# **8** VENTING REQUIREMENT

8.1	Design	Code
8.2	Fluid	

8.3 Concept

EN14015:2004 Demineralised Water Section 10.6 & Annex L

The venting system shall accommodate the following:

- 1. normal vacuum relief export or product from tank & decrease in tank surface temperature
- 2. normal pressure relief import or product to tank & increase in tank surface temperature
- 3. emergency vacuum & pressure relief due to fire exposure and rainfall

#### 8.3.1 Design Conditions

Tank Diameter	D =	11	m	
Tank Height	H =	12.4	m	
Max. emptying rate	R <sub>e</sub> =	1440	m <sup>3</sup> /hr	
Max. filling rate	R <sub>f</sub> =	1080	m <sup>3</sup> /hr	
Set Pressure	p <sub>o</sub> =	375	kgf/m <sup>3</sup>	(Vacuum)
	p <sub>i</sub> =	150	kgf/m <sup>3</sup>	(Pressure)
Volume of Tank	V <sub>T</sub> =	1178	m <sup>3</sup>	

#### 8.3.2 Required Normal Vacuum Relief (Inbreathing) Capacity

Required venting capacity for liquid export out of the tank :

$V_1$	=	R <sub>e</sub>	
	=	1440	m³/hr

2342

Additional venting capacity required for thermal inbreathing:

V <sub>2</sub>	=	$CV_T^{0.7}(1-(\Delta p_{av}/(140+P_{vp}))^{1.6})$		
V <sub>2</sub>	=	902 m <sup>3</sup> /hr		
where C	=	6.5	(Anne>	(L 3.3.3.1)
V <sub>T</sub>	=	volume of tank (m <sup>3</sup> )		
ΔP <sub>av</sub>	=	accumulation vacuum (mbar) =	5	mbar
P <sub>vp</sub>	=	vapour pressure of the liquid at 70℃ =	311	mbar
Total required inbreathing venting	ca	pacity; V <sub>i</sub> in m <sup>3</sup> /hr		
Vi	=	V1 + V2		

m<sup>3</sup>/hr

## 8.3.3 Required Normal Pressure Relief (Outbreathing) Capacity

Required venting capacity for liquid import into the tank :



### 8.3.4 Required Emergency Venting Capacity

Emergency vent valves shall be fitted for rapid temperature changes due to fires and heavy rainfall, as per PETRONAS's requirement.

The max flow rate of the emergency vent valves,  $V_{\text{FE}}\,(\text{m}^3/\text{h})$  for pressure venting is given as:



The max flow rate of the emergency vent valves,  $V_{RA}$  (m<sup>3</sup>/h) for vacuum venting due to rainfall is taken as:

8.3.5 Size and Number of Free Vents Selected free vent size $\emptyset = 250 \text{ mm}^{2} \text{ mm}^{2}$ Free vent flow area, $A_{at} = 49097 \text{ mm}^{2}$ plus wire-mesh screen, $II = 55\% \text{ meshes/m}^{2} = 4$ Free vent effective flow area, $A_{att} = 26998 \text{ mm}^{2}$ $= 0.0491 \text{ m}^{2}$ mean speed through screen $U = \frac{\sqrt{(2gAP)}}{\sqrt{(10)}} \text{ m/s}$ U = 12.5  m/s where, $\Delta P$ = venting pressure max differential (kg-l/m <sup>2</sup> ) = 38 110 g = gravitational acceleration (m/s <sup>2</sup> ) = 9.8 f = total frictional coefficient (screens, friction loss) = 3.8 d = vapour density (kg/m <sup>2</sup> ) = 1.23 where, $f = f_{1} + f_{2} + f_{3} + f_{4}$ $f_{1} = 0.5$ (reduced zone) $f_{2} = 0.3$ (pipe friction) $f_{3} = 1.5$ (bird screen) $f_{4} = 1.5$ (bird screen) $f_{4} = 1.5$ (bird screen) $f_{4} = 1.5$ (bird screen) $f_{5} = 1.5$ (bird screen) $f_{6} = 2216 \text{ m}^{3}/\text{hr}$ Thus, the number of free vents, N required is: $N = \frac{max(V_{c}, V_{1})}{2216 \text{ m}^{3}/\text{hr}}$ <b>Conclusion:</b> 2 free vent(s) with screen can be provided. Size of Vent: 250 mm Ø 8.3.5 Size and Number of Emergency Vents The required emergency pressure/vacuum vent capacity $= \frac{max(V_{c}, V_{bh})}{260 \text{ m}^{3}/\text{hr}}$		$V_{RA}$	=	3000	m <sup>3</sup> /hr =		[EJ]	[Annex L	.5]
Selected free vent size $\vec{Q} = 250 \text{ mm}^{2}$ plus wire-mesh screen, $\mathbf{II} = 55\%$ , meshes/ $\mathbf{n}^{2} = 4$ Free vent effective flow area, $A_{eff} = 25998 \text{ mm}^{2}$ $= 0.0491 \text{ m}^{2}$ mean speed through screen $U = \frac{\sqrt{(2gLP)}}{\sqrt{(10)}}$ , $\mathbf{m/s}$ U = 12.5  m/s where, $\Delta P$ = venting pressure max differential (kg- $t/\mathbf{n}^{2}$ ) = 38 100 $g$ = gravitational acceleration ( $\mathbf{m/s}^{2}$ ) = 9.8 f = total frictional coefficient (screens, friction loss) = 3.8 $d$ = vapour density (kg/ $\mathbf{m}^{2}$ ) = 1.23 where, $f$ = $f_{1} + f_{2} + f_{3} + f_{4}$ $f_{1}$ = 0.5 (reduced zone) $f_{2}$ = 0.8 (pipe friction) $f_{3}$ = 1.5 (bird screen) $f_{4}$ = 1 (expanded zone) The effective inbreathing/outbreathing flow capacity provided by 250mmØ vent: $Q = \frac{A_{eff}U}{2216} \frac{m^{3}}{n}hr$ $= \frac{216}{2216} \frac{m^{3}}{n}hr$ $= \frac{1.06}{2216} \frac{m^{3}}{n}hr$ Thus, the number of free vents, N required is: $N = \frac{max(V_{c}, V_{1})}{2216} \frac{m^{3}}{n}hr$ $= \frac{1.06}{2216} \frac{m^{3}}{n}hr$ EConclusion: 2 free vent(s) with screen can be provided. Size of Vent: 250 mm Ø 8.3.5 Size and Number of Emergency Vents The required emergency pressure/vacuum vent capacity $u = \frac{max(V_{c_{1}}, V_{c_{1}})}{200} \frac{m^{3}}{n}hr$	8.3.5 Size and Number of I	Free	Ve	ents					
mean speed through screen $U = \underbrace{\sqrt{2}(2h^2)}_{\sqrt{16}}$ m/s where, $\Delta P = \text{venting pressure max differential (kg-l/m2)} = 38 110 g = gravitational acceleration (m/s2) = 9.8 f = total frictional coefficient (screens, friction loss) = 3.8 d = vapour density (kg/3) = 1.23 where, f = f_1 + f_2 + f_3 + f_4f_1 = 0.5 (reduced zone)f_2 = 0.8 (pipe friction)f_3 = 1.5 (bird screen)f_4 = 1 (expanded zone)The effective inbreathing/outbreathing flow capacity provided by 250mmØ vent:Q = \frac{A_{eff}U}{2216} m^3/hrThus, the number of free vents, N required is:N = \frac{max(V_0, V_1)}{Q}= \frac{2342}{2216} m^3/hr= \frac{1.06}{2216}Conclusion: 2 free vent(s) with screen can be provided.Size of Vent: 250 mmØ8.3.5 Size and Number of Emergency VentsThe required emergency pressure/vacuum vent capacityv = \frac{max(V_{FE}, V_{FA})}{m^3/hr}$	Selected free vent size Free vent flow area, plus wire-mesh screen, Free vent effective flow area,	Ø A fl A <sub>eff</sub>	= = =	250 49087 55% 26998 0.0491	mmØ mm <sup>2</sup> <i>meshe</i> s mm <sup>2</sup> m <sup>2</sup>	S/in²	=	4	
where, $\Delta P$ = venting pressure max differential (kg-f/m <sup>2</sup> ) = 38 110 g = gravitational acceleration (m/s <sup>2</sup> ) = 9.8 f = total frictional coefficient (screens, friction loss) = 3.8 d = vapour density (kg/m <sup>3</sup> ) = 1.23 where, $f = f_1 + f_2 + f_3 + f_4$ $f_1 = 0.5$ (reduced zone) $f_2 = 0.8$ (pipe friction) $f_3 = 1.5$ (bird screen) $f_4 = 1$ (expanded zone) The effective inbreathing/outbreathing flow capacity provided by 250mmØ vent: $Q = A_{eff}U = m^3/s$ $= 2216 m^3/hr$ Thus, the number of free vents, N required is: $N = \frac{max (V_0, V_1)}{Q}$ $= 2342 m^3/hr$ $= 1.06 m^3/hr$ <b>Conclusion:</b> 2 free vent(s) with screen can be provided. Size of Vent: 250 mm Ø <b>8.3.5 Size and Number of Emergency Vents</b> The required emergency pressure/vacuum vent capacity $V = max (V_{FE}, V_{PA})$	mean speed through screen	U	=	√(2 <u>9</u> ∆P) √(fd) <b>12.5</b>	_m/s m/s				
where, $f = f_1 + f_2 + f_3 + f_4$ $f_1 = 0.5 (reduced zone)$ $f_2 = 0.8 (pipe friction)$ $f_3 = 1.5 (bird screen)$ $f_4 = 1 (expanded zone)$ The effective inbreathing/outbreathing flow capacity provided by 250mmØ vent: $Q = A_{eff}U = m^3/s$ $= 2216 m^3/hr$ Thus, the number of free vents, N required is: $N = \frac{max(V_0, V_1)}{Q}$ $= \frac{2342}{2216} m^3/hr$ $= 1.06$ Conclusion: 2 free vent(s) with screen can be provided. Size of Vent: 2 free vent(s) mith screen can be provided. Size of Vent: 250 mm Ø 8.3.5 Size and Number of Emergency Vents The required emergency pressure/vacuum vent capacity $u = \frac{max(V_{FE}, V_{FA})}{u^2}$	where,	ΔP g f d	= = =	venting pressure ma gravitational acceler total frictional coeffic vapour density (kg/n	ix differei ation (m/ sient (scro n <sup>3</sup> )	ntial (kg-f/m <sup>2</sup> ) ′s <sup>2</sup> ) eens, friction loss)	= = =	38 9.8 3.8 1.23	110%
The effective inbreathing/outbreathing flow capacity provided by 250mm/2 vent: $ \begin{array}{l} Q &= & A_{eff}U & m^{3}/s \\ = & 2216 & m^{3}/hr \\ \end{array} $ Thus, the number of free vents, N required is: $ \begin{array}{l} N &= & \frac{max(V_{0}, V_{1})}{Q} \\ = & 2342 & m^{3}/hr \\ = & 1.06 & m^{3}/hr \\ \end{array} $ <i>Conclusion:</i> 2 free vent(s) with screen can be provided. Size of Vent: 250 mm Ø 8.3.5 Size and Number of Emergency Vents The required emergency pressure/vacuum vent capacity $ \begin{array}{l} = & max(V_{FE}, V_{RA}) \\ V &= & max(V_{FE}, V_{RA}) \end{array} $		wh	iere,	f f f	f = 1 = 2 = 3 = 4 =	$f_1 + f_2 + f_3 + f_4$ 0.5 (reduced zone) 0.8 (pipe friction) 1.5 (bird screen) 1 (expanded zone)			
Thus, the number of free vents, N required is: $N = \frac{max (V_{o}, V_{i})}{Q}$ $= \frac{2342}{2216} m^{3/hr}$ $= 1.06$ Conclusion: 2 free vent(s) with screen can be provided. Size of Vent: 250 mm Ø 8.3.5 Size and Number of Emergency Vents The required emergency pressure/vacuum vent capacity $= max (V_{FE}, V_{RA})$ $V = max (V_{FE}, V_{RA})$	The effective inbreathing/ou	Q	e = =	g flow capacity provid A <sub>eff</sub> U 2216	m <sup>3</sup> /s	0mmØ vent:			
Conclusion:       2 free vent(s) with screen can be provided. Size of Vent:       250 mm Ø         8.3.5 Size and Number of Emergency Vents The required emergency pressure/vacuum vent capacity $max (V_{FE}, V_{RA})$	Thus, the number of free ve	nts, N N	N red = = =	uired is: <u>max ( V<sub>o</sub> , V<sub>i</sub> )</u> Q 2342 2216 <b>1.06</b>	_m <sup>3</sup> /hr m <sup>3</sup> /hr				
8.3.5 Size and Number of Emergency Vents The required emergency pressure/vacuum vent capacity $= \max (V_{FE}, V_{RA})$ $= \max^{3/br}$	Conclusion:	<mark>2 fre</mark> Size	ee ' e of	vent(s) with scre Vent:	en cai 250	n be provided. mm Ø			
	8.3.5 Size and Number of I The required emergency pre	E <b>me</b> essure	e/va =	cuum vent capacity max (V <sub>FE</sub> , V <sub>RA</sub> )	m <sup>3</sup> /hr				

The flow capacity of normal pressure relief vent may account for sizing the emergency venting:

 $Q = \frac{4432}{m^3/hr}$ 

*Conclusion:* Since Q < V<sub>E</sub>, the free vent is insufficient. Emergency vent valves shall be provided.