

Dossier CMP Arles : 783

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Client / Customer : MESSER

Engineered System N° :

# 1 RESERVOIR DE STOCKAGE LIN 1000MT

## 1 x 1000MT LIN STORAGE TANK

### NOTE DE CALCUL THERMIQUE

### THERMAL LOSSES CALCULATION NOTE

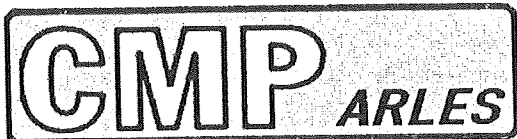
1		28/07/04	HULIN	WS	28/07/04	CABRELLI	AB	28/07/04	LEBOUCQ	AB	
EDITION EDITION N°	REFERENCE CLIENT REF.	DATE	NOM NAME	SIGN.	DATE	NOM NAME	SIGN.	DATE	NOM NAME	SIGN.	ETAT D'AVANC. STATUS
REDACTEUR DRAWN UP BY				VERIFICATEUR CHECKED BY				APPROBATEUR APPROVED BY			

Projet : **ASU KOSICE**  
ProjectClassement CMP Arles : **783-NC103**  
CMP Arles document N°

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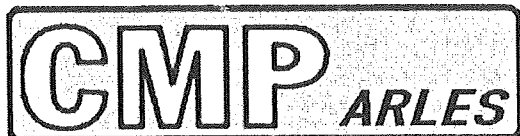
Item : 1 x 1000 MT LIN

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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



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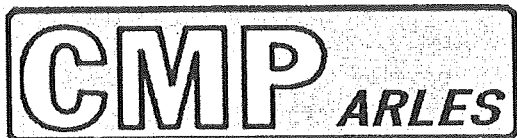
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## DATA :

Liquide :	Product :		Nitrogen
	Temperature :	T1 =	-196 deg.C
	Density:	W =	812 kg/m <sup>3</sup>
Heat of vaporisation :		L =	199.199 kJ/kg
External temperature :		T2 =	15 deg.C
Inner vessel :	Shell internal diameter :	D1 =	9.750 m
	Shell height :	H1 =	17.050 m
	Liquid height :	LH =	16.745 m
	Shell average thickness :	E1 =	0.005 m
	Roof external radius :	R1 =	9.205 m
	Roof height :	G1 =	1.397 m
Insulation Jacket :	Shell internal diameter :	D2 =	12.350 m
	Shell height :	H2 =	18.729 m
	Roof internal radius :	R2 =	10.500 m
	Roof height :	G2 =	2.008 m
Perlite thickness in the shell interspace :		E3 =	1.295 m
Perlite thickness in the roof interspace :		Er =	1.295 m
Foamglas thickness :	In the center :	E4 =	0.800 m
	At the periphery :	E'4 =	0.700 m
Foamglas external diameter :		D4 =	10.450 m
		D'4 =	8.850 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 =	32
Area of one anchor bolt ( or strap ) :		Sa =	0.001 m <sup>2</sup>
Internal shell stiffeners :	Number :	Nr =	10
	External diameter :	Dr =	10.090 m
	Height :	Hr =	0.080 m
Outer shell stiffeners :	Number :	Ns =	4
	External diameter :	Ds =	12.050 m
	Thickness :	Hs =	0.020 m



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## RESULTS :

Mass of liquid :

M = 1005022 kg

$$M = 0.99 \times (\pi \times D1^2 \times LH / 4) \times W$$

Inner shell average diameter :

Di = 9.776 m

$$Di = [ (H1 - Nr \times Hr) \times (D1 + 2 \times E1) + Nr \times Hr \times Dr ] / H1$$

Outer shell average diameter :

Do = 12.34872 m

$$Do = [ (H2 - Ns \times Hs) \times D2 + Ns \times Hs \times Ds ] / H2$$

Temperature difference :

delta\_T = 211.00 deg.C

$$\text{delta\_T} = T2 - T1$$

Average temperature :

Tm = -90.5 deg.C

$$Tm = (T1 + T2) / 2$$

Stainless steel thermal conductivity :

Lambda = 14 W/m deg.C

Perlite thermal conductivity :

Lambda3 = 0.0289 W/m deg.C

$$\text{lambda3} = (1.292E-4 + 0.2564E-6 \times Tm) \times (W3 + 400) - 0.019478$$

Foamglas thermal conductivity :

Lambda4 = 0.0315 W/m deg.C

Foamglas quality : HLB1000

**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 =	61.51	m <sup>2</sup>
		S'4 =	24.25	m <sup>2</sup>
Perlite :	Roof :	Sr =	103.45	m <sup>2</sup>
	$Sr = [ ( 2 \times PI \times R1 \times G1 ) \times ( 2 \times PI \times R2 \times G2 ) ] (1/2)$			
	Shell :	S3 =	621.72	m <sup>2</sup>
	$S3 = PI \times 0.5 \times ( Do + Di ) \times 0.5 \times ( H1 + H2 )$			
Bottom :		SB =	10.35	m <sup>2</sup>
	$SB = PI \times [ ( 0.5 \times ( Do + Di ) )^2 - D4^2 ] / 4$			
Anchor bolts ( or straps ) :		S7 =	0.032	m <sup>2</sup>
	$S7 = Na \times Sa$			
Foamglas stainless steel belt :		S8 =	0.02	m <sup>2</sup>
	$S8 = PI \times D4 \times 0.0005$			
Piping ( estimated ) :		S6 =	0.025	m <sup>2</sup>

**CALCULATION OF THERMAL LOSSES :**

Foamglas :		Q4 =	740	W
	$Q4 = \lambda \times ( S4 / E4 + S'4 / E'4 ) \times \Delta T$			
Perlite :		Q3 =	3519.05	W
	$Q3 = \lambda \times ( Sr / Er + S3 / ( 0.5 \times ( Do - Di ) ) + SB / E'4 ) \times \Delta T$			
Anchor bolts ( or straps ) :		Q7 =	135.04	W
	$Q7 = \lambda \times S7 \times \Delta T / E'5$			
Foamglas belt :		Q8 =	69.27	W
	$Q8 = \lambda \times S8 \times \Delta T / E'5$			
Piping :		Q6 =	57.04	W
	$Q6 = \lambda \times S6 \times \Delta T / E4$			
Total :		Q =	4521	W
	$Q = Q3 + Q4 + Q6 + Q7 + Q8$			

**CALCULATION EVAPORATION RATE PER DAY :**

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

$$E = 0.20\%$$