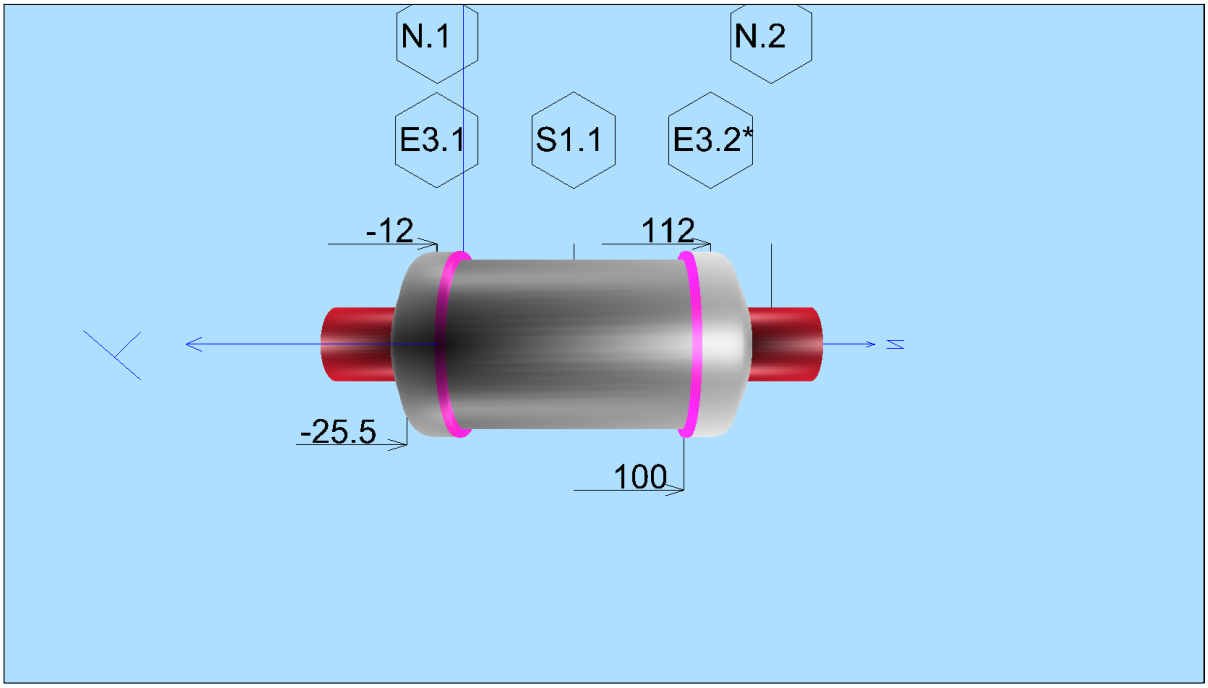
## (0) Drawing

3D View of Vessel (alter by using the Save User Specified View command)

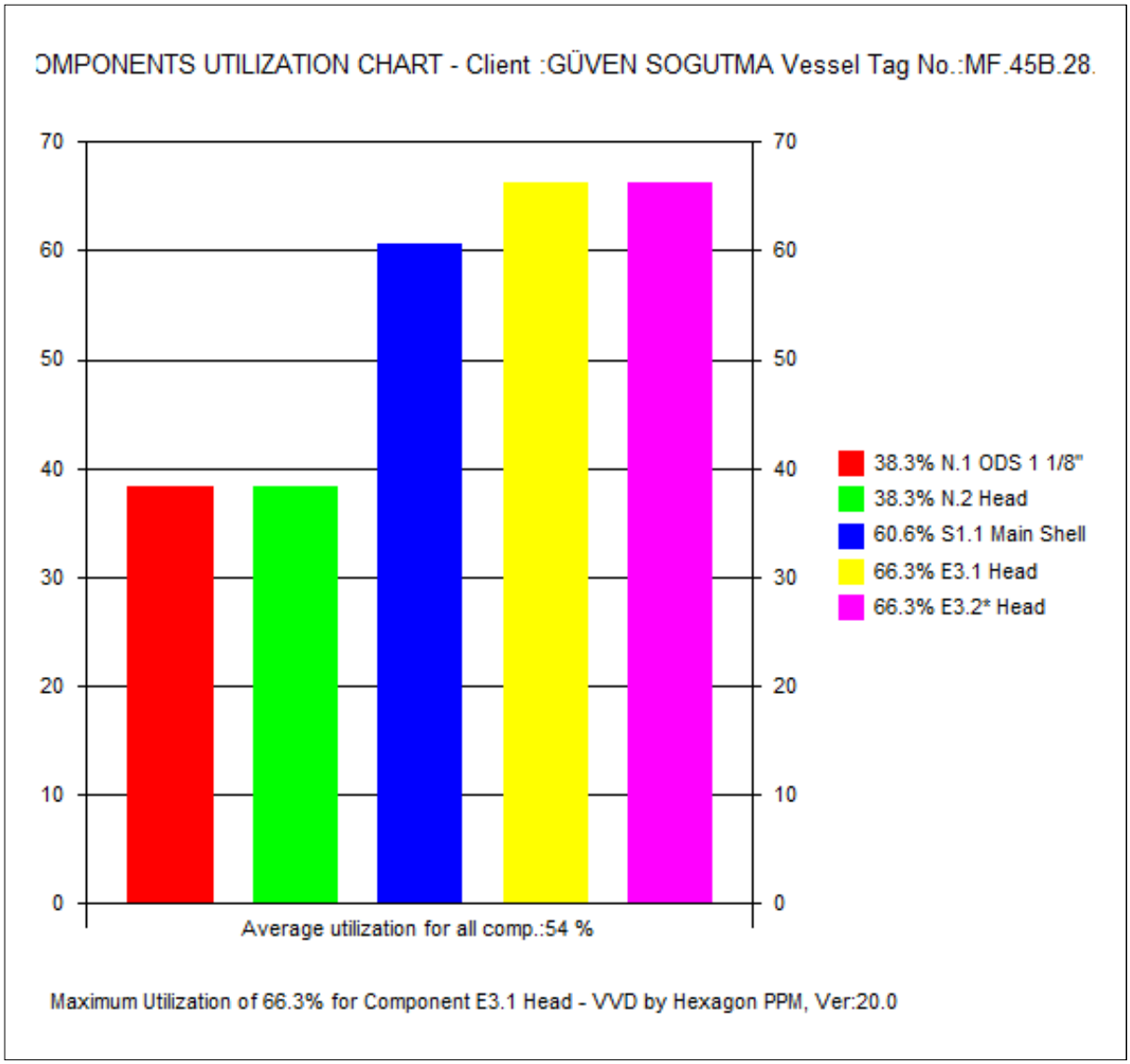



## Design Data & Process Information

| Description | Units | Design Data |
|---|---|---|
| Process Card | | General Design Data |
| Design Code & Specifications | | EN13445 TG = 3b |
| Internal Design Pressure (MPa) | MPa | 4.5 |
| External Design Pressure (MPa) | MPa | |
| Hydrotest Pressure (MPa) | MPa | |
| Maximum Design Temperature ('C) | 'C | 130 |
| Minimum Design Temperature ('C) | 'C | -20 |
| Operating Temperature ('C) | 'C | |
| Corrosion Allowance (mm) | mm | 0.5 |
| Content of Vessel | | |
| Specific Density of Oper.Liq | | |
| Normal Liquid Level NLL (mm) | mm | |

## Utilization Chart

Utilization Chart




## Welding Information

EN1708-1 Welding Requirements for Pressurized Components
NOTE: No welding information has been specified by the user.

# INPUT DATA

## COMPONENT ATTACHMENT/LOCATION

```
Distance from end of cylinder to ref. DATUM LINE....:mm          0.00 mm
```

## GENERAL DESIGN DATA

```
PRESSURE LOADING: Design Component for Internal Pressure Only
PROCESS CARD:
General Design Data : Temp= 130°C, P=4.5000 MPa, c=0.5 mm, Pext=0.0000 MPa
SPECIFIC DENSITY OF OPERATING LIQUID.................:SG          0.00
LIQUID HEAD.........................................:LH          0.00 mm
```

## SHELL DATA

```
CYLINDER FABRICATION: Welded Pipe
WELD JOINT COEFFICIENT: Testing Group  3   (z=0.85)
NEGATIVE TOLERANCE: Negative tolerance specified in mm
EN 10217-3:2019, 1.0565 P355NH welded tube, HT:N THK<=20mm 130'C
Rm=490 Rp=355 Rpt=292 f=194.67 f20=204.17 ftest=338.1 E=203868(N/mm2) ro=7.85
OUTSIDE DIAMETER OF SHELL............................:De         76.00 mm
LENGTH OF CYLINDRICAL PART OF SHELL..................:Lcyl      100.00 mm
NOMINAL WALL THICKNESS (uncorroded)..................:en         3.0000 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE................:th         0.3000 mm
Split shell into several shell courses and include welding information: NO
```

## WELDING REQUIREMENTS TO EN 1708-1:2010

```
Comment(Optional):
Type of welded connection: Not Applicable
```

# CALCULATION DATA

## 7.4.2 - CYLINDRICAL SHELLS UNDER INTERNAL PRESSURE

```
Required Minimum Shell Thickness Excl.Allow. emin :
emin = De * P / (2 * f * z + P)                                  (7.4-2)
=76*4.5/(2*194.67*0.85+4.5)=                              1.0196 mm

Required Minimum Shell Thickness Incl.Allow. :
emina = emin + c + NegDev =1.02+0.5+0.3=                   1.8196 mm

Analysis Thickness
ea = en - c - NegDev =3-0.5-0.3=                           2.2000 mm
```

»7.4.1 Cond.of Applicabilty emin/De=0.0134 <= 0.16« » OK«

| | | |
|---|---|---|
| Internal Pressure emina=1.82 <= en=3[mm] | 60.6% | OK |

## MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :

```
Inside Diameter of Shell
Di = De - 2 * ea =76-2*2.2=                                  71.60 mm
Mean Diameter of Shell
Dm = (De + Di) / 2 =(76+71.6)/2=                             73.80 mm
MAWP HOT & CORR. (Corroded condition at design temp.)
MAWPHC = 2 * f * z * ea / Dm =2*194.67*0.85*2.2/73.8=       9.8654 MPa

MAWP NEW & COLD (Uncorroded condition at ambient temp.)
MAWPNC = 2 * f20 * z * (ea + c) / Dm
=2*204.17*0.85*(2.2+0.5)/73.8=                             12.70 MPa
```

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

```
Ptmax = 2 * ftest * ztest * (ea + c) / Dm
=2*338.1*1*(2.2+0.5)/73.8=                                 24.74 MPa
```

### EN13445-5;10.2.3.3 REQUIRED MIN.HYDROSTATIC TEST PRESSURE:Ptmin

NEW AT AMBIENT TEMP. FOR TEST GROUPS 1, 2 and 3
Ptmin = 1.25 * Pd * f20 / f =1.25*4.5*204.17/194.67= 5.8995 MPa

Ptmin = 1.43 * Pd =1.43*4.5= 6.4350 MPa

| | | |
|---|---|---|
| Test Pressure Ptmin=6.435 <= Ptmax=24.74[MPa] | 26.0% | OK |

### MAXIMUM DIAMETER OF UNREINFORCED OPENING IN SHELL

Inside Radius of Shell
ris = Di / 2 (9.5-3) =71.6/2= 35.80 mm
Length of Shell Contributing to Reinforcement
Is = Sqr(( 2 * ris + ea) * ea) (9.5-2) =Sqr((2*35.8+2.2)*2.2)= 12.74 mm
Maximum Diameter of Unreinforced Opening in Shell Checked to Rules in Section 9
dmax1 = MIN(0.5*Di,(ea*Is*(f-0.5*P)/P-ris*Is)/(0.5*ris+0.5*ea)) (9.5-7,22,23)
=MIN(0.5*71.6,(2.2*12.74*(194.67-0.5*4.5)/4.5-35.8*12.74)/(0.5*35.8+0.5*2.2
))= = 35.80 mm

Maximum diameter of Opening Not Requiring Reinforcement Check
dmax2 = 0.15 * Sqr(( 2 * ris + ea) * ea) (9.5-18)
=0.15*Sqr((2*35.8+2.2)*2.2)= 1.9113 mm

Maximum Diameter of Unreinforced Opening
dmax = MAX( dmax1, dmax2) =MAX(35.8,1.91)= 35.80 mm

## CALCULATION SUMMARY

### 7.4.2 - CYLINDRICAL SHELLS UNDER INTERNAL PRESSURE

Required Minimum Shell Thickness Excl.Allow. emin :
emin = De * P / (2 * f * z + P) (7.4-2)
=76*4.5/(2*194.67*0.85+4.5)= 1.0196 mm

Required Minimum Shell Thickness Incl.Allow. :
emina = emin + c + NegDev =1.02+0.5+0.3= 1.8196 mm

| | | |
|---|---|---|
| Internal Pressure emina=1.82 <= en=3[mm] | 60.6% | OK |

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

Ptmax = 2 * ftest * ztest * (ea + c) / Dm
=2*338.1*1*(2.2+0.5)/73.8= 24.74 MPa

### EN13445-5;10.2.3.3 REQUIRED MIN.HYDROSTATIC TEST PRESSURE:Ptmin

NEW AT AMBIENT TEMP. FOR TEST GROUPS 1, 2 and 3
Ptmin = 1.25 * Pd * f20 / f =1.25*4.5*204.17/194.67= 5.8995 MPa

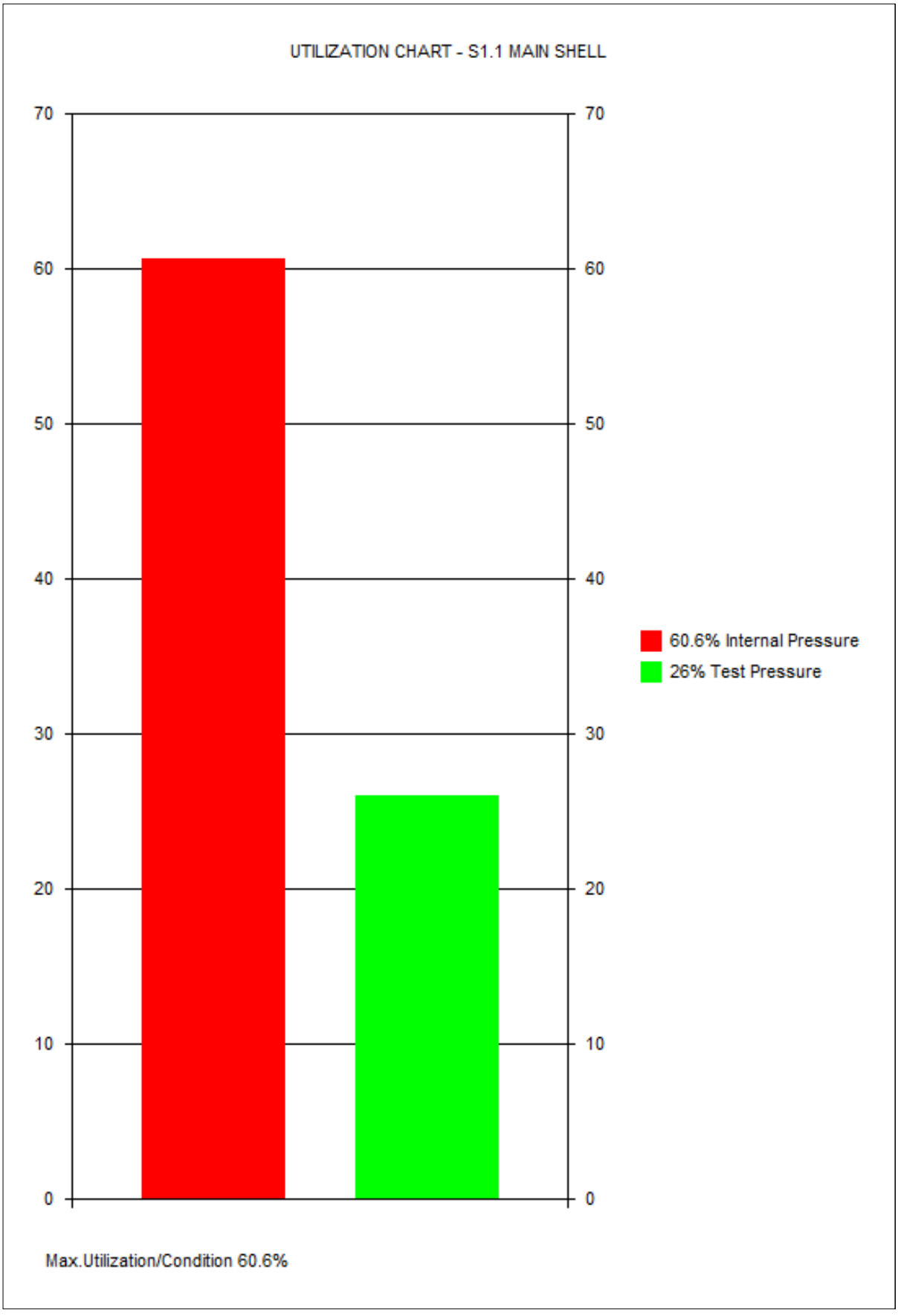
Ptmin = 1.43 * Pd =1.43*4.5= 6.4350 MPa

| | | |
|---|---|---|
| Test Pressure Ptmin=6.435 <= Ptmax=24.74[MPa] | 26.0% | OK |

### MAXIMUM DIAMETER OF UNREINFORCED OPENING IN SHELL

Maximum Diameter of Unreinforced Opening
dmax = MAX( dmax1, dmax2) =MAX(35.8,1.91)= 35.80 mm

Volume:0.0004026 m3 Weight:0.5 kg (SG= 7.85 )


UTILIZATION CHART - S1.1 MAIN SHELL
70
60
50
40
30
20
10
0
60.6% Internal Pressure
26% Test Pressure
Max.Utilization/Condition 60.6%

# INPUT DATA

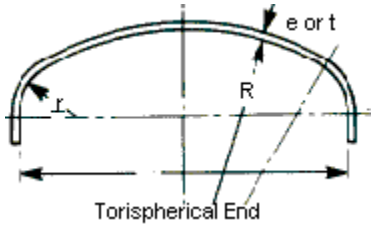
## COMPONENT ATTACHMENT/LOCATION

```
Attachment: S1.1    Cylindrical Shell    Main Shell
Location: Along z-axis zo=  0
```

## GENERAL DESIGN DATA

```
PRESSURE LOADING: Design Component for Internal Pressure Only
PROCESS CARD:
General Design Data : Temp= 130°C, P=4.5000 MPa, c=0.5 mm, Pext=0.0000 MPa
SPECIFIC DENSITY OF OPERATING LIQUID.................:SG          0.00
LIQUID HEAD..........................................:LH         38.80 mm
```

## DIMENSIONS OF END




```
Type of Torispherical End: Dished End NOT listed above
WELD JOINT COEFFICIENT: Testing Group  3   (z=0.85)
OUTSIDE DIAMETER OF CYLINDRICAL FLANGE OF END.......:De         82.60 mm
LENGTH OF CYLINDRICAL FLANGE OF END.................:Lcyl       12.00 mm
INSIDE SPHERICAL RADIUS (corroded)..................:R          63.00 mm
DEPTH OF HEAD INCLUDING HEAD THICKNESS..............:h          15.00 mm
INSIDE KNUCKLE RADIUS (corroded)....................:r         5.0000 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE...............:th        0.3000 mm
NOMINAL THICKNESS OF HEAD/END (uncorroded)..........:en        3.0000 mm
Include calculation of forming during fabrication to EN13445-4 Section 9.: NO
```

## MATERIAL DATA FOR END

```
EN 10028-2:2017, 1.0473 P355GH plate and strip, HT:N THK<=16mm 130'C
Rm=510 Rp=355 Rpt=308.6 f=205.73 f20=212.5 ftest=338.1 E=203868(N/mm2) ro=7.85
Material & Delivery Form: NOT Cold Spun Seamless Austenitic Stainless Steel
```

## NOZZLES IN KNUCKLE REGION TO SECTION 7.7

```
Nozzles In Knuckle Region: NO
```

## WELDING REQUIREMENTS TO EN 1708-1:2010

```
Comment(Optional):
Type of welded connection: Not Applicable
```

# CALCULATION DATA

## 7.5.3 - TORISPHERICAL ENDS UNDER INTERNAL PRESSURE

### 7.5.3.2 Required Minimum End Thickness

```
Required Thickness of End to Limit Membrane Stress in Central Part
es = P * R / (2 * f * z - 0.5 * P)                                  (7.5-1)
=4.5*63/(2*205.73*0.85-0.5*4.5)=                          0.8158 mm

fb = Rpt / 1.5 (7.5-4) =308.6/1.5=                          205.73 N/mm2
Required Thickness of Knuckle to Avoid Plastic Buckling
eb = (0.75*R+0.2*Di)*((P/(111*fb)*(Di/r)^0.825)^(0.667)             (7.5-3)
=(0.75*63+0.2*77.6)*((4.5/(111*205.73)*(77.6/5)^0.825)^(0.667)=   0.9584 mm

7.5.3.5 Formulas for Calculation of Factor Beta
Y = MIN( emin / R, 0.04) (7.5-9) =MIN(1.18/63,0.04)=         0.0188
```

```
Z = LOG( 1 / Y) (7.5-10) =LOG(1/0.0188)=                          1.7264
X = r / Di (7.5-11) =5/80.23=                                     0.0623
N = 1.006 - 1 / (6.2 + (90 * Y) ^ 4)                                    (7.5-12)
=1.006-1/(6.2+(90*0.0188)^4)=                                   0.9363
Beta006 = N*(-0.3635*Z^3+2.2124*Z^2-3.2937*Z+1.8873)                    (7.5-13)
=0.9363*(-0.3635*1.73^3+2.2124*1.73^2-3.2937*1.73+1.8873)=   0.8658
Beta01 = N*(-0.1833*Z^3+1.0383*Z^2-1.2943*Z+0.837)                       (7.5-15)
=0.9363*(-0.1833*1.73^3+1.0383*1.73^2-1.2943*1.73+0.837)=   0.7060
beta = 25 * ((0.1 - X) * Beta006 + (X - 0.06) * Beta01)                  (7.5-14)
=25*((0.1-0.0623)*0.8658+(0.0623-0.06)*0.706)=              0.8565
Required Thickness of Knuckle to Avoid Axisymmetric Yielding
ey = beta * P * (0.75 * R + 0.2 * Di) / f                                (7.5-2)
=0.8565*4.5*(0.75*63+0.2*80.23)/205.73=                     1.1859 mm
```

NOTE 3, since ey(1.2) > 0.005*Di(0.4) it is NOT necessary to calculate/consider eb.

```
Required Minimum End Thickness Excl.Allow. emin :
emin = emin =1.19=                                          1.1859 mm

Required Minimum End Thickness Incl.Allow. :
emina = emin + c + th =1.19+0.5+0.3=                        1.9900 mm
```

| Internal Pressure emina=1.99 <= en=3[mm] | 66.3% | OK |
|---|---|---|

```
Analysis Thickness
ea = en - c - th =3-0.5-0.3=                                2.2000 mm
Inside Diameter of Shell
Di = De - 2 * (en - c) =82.6-2*(3-0.5)=                      77.60 mm
Mean Diameter of Shell
Dm = (De + Di) / 2 =(82.6+77.6)/2=                           80.10 mm
```

### 7.5.3.4 - Required Minimum Thickness of Straight Cylindrical Flange

```
Llim = 0.2 * SQR( Di * emin) =0.2*SQR(77.6*1.19)=           1.9186 mm
Since Lcyl > Llim, Required Thickness of Straight Cylindrical Flange to 7.4.2
Minimum Thickness of Straight Flange Excl. Allow.
ecyl = P * Di / (2 * f * z - P)                                          (7.4-1)
=4.5*77.6/(2*205.73*0.85-4.5)=                              1.0115 mm

Minimum Thickness of Straight Flange Incl.Corr. :
ecyla = ecyl + c =1.01+0.5=                                 1.5100 mm
```

### 7.5.3.1 Conditions of Applicability - Torispherical Ends

»Geometry Check r=5 <= 0.2 * Di[mm] « » OK«
»Geometry Check r=5 >= 0.06 * Di=4.66[mm] « » OK«
»Geometry Check r=5 >= 2*e=2.37[mm] « » OK«
»Geometry Check e=1.19 <= 0.08*De=6.61[mm] « » OK«
»Geometry Check ea=2.2 >= 0.001*De=0.0826[mm] « » OK«
»Geometry Check R=63 <= De=82.6[mm] « » OK«

### MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :NEW & COLD

```
Ps = 2 * f * z * ea / (R + 0.5 * ea)                                     (7.5-6)
=2*212.5*0.85*2.7/(62.5+0.5*2.7)=                           15.28 MPa
Py = f * ea / ( beta * ( 0.75 * R + 0.2 * Di))                           (7.5-7)
=212.5*2.7/(0.6072*(0.75*62.5+0.2*77.6))=                   15.14 MPa
PB = 111*fb*(ea/(0.75*R+0.2*Di))^1.5*(r/Di)^0.825                        (7.5-8)
=111*236.67*(2.7/(0.75*62.5+0.2*77.6))^1.5*(5/77.6)^0.825=    24.62 MPa
Pcyl = 2 * ea * f * z / (Di + ea)
=2*2.7*212.5*0.85/(77.6+2.7)=                               12.15 MPa
Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=12.15=                                                     12.15 MPa
```

## MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :HOT & CORR

```
Ps = 2 * f * z * ea / (R + 0.5 * ea)                                (7.5-6)
=2*205.73*0.85*2.2/(63+0.5*2.2)=                          12.00 MPa
Py = f * ea / ( beta * ( 0.75 * R + 0.2 * Di))                      (7.5-7)
=205.73*2.2/(0.6502*(0.75*63+0.2*77.6))=                  11.09 MPa
PB = 111*fb*(ea/(0.75*R+0.2*Di))^1.5*(r/Di)^0.825                   (7.5-8)
=111*205.73*(2.2/(0.75*63+0.2*77.6))^1.5*(5/77.6)^0.825=  15.60 MPa
Pcyl = 2 * ea * f * z / (Di + ea)
=2*2.2*205.73*0.85/(77.6+2.2)=                           9.6420 MPa
Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=9.64=                                                   9.6420 MPa
```

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

```
Ps = 2 * f * z * ea / (R + 0.5 * ea)                                (7.5-6)
=2*338.1*1*2.7/(62.5+0.5*2.7)=                            28.59 MPa
Py = f * ea / ( beta * ( 0.75 * R + 0.2 * Di))                      (7.5-7)
=338.1*2.7/(0.6072*(0.75*62.5+0.2*77.6))=                 24.09 MPa
PB = 111*fb*(ea/(0.75*R+0.2*Di))^1.5*(r/Di)^0.825                   (7.5-8)
=111*338.1*(2.7/(0.75*62.5+0.2*77.6))^1.5*(5/77.6)^0.825=  35.17 MPa
Pcyl = 2 * ea * f * z / (Di + ea)
=2*2.7*338.1*1/(77.6+2.7)=                                22.74 MPa
Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=22.74=                                                   22.74 MPa
```

## EN13445-5;10.2.3.3 REQUIRED MIN.HYDROSTATIC TEST PRESSURE:Ptmin

```
NEW AT AMBIENT TEMP. FOR TEST GROUPS 1, 2 and 3
Ptmin = 1.25 * Pd * f20 / f =1.25*4.5*212.5/205.73=        5.8101 MPa

Ptmin = 1.43 * Pd =1.43*4.5=                               6.4350 MPa
```

| Test Pressure Ptmin=6.435 <= Ptmax=22.74[MPa] | 28.3% | OK |
|---|---|---|

## Maximum diameter of Opening Not Requiring Reinforcement Check , dmax

```
ris = R (9.5-4) =63=                                        63.00 mm
Length of Shell Contributing to Reinforcement
Is = Sqr(( 2 * ris + ea) * ea) (9.5-2) =Sqr((2*63+2.2)*2.2)=    16.79 mm
Maximum Diameter of Unreinforced Opening in Shell Checked to Rules in Section 9
dmax1 = MIN(0.5*Di,(ea*Is*(f-0.5*P)/P-ris*Is)/(0.5*ris+0.5*ea))    (9.5-7,22,23)
=MIN(0.5*77.6,(2.2*16.79*(205.73-0.5*4.5)/4.5-63*16.79)/(0.5*63+0.5*2.2))
=    18.79 mm

Maximum diameter of Opening Not Requiring Reinforcement Check
dmax2 = 0.15 * Sqr(( 2 * ris + ea) * ea)                            (9.5-18)
=0.15*Sqr((2*63+2.2)*2.2)=                               2.5191 mm

Maximum Diameter of Unreinforced Opening
dmax = MAX( dmax1, dmax2) =MAX(18.79,2.52)=                 18.79 mm
```

# CALCULATION SUMMARY

## 7.5.3 - TORISPHERICAL ENDS UNDER INTERNAL PRESSURE

### 7.5.3.2 Required Minimum End Thickness

```
Required Minimum End Thickness Excl.Allow. emin :
emin = emin =1.19=                                         1.1859 mm

Required Minimum End Thickness Incl.Allow. :
emina = emin + c + th =1.19+0.5+0.3=                       1.9900 mm
```

| Internal Pressure emina=1.99 <= en=3[mm] | 66.3% | OK |
|---|---|---|

```
Minimum Thickness of Straight Flange Incl.Corr. :
ecyla = ecyl + c =1.01+0.5=                                1.5100 mm
```

## MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :NEW & COLD

Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=12.15= 12.15 MPa

## MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :HOT & CORR

Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=9.64= 9.6420 MPa

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

Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=22.74= 22.74 MPa

## EN13445-5;10.2.3.3 REQUIRED MIN.HYDROSTATIC TEST PRESSURE:Ptmin

NEW AT AMBIENT TEMP. FOR TEST GROUPS 1, 2 and 3
Ptmin = 1.25 * Pd * f20 / f =1.25*4.5*212.5/205.73= 5.8101 MPa

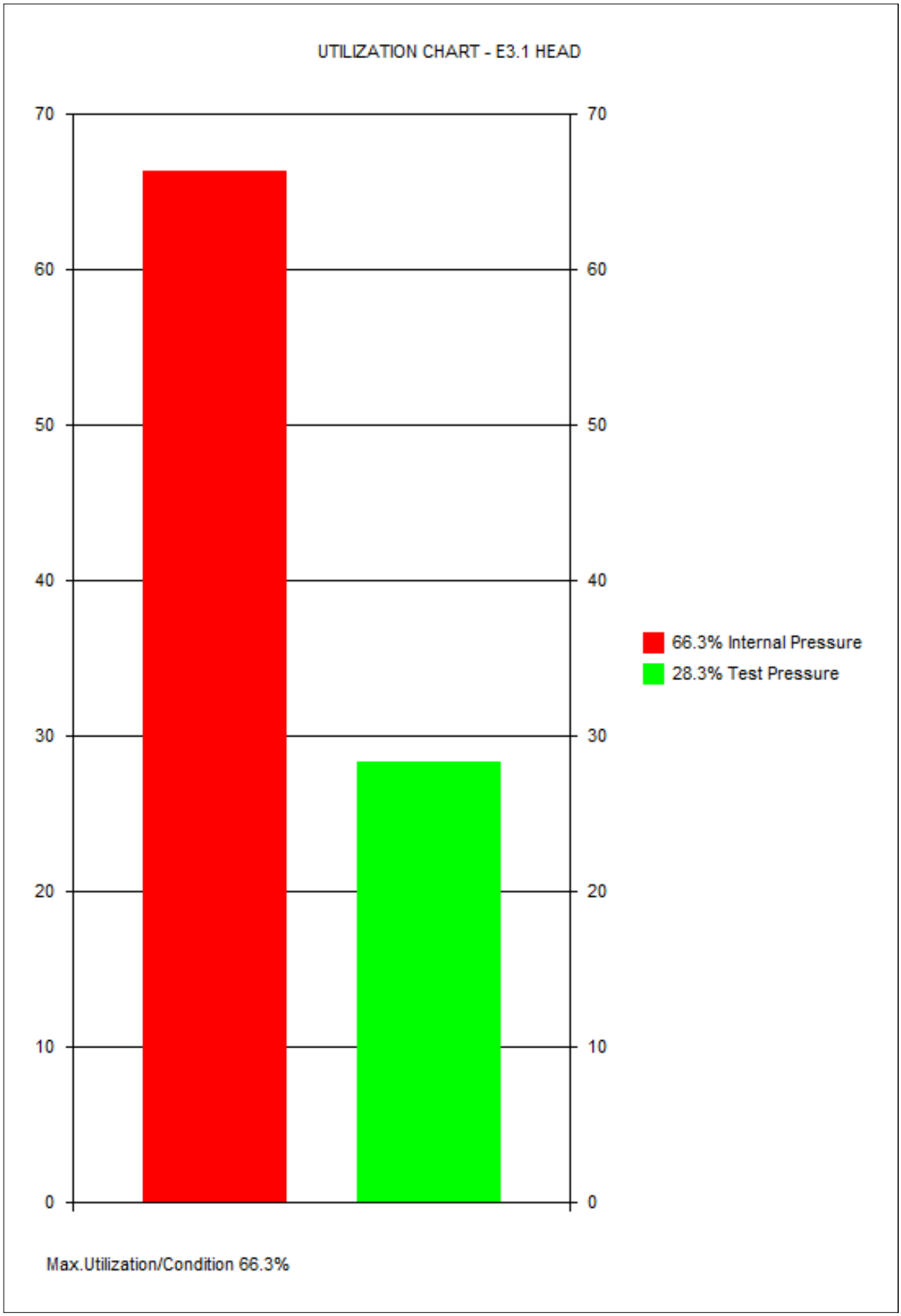
Ptmin = 1.43 * Pd =1.43*4.5= 6.4350 MPa

| | | |
|---|---|---|
| Test Pressure Ptmin=6.435 <= Ptmax=22.74[MPa] | 28.3% | OK |

## Maximum diameter of Opening Not Requiring Reinforcement Check , dmax

Maximum Diameter of Unreinforced Opening
dmax = MAX( dmax1, dmax2) =MAX(18.79,2.52)= 18.79 mm

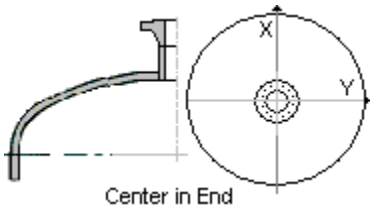
Volume:0.0000900 m3 Weight:0.2 kg (SG= 7.85 )


UTILIZATION CHART - E3.1 HEAD
70
60
50
40
30
20
10
0
66.3% Internal Pressure
28.3% Test Pressure
Max.Utilization/Condition 66.3%

# INPUT DATA

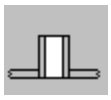
## COMPONENT ATTACHMENT/LOCATION

```
Attachment: E3.1    Torispherical End    Head                              S1.1
Connect this nozzle to the nozzle neck of another nozzle: NO
```




```
Orientation & Location of Nozzle: Center in End
```

## GENERAL DESIGN DATA



```
Type of Opening: Nozzle Without Standard ASME or DIN/EN Flange Attachment
PRESSURE LOADING: Design Component for Internal Pressure Only
PROCESS CARD:
General Design Data : Temp= 130°C, P=4.5000 MPa, c=0.5 mm, Pext=0.0000 MPa
SPECIFIC DENSITY OF OPERATING LIQUID.................:SG          0.00
LIQUID HEAD.........................................:LH          0.00 mm
Apply a different corrosion allowance to nozzle neck than the shell thickness.: NO
Include Nozzle Load Calculation: NO
```

## SHELL DATA (E3.1)

```
Shell Type: Torispherical End
OUTSIDE DIAMETER OF SHELL............................:De         82.60 mm
NOMINAL WALL THICKNESS (uncorroded)..................:en        3.0000 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE................:th        0.3000 mm
INSIDE SPHERICAL RADIUS (corroded)...................:R          63.00 mm
EN 10028-2:2017, 1.0473 P355GH plate and strip, HT:N THK<=16mm 130'C
Rm=510 Rp=355 Rpt=308.6 fs=205.73 f20=212.5 ftest=338.1 E=203868(N/mm2) ro=7.85
```

## NOZZLE MATERIAL DATA

```
Delivery Form: Seamless Pipe
EN 10216-2:2013, 1.0345 P235GH seamless tube, HT:N THK<=16mm 130'C
Rm=360 Rp=235 Rpt=191.4 fb=127.6 f20=150 ftest=223.81 E=203868(N/mm2) ro=7.85
```

## NOZZLE DIMENSIONAL DATA

```
Attachment: Set In Flush Nozzle
Shape of Nozzle/Opening: Circular
Application:
9.4.6.3 NOT a critical fatigue area, and calc.temp.is outside creep range.
OUTSIDE NOZZLE DIAMETER..............................:deb        33.30 mm
NOMINAL NOZZLE THICKNESS (uncorroded)................:enb       5.1500 mm
Size of Flange and Nozzle:
Comment (Optional):
NEGATIVE TOLERANCE/THINNING ALLOWANCE................:           12.50 %
NOZZLE STANDOUT MEASURED FROM VESSEL OD..............:ho         30.00 mm
```

## WELDING DATA

```
Nozzle/Pad to Shell Welding Area: Exclude Area of Nozzle to Shell Weld
Nozzle Weld Intersect: Nozzle Does NOT Intersect with a Welded Shell Seam
ANGLE BETWN.BRANCH AXIS AND A LINE NORMAL TO MAIN BODY:Phi       0.00 Degr.
```

## DATA FOR REINFORCEMENT PAD

```
Type of Pad: No Pad
```

## LIMITS OF REINFORCEMENT

```
Reduction of Limits of Reinforcement: No Reduction Required
```

## WELDING REQUIREMENTS TO EN 1708-1:2010

```
Comment(Optional):
Type of welded connection: Not Applicable
```

# CALCULATION DATA

## PRELIMINARY CALCULATIONS

```
Shell Analysis Thickness eas
eas = en - c - th =3-0.5-0.3=                                  2.2000 mm
Nozzle Analysis Thickness eab
eab = enb - cn - NegDev =5.15-0.5-0.6438=                      4.0063 mm
ris = R (9.5-4) =63=                                            63.00 mm
dib = deb - 2 * eab =33.3-2*4.01=                               25.29 mm
Min.Nozzle Thk.Based on Internal Pressure ebp
ebp = P * deb / (2 * fb * z + P)
=4.5*33.3/(2*127.6*1+4.5)=                                   0.5800 mm
Allowable Stresses
fob = Min( fs, fb) (9.5-8) =Min(205.73,127.6)=                  127.60 N/mm2
```

## GEOMETRIC LIMITATIONS

»Check Max.Diameter of Nozzle dib/De=0.3061 <= 0.60=0.6[mm] (9.4.5.3)«» OK«

| | | |
|---|---|---|
| Min.Nozzle Thk. ebp=0.58 <= eab=4.01[mm] | 14.4% | OK |

»Location in End to Fig.9.5-4 L=24.65 >= De/10=8.26[mm] « » OK«

# 9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

## Calculation of Stress Loaded Areas Effective as Reinforcement

### Area of Shell Afs

```
Limit of Reinforcement Along Shell Reduced by Location in Dished End
Iso =  ==                                                       17.87 mm
Set In Nozzle
Afs = eas * Is (9.5-79) =2.2*17.87=                             39.31 mm2
```

### Area of Nozzle Afb

```
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                                (9.5-76)
=MIN(Sqr((33.3-4.01)*4.01,)30)=                                10.83 mm
Set In Nozzle
Afb = eb * (Ibo + Ibi + eas) (9.5-78) =4.01*(10.83+0+2.2)=      52.21 mm2
```

## Calculation of Pressure Loaded Areas

In the Nozzle Apb
Apb = 0.5 * dib * (Ibo + eas) (9.5-84) =0.5*25.29*(10.83+2.2)= 164.79 mm2

Spherical Shell/End on any Section Aps
Aps = 0.5 * ris ^ 2 * (Is + a) / (0.5 * eas + ris) (9.5-105)
=0.5*63^2*(17.87+16.84)/(0.5*2.2+63)= 1074.66 mm2

## 9.5.2 Reinforcement Rules

### Pressure Area Required pA(req.)

pAReq = P * (Aps + Apb + 0.5 * Apphi) (9.5-7)
=4.5*(1074.66+164.79+0.5*0)= 5.5775 kN

### Pressure Area Available pA(aval.)

pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P) (9.5-7)
=(39.31+0)*(205.73-0.5*4.5)+0*(0-0.5*4.5)+52.21*(127.6-0.5*4.5)= 14.54 kN

| | | |
|---|---|---|
| Nozzle Reinforcement pAAval=14.54 >= pAReq=5.58[kN] | 38.3% | OK |

### Maximum Allowable Pressure Pmax

Pmax = (Afs+Afw)*fs+Afb*fob/((Aps+Apb+0.5*Apphi)+0.5*(Afs+Afw+Afb+Afp)) (9.5-10)
=(39.31+0)*205.73+52.21*127.6/((1074.66+164.79+0.5*0)+0.5*(39.31+0+52.21+0)
)= = 11.48 MPa

### Max.Allowable Test Pressure Ptmax

Ptmax = == 22.78 MPa

Weight of Nozzle: .126kg

## CALCULATION SUMMARY

| | | |
|---|---|---|
| Min.Nozzle Thk. ebp=0.58 <= eab=4.01[mm] | 14.4% | OK |

## 9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

Limit of Reinforcement Along Shell Reduced by Location in Dished End
Iso = == 17.87 mm
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho) (9.5-76)
=MIN(Sqr((33.3-4.01)*4.01,)30)= 10.83 mm

### Pressure Area Required pA(req.)

pAReq = P * (Aps + Apb + 0.5 * Apphi) (9.5-7)
=4.5*(1074.66+164.79+0.5*0)= 5.5775 kN

### Pressure Area Available pA(aval.)

pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P) (9.5-7)
=(39.31+0)*(205.73-0.5*4.5)+0*(0-0.5*4.5)+52.21*(127.6-0.5*4.5)= 14.54 kN

| | | |
|---|---|---|
| Nozzle Reinforcement pAAval=14.54 >= pAReq=5.58[kN] | 38.3% | OK |

### Maximum Allowable Pressure Pmax

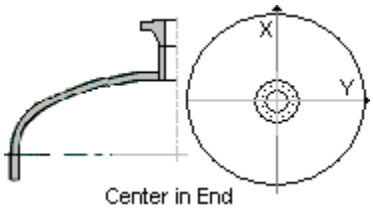
Pmax = (Afs+Afw)*fs+Afb*fob/((Aps+Apb+0.5*Apphi)+0.5*(Afs+Afw+Afb+Afp)) (9.5-10)
=(39.31+0)*205.73+52.21*127.6/((1074.66+164.79+0.5*0)+0.5*(39.31+0+52.21+0)
)= = 11.48 MPa

Volume:0.00 m3 Weight:0.1 kg (SG= 7.85 )

# INPUT DATA

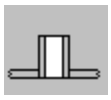
## COMPONENT ATTACHMENT/LOCATION

```
Attachment: E3.2*   Torispherical End    Head                              S1.1
Connect this nozzle to the nozzle neck of another nozzle: NO
```




```
Orientation & Location of Nozzle: Center in End
```

## GENERAL DESIGN DATA



```
Type of Opening: Nozzle Without Standard ASME or DIN/EN Flange Attachment
PRESSURE LOADING: Design Component for Internal Pressure Only
PROCESS CARD:
General Design Data : Temp= 130°C, P=4.5000 MPa, c=0.5 mm, Pext=0.0000 MPa
SPECIFIC DENSITY OF OPERATING LIQUID.................:SG          0.00
LIQUID HEAD.........................................:LH          0.00 mm
Apply a different corrosion allowance to nozzle neck than the shell thickness.: NO
Include Nozzle Load Calculation: NO
```

## SHELL DATA (E3.2*)

```
Shell Type: Torispherical End
OUTSIDE DIAMETER OF SHELL............................:De         82.60 mm
NOMINAL WALL THICKNESS (uncorroded)..................:en        3.0000 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE................:th        0.3000 mm
INSIDE SPHERICAL RADIUS (corroded)...................:R          63.00 mm
EN 10028-2:2017, 1.0473 P355GH plate and strip, HT:N THK<=16mm 130'C
Rm=510 Rp=355 Rpt=308.6 fs=205.73 f20=212.5 ftest=338.1 E=203868(N/mm2) ro=7.85
```

## NOZZLE MATERIAL DATA

```
Delivery Form: Seamless Pipe
EN 10216-2:2013, 1.0345 P235GH seamless tube, HT:N THK<=16mm 130'C
Rm=360 Rp=235 Rpt=191.4 fb=127.6 f20=150 ftest=223.81 E=203868(N/mm2) ro=7.85
```

## NOZZLE DIMENSIONAL DATA

```
Attachment: Set In Flush Nozzle
Shape of Nozzle/Opening: Circular
Application:
9.4.6.3 NOT a critical fatigue area, and calc.temp.is outside creep range.
OUTSIDE NOZZLE DIAMETER..............................:deb        33.30 mm
NOMINAL NOZZLE THICKNESS (uncorroded)................:enb       5.1500 mm
Size of Flange and Nozzle:
Comment (Optional):
NEGATIVE TOLERANCE/THINNING ALLOWANCE................:           12.50 %
NOZZLE STANDOUT MEASURED FROM VESSEL OD..............:ho         30.00 mm
```

### WELDING DATA

```
Nozzle/Pad to Shell Welding Area: Exclude Area of Nozzle to Shell Weld
Nozzle Weld Intersect: Nozzle Does NOT Intersect with a Welded Shell Seam
ANGLE BETWN.BRANCH AXIS AND A LINE NORMAL TO MAIN BODY:Phi       0.00 Degr.
```

### DATA FOR REINFORCEMENT PAD

```
Type of Pad: No Pad
```

### LIMITS OF REINFORCEMENT

```
Reduction of Limits of Reinforcement: No Reduction Required
```

### WELDING REQUIREMENTS TO EN 1708-1:2010

```
Comment(Optional):
Type of welded connection: Not Applicable
```

## CALCULATION DATA

### PRELIMINARY CALCULATIONS

```
Shell Analysis Thickness eas
eas = en - c - th =3-0.5-0.3=                                  2.2000 mm
Nozzle Analysis Thickness eab
eab = enb - cn - NegDev =5.15-0.5-0.6438=                      4.0063 mm
ris = R (9.5-4) =63=                                            63.00 mm
dib = deb - 2 * eab =33.3-2*4.01=                               25.29 mm
Min.Nozzle Thk.Based on Internal Pressure ebp
ebp = P * deb / (2 * fb * z + P)
=4.5*33.3/(2*127.6*1+4.5)=                                   0.5800 mm
Allowable Stresses
fob = Min( fs, fb) (9.5-8) =Min(205.73,127.6)=                  127.60 N/mm2
```

### GEOMETRIC LIMITATIONS

»Check Max.Diameter of Nozzle dib/De=0.3061 <= 0.60=0.6[mm] (9.4.5.3)«» OK«

| | | |
|---|---|---|
| Min.Nozzle Thk. ebp=0.58 <= eab=4.01[mm] | 14.4% | OK |

»Location in End to Fig.9.5-4 L=24.65 >= De/10=8.26[mm] « » OK«

## 9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

### Calculation of Stress Loaded Areas Effective as Reinforcement

### Area of Shell Afs

```
Limit of Reinforcement Along Shell Reduced by Location in Dished End
Iso =  ==                                                       17.87 mm
Set In Nozzle
Afs = eas * Is (9.5-79) =2.2*17.87=                             39.31 mm2
```

### Area of Nozzle Afb

```
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                                (9.5-76)
=MIN(Sqr((33.3-4.01)*4.01,)30)=                                10.83 mm
Set In Nozzle
Afb = eb * (Ibo + Ibi + eas) (9.5-78) =4.01*(10.83+0+2.2)=      52.21 mm2
```

## Calculation of Pressure Loaded Areas

In the Nozzle Apb
Apb = 0.5 * dib * (Ibo + eas) (9.5-84) =0.5*25.29*(10.83+2.2)= 164.79 mm2

Spherical Shell/End on any Section Aps
Aps = 0.5 * ris ^ 2 * (Is + a) / (0.5 * eas + ris) (9.5-105)
=0.5*63^2*(17.87+16.84)/(0.5*2.2+63)= 1074.66 mm2

## 9.5.2 Reinforcement Rules

### Pressure Area Required pA(req.)

pAReq = P * (Aps + Apb + 0.5 * Apphi) (9.5-7)
=4.5*(1074.66+164.79+0.5*0)= 5.5775 kN

### Pressure Area Available pA(aval.)

pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P) (9.5-7)
=(39.31+0)*(205.73-0.5*4.5)+0*(0-0.5*4.5)+52.21*(127.6-0.5*4.5)= 14.54 kN

| | | |
|---|---|---|
| Nozzle Reinforcement pAAval=14.54 >= pAReq=5.58[kN] | 38.3% | OK |

### Maximum Allowable Pressure Pmax

Pmax = (Afs+Afw)*fs+Afb*fob/((Aps+Apb+0.5*Apphi)+0.5*(Afs+Afw+Afb+Afp)) (9.5-10)
=(39.31+0)*205.73+52.21*127.6/((1074.66+164.79+0.5*0)+0.5*(39.31+0+52.21+0)
)= = 11.48 MPa

### Max.Allowable Test Pressure Ptmax

Ptmax = == 22.78 MPa

Weight of Nozzle: .126kg

## CALCULATION SUMMARY

| | | |
|---|---|---|
| Min.Nozzle Thk. ebp=0.58 <= eab=4.01[mm] | 14.4% | OK |

## 9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

Limit of Reinforcement Along Shell Reduced by Location in Dished End
Iso = == 17.87 mm
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho) (9.5-76)
=MIN(Sqr((33.3-4.01)*4.01,)30)= 10.83 mm

### Pressure Area Required pA(req.)

pAReq = P * (Aps + Apb + 0.5 * Apphi) (9.5-7)
=4.5*(1074.66+164.79+0.5*0)= 5.5775 kN

### Pressure Area Available pA(aval.)

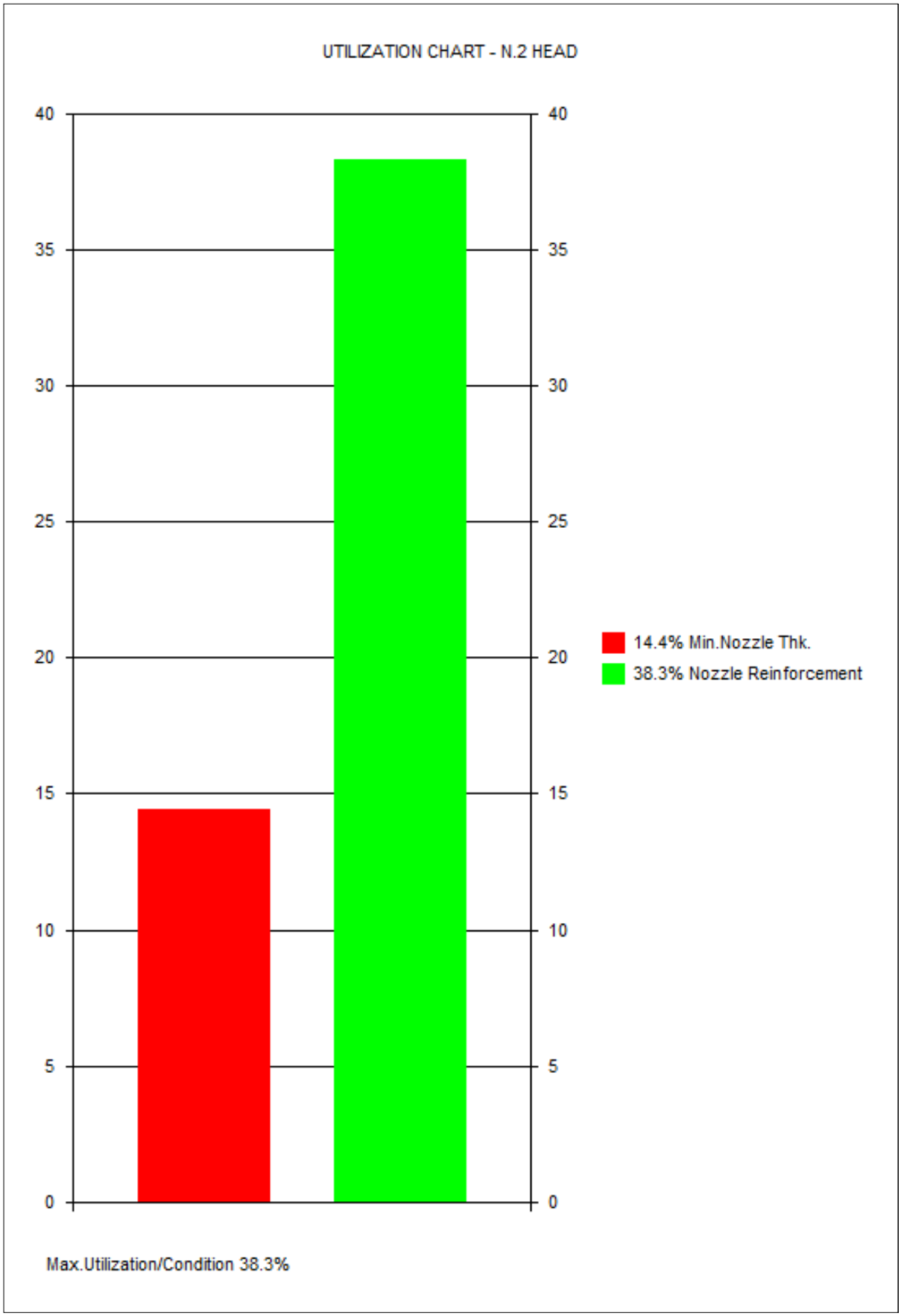
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P) (9.5-7)
=(39.31+0)*(205.73-0.5*4.5)+0*(0-0.5*4.5)+52.21*(127.6-0.5*4.5)= 14.54 kN

| | | |
|---|---|---|
| Nozzle Reinforcement pAAval=14.54 >= pAReq=5.58[kN] | 38.3% | OK |

### Maximum Allowable Pressure Pmax

Pmax = (Afs+Afw)*fs+Afb*fob/((Aps+Apb+0.5*Apphi)+0.5*(Afs+Afw+Afb+Afp)) (9.5-10)
=(39.31+0)*205.73+52.21*127.6/((1074.66+164.79+0.5*0)+0.5*(39.31+0+52.21+0)
)= = 11.48 MPa

Volume:0.00 m3 Weight:0.1 kg (SG= 7.85 )


UTILIZATION CHART - N.2 HEAD
40
35
30
25
20
15
10
5
0
14.4% Min.Nozzle Thk.
38.3% Nozzle Reinforcement
Max.Utilization/Condition 38.3%