

**MATICON** Ternehaven 87, DK-4000 Roskilde, Denmark

Vessel Tag No.:K02 - Heat Exchanger

Tg.: -----

Visual Vessel Design by OhmTech Ver:10.0-01 Operator :LBH Rev.:A

ASME VIII Div.1:2007 A08 - UG-32 TORISPHERICAL HEADS

E3.1 Dished End 24 Mar. 2009 16:11 ConnID:S1.2 PC# 2

**INPUT DATA**

**COMPONENT ATTACHMENT/LOCATION**

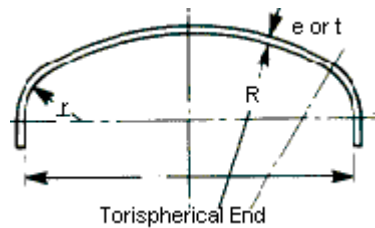
Attachment: S1.2 Cylindrical Shell Bottom Section F.1  
No. of Identical Components.....:Qty. 1.00

**GENERAL DESIGN DATA**

PRESSURE LOADING: Design Component for Internal Pressure Only  
PROCESS CARD: Tube Side : Temp= 180°C, P= .5MPa, c= 0mm, Pext= 0MPa  
SPECIFIC DENSITY OF OPERATING LIQUID.....:SG 1.00  
LIQUID HEAD.....:LH 0.00 mm

**DIMENSIONS OF END**

Design Diameter: Base Design on Outside Diameter



Type of Torispherical End:

Dished End KLOPPERFORM EN 28011-28012(r=0.10\*D, R=1.0\*D)  
WELD JOINT EFFICIENCY FACTOR: Seamless Head (E=1.0)  
OUTSIDE DIAMETER OF END.....:Do 458.00 mm  
LENGTH OF CYLINDRICAL PART OF END.....:Lcyl 14.00 mm  
NEGATIVE TOLERANCE/THINNING ALLOWANCE.....:th 0.3000 mm  
AS BUILT THICKNESS OF HEAD/END (uncorroded).....:tn 3.60 mm

**MATERIAL DATA FOR END**

SA-240(M) Gr.316L, S31603 Plate THK<=0mm 180'C  
ST=485 SY=170 SYd=124.2 S=111.4 Sr=115 Stest=153 (N/mm2)  
MODULUS OF ELASTICITY at design temp.....:E 1,82E05 N/mm2

**CALCULATION DATA**

**UG-32(e) TORISPHERICAL HEADS UNDER INTERNAL PRESSURE**

**7.5.3.2 Required Minimum End Thickness**

M-factor to Article 1-4(d) of Appendix 1  
 $M = (3 + \text{SQR}(L / r)) / 4 = (3 + \text{SQR}(458/45.8)) / 4 = 1.54$   
Required Minimum Thickness of Torispherical End to Appendix 1-4  
 $t_{min} = P * L * M / (2 * S * E - 0.2 * P)$  (App.1-4(d))  
 $= 0.5 * 458 * 1.54 / (2 * 111.4 * 1 - 0.2 * 0.5) = 1.58 \text{ mm}$   
Required Minimum End Thickness Incl.Allow. :  
 $t_{mina} = t_{min} + c + th = 1.58 + 0 + 0.3 = 1.88 \text{ mm}$

»Internal Pressure  $t_{mina}=1.88 \leq t_n=3.6[\text{mm}]$  « » (U= 52.2%) OK«

Analysis Thickness  
 $t_a = t_n - c - th = 3.6 - 0 - 0.3 = 3.30 \text{ mm}$   
Inside Diameter of Shell  
 $D_i = D_o - 2 * (t_n - c) = 458 - 2 * (3.6 - 0) = 450.80 \text{ mm}$   
Mean Diameter of Shell  
 $D_m = (D_o + D_i) / 2 = (458 + 450.8) / 2 = 454.40 \text{ mm}$

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**7.5.3.1 Torispherical Ends - Limitations**»Geometry Check  $r=45.8 \leq 0.2 * D_{i0}=90.16[\text{mm}]$  « » OK«»Geometry Check  $r=45.8 \geq 0.06 * D_{i0}=27.05[\text{mm}]$  « » OK«»Geometry Check  $r=45.8 \geq 2 * e=3.17[\text{mm}]$  « » OK«»Geometry Check  $e=1.58 \leq 0.08 * D_{o0}=36.64[\text{mm}]$  « » OK«»Geometry Check  $t_a=3.3 \geq 0.001 * D_{o0}=0.458[\text{mm}]$  « » OK«»Geometry Check  $R=458 \leq D_{o0}=458[\text{mm}]$  « » OK«**MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :NEW & COLD**

$$P_{\max} = 2 * S * E * t_a / (L * M + 0.2 * t_a)$$

$$= 2 * 115 * 1 * 3.3 / (458 * 1.54 + 0.2 * 3.3) =$$

1.07 MPa**MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :HOT & CORR**

$$P_{\max} = 2 * S * E * t_a / (L * M + 0.2 * t_a)$$

$$= 2 * 111.4 * 1 * 3.3 / (458 * 1.54 + 0.2 * 3.3) =$$

1.04 MPa**MAX TEST PRESSURE (Uncorroded cond.at ambient temp.)**

$$P_{\max} = 2 * S * E * t_a / (L * M + 0.2 * t_a)$$

$$= 2 * 153 * 1 * 3.3 / (458 * 1.54 + 0.2 * 3.3) =$$

1.43 MPa**PED - REQUIRED MINIMUM TEST PRESSURE: NEW AT AMBIENT TEMP. P<sub>tmin</sub>**

$$P_{tmin} = \text{MAX}(1.43 * P_d, 1.25 * P_d * S_r / S)$$

$$= \text{MAX}(1.43 * 0.5, 1.25 * 0.5 * 115 / 111.4) =$$

0.7150 MPa»Test Pressure  $P_{tmin}=0.715 \leq P_{tmax}=1.43[\text{MPa}]$  « » (U= 50%) OK«**UHA-44 Extreme Fiber Elongation**

$$f_{ext} = 75 * t_n / R_f * (1 - R_f / \text{INFINITY})$$

$$= 75 * 3.6 / 47.6 * (1 - 47.6 / \text{Infinity}) =$$

5.67 %**CALCULATION SUMMARY****UG-32(e) TORISPHERICAL HEADS UNDER INTERNAL PRESSURE****7.5.3.2 Required Minimum End Thickness**

Required Minimum End Thickness Incl.Allow. :

$$t_{min a} = t_{min} + c + t_h = 1.58 + 0 + 0.3 =$$

1.88 mm»Internal Pressure  $t_{min a}=1.88 \leq t_n=3.6[\text{mm}]$  « » (U= 52.2%) OK«**MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :NEW & COLD**

$$P_{\max} = 2 * S * E * t_a / (L * M + 0.2 * t_a)$$

$$= 2 * 115 * 1 * 3.3 / (458 * 1.54 + 0.2 * 3.3) =$$

1.07 MPa**MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :HOT & CORR**

$$P_{\max} = 2 * S * E * t_a / (L * M + 0.2 * t_a)$$

$$= 2 * 111.4 * 1 * 3.3 / (458 * 1.54 + 0.2 * 3.3) =$$

1.04 MPa

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**MAX TEST PRESSURE (Uncorroded cond.at ambient temp.)**

$$P_{max} = 2 * S * E * t_a / (L * M + 0.2 * t_a)$$

$$= 2 * 153 * 1 * 3.3 / (458 * 1.54 + 0.2 * 3.3) =$$

1.43 MPa

$$P_{tmin} = \text{MAX}( 1.43 * P_d , 1.25 * P_d * S_r / S )$$

$$= \text{MAX}(1.43 * 0.5, 1.25 * 0.5 * 115 / 111.4) =$$

0.7150 MPa

»Test Pressure  $P_{tmin}=0.715 \leq P_{tmax}=1.43$ [MPa] «      » (U= 50%) OK«

Volume:0.01 m3    Weight:6.4 kg (SG= 7.85 )

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