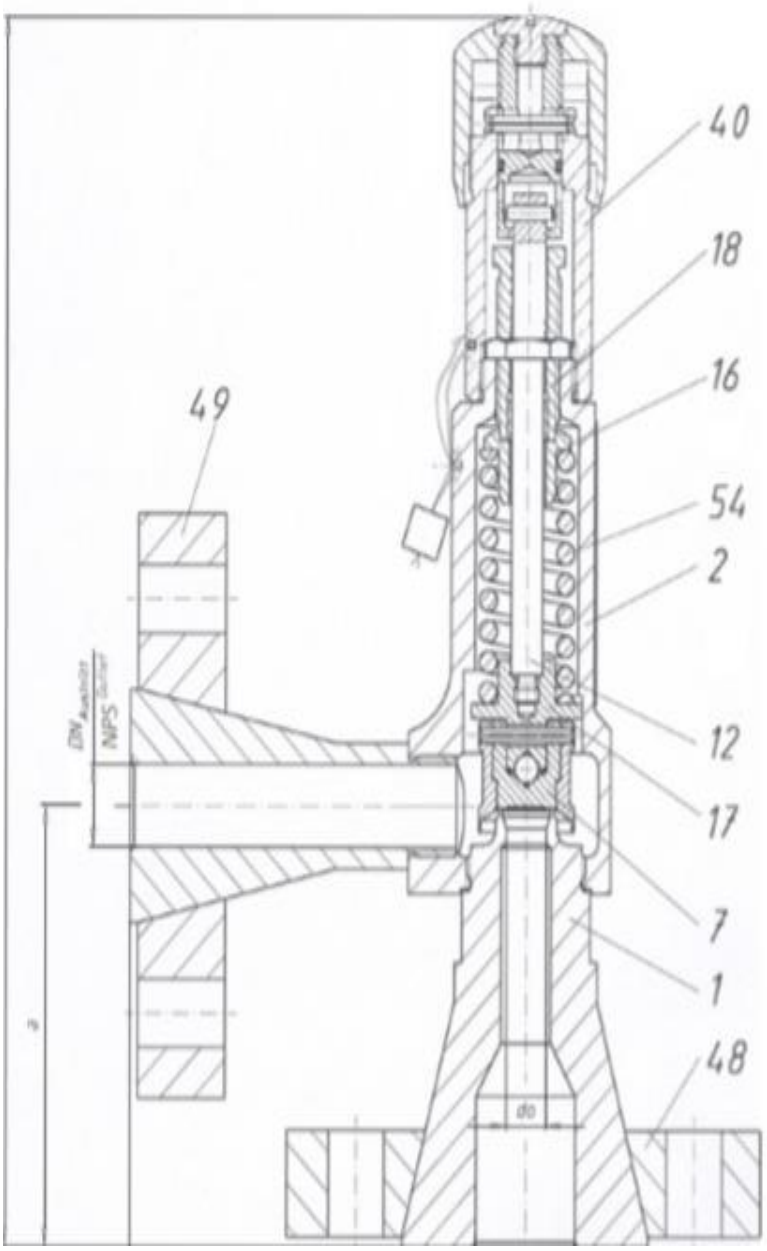
Kv	**0.98**
Re	**48523**

Selected orifice area	**0.11 inch**

PSV Designation	**¾" D 1"**

Table 3—Spring-loaded Pressure-relief Valves "D" Orifice [1] (Effective Orifice Area = 0.110 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	1D2 1D2 [c] 1D2 1D2 1 1/2D2 1 1/2D2 1 1/2D3	150 300 300 600 900 1500 2500	150 150 150 150 300 300 300			285 (285) 740 1480 2220 3705 (6000)	185 (285) 620 1235 1855 3090 5150	80 (285) 410 825 1235 2055 3430		285 285 285 285 (600) (600) 740	230 230 230 230 500 500 500	4 1/8 4 1/8 4 1/8 4 1/8 4 1/8 4 1/8 5 1/2	4 1/2 4 1/2 4 1/2 4 1/2 5 1/2 5 1/2 7
Temperature Range Inclusive 801 °F to 1000 °F													
Chrome Molybdenum Steel	1D2 1D2 1 1/2D2 1 1/2D2 1 1/2D3	300 600 900 1500 2500	150 150 300 300 300					510 1015 1525 2540 4230	215 430 650 1080 1800	290 290 (600) (600) 750	230 230 500 500 500	4 1/8 4 1/8 4 1/8 4 1/8 5 1/2	4 1/2 4 1/2 4 1/2 4 1/2 7



Specific Valve Data		
Pos	Description	Data
1	Purchase Order No.	A-2-LCNZ2101-Methanol/HK170414les-1
2	LESER Job No.	20329048
3	LESER Pos.	300
4	Type	4979.2604
5	Orifice	not specified
6	Inlet size	NPS 3/4"
7	Inlet pressure rating	300 lbs
8	Inlet flange facing	standard
9	Outlet size	NPS 1"
10	Outlet pressure rating	150 lbs
11	Outlet flange facing	standard
12	d0 [mm]	10,00
13	Set pressure	7,50
14	Pressure unit	bar-g
15	CDTP (bar-g)	7,50
16	Dimension a [mm]	103,50
17	Dimension b [mm]	100,00
18	Dimension s [mm]	-
19	Dimension H [mm]	264,00
20	Weight (kg)	4,80
21	Tag No. 1+2	PSV-5085; PSV-5108
22	Tag No. 3+4	PSV-5220; PSV-5444
23	Tag No. 5+6	PSV-5308; PSV-5339
24	Tag No. 7+8	PSV-5370; PSV-6085
25	Tag No. 9+10	PSV-7256
26	Tag No. 11+12	

List of Parts Main Valve			
Pos	Description	Qty	Material
1	Inlet Body	1	1.4401/ 1.4404/ 316/ 316L
2	Outlet Chamberbody AS	1	1.4401/ 1.4404/ 316/ 316L
7	Disc AS	1	1.4401/ 1.4404/ 316/ 316L
12	Spindle AS	1	1.4021/ Chrome Steel
16	Spring Plate	1	1.4104/ 430F
17	Spring Plate	1	1.4104/ 430F
18	Adjusting Screw AS	1	1.4104/ 430F + PTFE/ Glas
40	Cap/ Lifting Device AS	1	1.4104/ 430F + FKM
48	Flange	1	1.4401/ 1.4404/ 316/ 316L
49	Flange	1	1.4401/ 1.4404/ 316/ 316L
54	Compression Spring	1	1.4310 / Stainless Steel