8 VENTING REQUIREMENT

8.1 Design Code EN14015:2004
8.2 Fluid Demineralised Water
8.3 Concept 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_e	=	1440	m^3/hr	
Max. filling rate	R_f	=	1080	m^3/hr	
Set Pressure	p_o	=	375	kgf/m^3	(Vacuum)
	p_i	=	150	kgf/m^3	(Pressure)
Volume of Tank	V_T	=	1178	m^3	

8.3.2 Required Normal Vacuum Relief (Inbreathing) Capacity

Required venting capacity for liquid export out of the tank :

$V_1 = R_e$
$= 1440$ m^3/hr

Additional venting capacity required for thermal inbreathing:

$V_2 = CV_T^{0.7}(1-(\Delta p_{av}/(140+P_{vp}))^{1.6}$
$V_2 = 902$ m^3/hr

where $C = 6.5$ (Annex L 3.3.3.1)
V_T = volume of tank (m^3)
ΔP_{av} = accumulation vacuum (mbar) = 5 mbar
P_{vp} = vapour pressure of the liquid at 70℃ = 311 mbar

Total required inbreathing venting capacity; V_i in m^3/hr

$V_i = V1 + V2$
$=$ **2342** m^3/hr

8.3.3 Required Normal Pressure Relief (Outbreathing) Capacity

Required venting capacity for liquid import into the tank :

$V_3 = R_f$
$= 1080$ m^3/hr

Additional venting capacity required for thermal inbreathing:

$V_4 = 0.32V_T^{0.9}(1-(\Delta p_{ap}/140)^{1.6}$
$V_4 = 182$ m^3/hr

where (Annex L 3.3.2.1)
V_T = volume of tank (m^3)
ΔP_{ap} = accumulation pressure (mbar) = 2 mbar

Total required inbreathing venting capacity; V_o in m^3/hr

$V_o = V3 + V4$
$=$ **1262** m^3/hr

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_{FE} (m^3/h) for pressure venting is given as:

V_{FE} = $15V_T^{0.7}R_{inf}$ [Annex L.4.2.2]

= **2118** m^3/hr

where V_T = volume of tank (m^3)

R_{inf} = 1, for uninsulated tanks in case of fire (m^3)

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

V_{RA} = **3000** m^3/hr [EJ] [Annex L.5]

8.3.5 Size and Number of Free Vents

Selected free vent size	Ø	=	250	mmØ			
Free vent flow area,	A	=	49087	mm^2			
plus wire-mesh screen,	fl	=	55%	*meshes/in^2*	=	*4*	
Free vent effective flow area,	A_{eff}	=	26998	mm^2			
		=	**0.0491**	m^2			

mean speed through screen U = $\frac{\sqrt{(2g\Delta P)}}{\sqrt{(fd)}}$ m/s

U = **12.5** m/s

where,	ΔP	=	venting pressure max differential (kg-f/m^2)	=	38	**110%**
	g	=	gravitational acceleration (m/s^2)	=	9.8	
	f	=	total frictional coefficient (screens, friction loss)	=	3.8	
	d	=	vapour density (kg/m^3)	=	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 = $\frac{\max(V_o, V_i)}{Q}$

= $\frac{2342}{2216}$ $\frac{m^3/hr}{m^3/hr}$

= **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_E = **3000** m^3/hr

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

Q = **4432** m^3/hr

Conclusion: **Since Q < V_E, the free vent is insufficient. Emergency vent valves shall be provided.**