

Dossier CMP Arles : 783

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Client / Customer : MESSER




Engineered System N° :

1 RESERVOIR DE STOCKAGE LOX 1800MT

1 x 1800MT LOX STORAGE TANK

NOTE DE CALCUL THERMIQUE

THERMAL LOSSES CALCULATION NOTE

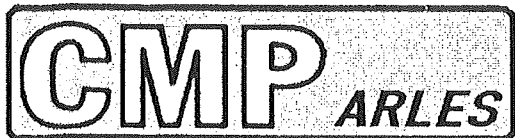
1		28/07/04	HULIN		28/07/04	GABRELLI		28/07/04	LEBOUCQ		
EDITION EDITION N°	REFERENCE CLIENT REF.	DATE	NOM NAME	SIGN.	DATE	NOM NAME	SIGN.	DATE	NOM NAME	SIGN.	ETAT D'AVANC. STATUS
		REDACTEUR DRAWN UP BY		VERIFICATEUR CHECKED BY		APPROBATEUR APPROVED BY					

Projet : ASU KOSICE
ProjectClassement CMP Arles : 783-NC03
CMP Arles document N°

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Item : 1 x 1800 MT LOX

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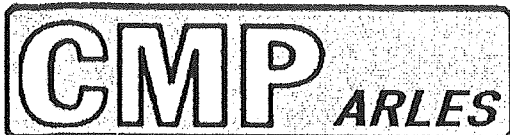
OBJET DES MODIFICATIONS :

(subject of modifications)

INDICE DE L'EDITION Edition n°	OBJET DE LA MODIFICATION (subject of modifications)
1	Premiere diffusion / First issue

DATA :

Liquide :	Product :	Oxygen
	Temperature :	T1 = -183 deg.C
	Density:	W = 1140 kg/m ³
Heat of vaporisation :		L = 213 kJ/kg
External temperature :		T2 = 15 deg.C
Inner vessel :	Shell internal diameter :	D1 = 12.550 m
	Shell height :	H1 = 13.210 m
	Liquid height :	LH = 12.895 m
	Shell average thickness :	E1 = 0.006 m
	Roof external radius :	R1 = 11.006 m
	Roof height :	G1 = 1.964 m
Insulation Jacket :	Shell internal diameter :	D2 = 14.750 m
	Shell height :	H2 = 14.770 m
	Roof internal radius :	R2 = 12.100 m
	Roof height :	G2 = 2.507 m
Perlite thickness in the shell interspace :		E3 = 1.094 m
Perlite thickness in the roof interspace :		Er = 1.094 m
Foamglas thickness :	In the center :	E4 = 0.800 m
	At the periphery :	E'4 = 0.700 m
Foamglas external diameter :		D4 = 13.250 m
		D'4 = 11.650 m
Width of the reinforced concrete ring :		Lb = 0.800 m
Perlite specific gravity :		W3 = 56 kg/m3
Foamglas specific gravity :		W4 = 130 kg/m3
Number of inner vessel anchor bolt (or straps) :		Na = 40
Area of one anchor bolt (or strap) :		Sa = 0.001 m ²
Internal shell stiffeners :	Number :	Nr = 6
	External diameter :	Dr = 12.939 m
	Height :	Hr = 0.100 m
Outer shell stiffeners :	Number :	Ns = 3
	External diameter :	Ds = 14.450 m
	Thickness :	Hs = 0.020 m



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RESULTS :

Mass of liquid : $M = 0.99 \times (PI \times D1^2 \times LH / 4) \times W$	M =	1800274	kg
Inner shell average diameter : $Di = [(H1 - Nr \times Hr) \times (D1 + 2 \times E1) + Nr \times Hr \times Dr] / H1$	Di =	12.58	m
Outer shell average diameter : $Do = [(H2 - Ns \times Hs) \times D2 + Ns \times Hs \times Ds] / H2$	Do =	14.74878	m
Temperature difference : $\Delta T = T2 - T1$	$\Delta T =$	198.00	deg.C
Average temperature : $Tm = (T1 + T2) / 2$	$Tm =$	-84	deg.C
Stainless steel thermal conductivity :	Lambda =	14	W/m deg.C
Perlite thermal conductivity : $\lambda3 = (1.292E-4 + 0.2564E-6 \times Tm) \times (W3 + 400) - 0.019478$	Lambda3 =	0.0296	W/m deg.C
Foamglas thermal conductivity : Foamglas quality : HLB1000	Lambda4 =	0.0320	W/m deg.C

CALCULATION OF AVERAGE SURFACES :

Foamglas :	$S4 = PI \times D'^4 / 4$ (if there is a concrete ring) : $S'4 = PI \times D4^2 / 4 - S4$	S4 =	106.60	m ²
		S'4 =	31.29	m ²
Perlite :	Roof : $Sr = [(2 \times PI \times R1 \times G1) \times (2 \times PI \times R2 \times G2)] (1/2)$ Shell : $S3 = PI \times 0.5 \times (Do + Di) \times 0.5 \times (H1 + H2)$	Sr =	160.91	m ²
		S3 =	600.56	m ²
Bottom :	$SB = PI \times [(0.5 \times (Do + Di))^2 - D4^2] / 4$	SB =	8.76	m ²
Anchor bolts (or straps) :	$S7 = Na \times Sa$	S7 =	0.04	m ²
Foamglas stainless steel belt :	$S8 = PI \times D4 \times 0.0005$	S8 =	0.02	m ²
Piping (estimated) :		S6 =	0.025	m ²

CALCULATION OF THERMAL LOSSES :

Foamglas :	$Q4 = \lambda_{da4} \times (S4 / E4 + S'4 / E'4) \times \delta_{T_T}$	Q4 =	1129	W
Perlite :	$Q3 = \lambda_{da3} \times (Sr / Er + S3 / (0.5 \times (Do - Di)) + SB / E'4) \times \delta_{T_T}$	Q3 =	4183.44	W
Anchor bolts (or straps) :	$Q7 = \lambda_{da} \times S7 \times \delta_{T_T} / E'5$	Q7 =	158.4	W
Foamglas belt :	$Q8 = \lambda_{da} \times S8 \times \delta_{T_T} / E'5$	Q8 =	82.42	W
Piping :	$Q6 = \lambda_{da} \times S6 \times \delta_{T_T} / E4$	Q6 =	63.37	W
Total :	$Q = Q3 + Q4 + Q6 + Q7 + Q9$	Q =	5617	W

CALCULATION EVAPORATION RATE PER DAY :

$$E = Q \times 86400 / (L \times M \times 1E3)$$

$$E = 0.13\%$$