13. Check for Venting Requirements as per API 2000

Out breathing

As per Clause 4.3.2.2

The requirement of venting capacity for maximum liquid movement in to a tank with a flash point of 37.8℃ or above should be equivalent to 1.01 Nm^3/h per cubic meter per hour of maximum filling rate.

In our case the filling rate is = 30 Cu.M/h

Required venting capacity for the maximum liquid movement into a tank = 30.3 Nm^3/h

As per Clause 4.3.2.2.2, the requirement for venting capacity for thermal outbreathing for liquid with a flash point of 37.8 ℃ or above should be at least as shown in the Column 3 of Table 2:

Tank capacity = 510.4 Cu.M

Required venting capacity for thermal outbreathing
50.6 + [(70.8 - 50.6) / (700 – 500)] * (510.4 - 500) = 51.65 Nm^3/h

<u>Total venting capacity required for out breathing</u> = **<u>81.95 Nm^3/h</u>**

Inbreathing

As per Clause 4.3.2.1

The requirement of venting capacity for maximum liquid movement out of the tank should be equivalent to 0.94 Nm^3/h of air for each Cu.M per hour of maximum empting rate.

In our case the empting rate is = 30 Cu.M/h

Required venting capacity for the maximum liquid Movement out of a tank = 28.20 Nm^3/h

As per Clause 4.3.2.1.2 the requirement for venting capacity for thermal in breathing for liquid with a flash point of 37.8℃ of above should be at least as shown in the Column 3 of Table 2:

Tank capacity = 510,4 Cu.M

Required venting capacity for thermal inbreathing
84.3 + [(118 – 84.3) / (700 – 500)] * (510.4 – 500) = 86.05 Nm^3/h

<u>Total venting capacity required for inbreathing</u> = **<u>114.25 Nm^3/h</u>**

As per Clause 4.6.1.2 theoretical flow shall be determined by:

Nm^3/h_{theo} $= 12503 * P_1 * A * \text{sqrt} \{k/MTZ (k-1)*[(P_2/P_1)^{2/k} - (P_2/P_1)^{(k+1)/k}]\}$

Where
Nm^3/h_{theo} = theoretical flow rate, in normal cubic meters per hour of test medium (typically air)

A = Minimum flow area of device, cm^2
P_1 = Pressure at device inlet, bar
P_2 = Pressure at device outlet, bar
k = Ratio of specific heat
T = absolute temp at device inlet, °K
M = Molecular weight of gas
Z = Compressibility factor to account for deviation of actual gas from a perfect gas

As per Clause F.4.1 of API 650, the maximum design pressure, for a tank that has been constructed P:

P = $(1.1)(A)(\tan \theta)/D^2+0.08t_h$

θ = 10°
A = Area resisting the compressive force mm^2 as illustrated in Figure F-2
A = $w_c * t_c + w_h * t_h$
A = $0.6 * (9500mm*5mm)^{0.5} *5mm + 0.3 * (9500mm*5mm /\sin\theta)^{0.5} * 5mm$
A = 130.8mm * 5mm + 156.9mm * 5mm = 1438.5 mm^2

D = Tank Diameter 9.505 m

t_h = Nominal roof thickness 5 mm

P = 3.49 kPa

Outbreathing requirement

P_1	=	104.815 kPa	P2 =101.325 kPa
P_1	=	1.05 bar	
P_2/P_1	=	0.97	
=> K	=	0.71	(Refer Fig 1 of API 2000)
K	=	Co-efficient of discharge	
Nm^3/h_{theo}	=	Nm^3/h_{act} / K	(see equation 3 in API 2000)
=> Nm^3/h_{theo}	=	81.95 Nm^3/h / 0,71	
	=	115.4 Nm^3/h	
k	=	C_p/C_v	
For air C_p	=	1.01	for air C_v= 0.72
=> k	=	1.40	
Design Temp.	=	80 ℃	
T	=	353.15 K	
M (for air)	=	29 g/mol	
Z	=	1	
2/k	=	1.43	
(k+1)/k	=	1.71	
A_{req}	=	Nm^3/h_{theo} / (12503 * P_1 * sqrt {k/MTZ (k-1)*[$(P_2/P_1)^{2/k}$ - $(P_2/P_1)^{(k+1)/k}$]})	
=> A_{req}	=	5.27 cm^2	
Provided Size	=	300 mm	
Provided qty.	=	1 No.	
A_{prov}	=	706.86 cm^2	

In breathing requirement

P_1	=	101.325 kPa kPa		P_2 =101.325 kPa
P_1	=	1.01 bar		
P_2 / P_1	=	1.0		
=> K	=	0.7		
K	=	Co-efficient of discharge		
Nm^3/h_{theo}	=	Nm^3/h_{act} / K	(see equation 3 in API 2000)	
=> Nm^3/h_{theo}	=	114.25 Nm^3/h / 0.70		
	=	163.2 Nm^3/h		
For air Cp	=	1.01		
For air Cv	=	0.72		
k	=	1.403		
Amp temp.	=	257 ℉	125 ℃	
T	=	717		
M (for air)	=	29		
Z	=	1		
2/k	=	1.426		
(k+1)/k	=	1.713		
A	=	5.738 inch	=	3701.71 mm^2
Provided Size	=	12 inch	=	300 mm
Provided qty.	=	1 No.		
A	=	113.10 sq.in 72965.88 mm^2		

<u>Hence provided vent is safe</u>