Specific Symbols

Di is the inside diameter of the shell;

De is the outside diameter of the cylindrical flange;

eb is required thickness of knuckle to avoid plastic buckling;

es is required thickness of end to limit membrane stress in central part;

ey is required thickness of knuckle to avoid axisymmetric yielding;

e is the maximum calculated thickness of es, ey, eb;

ea analysis thickness, actual plate thickness less thinning and corrosion allowances;

fb is design stress for buckling equation;

hi is inside height of end measured from the tangent line;

K is shape factor for an ellipsoidal end;

N is a parameter;

R is inside spherical radius of central part of torispherical end;

X is ratio of knuckle inside radius to shell inside diameter;

y is a parameter;

Z is a parameter;

Beta is a factor.

Dished Heads To EN13445 Part 3 Section 7.5

$Di := 3000$	Inside Diameter
$e_a := 15.65$	Thickness
$R := 3000$	Inside Spherical Radius
$r := 300$	Inside Knuckle Radius
$P := 0.7$	Design Pressure
$f := 120$	Design Stress
$z := 1$	Joint Factor
$R_{p0.2} := 195$	0.2% Proof stress at design temperature For Austenitic ss multyply Rp by 1.6

$e := e_a$ Assume e = ea as a first estimate

Limits

$De := Di + 2 \cdot e_a$ $De = 3031.3$

$test := if(r \le 0.2 \cdot Di, 1, 0)$ $test = 1$ 1 = Acceptable

$test := if(r \ge 0.06 \cdot Di, 1, 0)$ $test = 1$

$test := if(r \ge 2 \cdot e, 1, 0)$ $test = 1$

$test := if(e \le 0.08 \cdot De, 1, 0)$ $test = 1$

$test := if\left(e_a \ge 0.001 \cdot De, 1, 0\right)$ $test = 1$

Factors

$\frac{e}{R} = 5.217 \cdot 10^{-3}$ $Y := if\left(\frac{e}{R} > 0.04, 0.04, \frac{e}{R}\right)$ $Y = 5.217 \cdot 10^{-3}$

$Z := \log\left(\frac{1}{Y}\right)$ $Z = 2.283$ $X := \frac{r}{Di}$ $X = 0.1$

$N := 1.006 - \frac{1}{\left(6.2 + (90 \cdot Y)^4\right)}$ $N = 0.846$

$$\beta_{0.06} := N\cdot(-0.3635\cdot Z^3 + 2.2124\cdot Z^2 - 3.2937\cdot Z + 1.8873) \qquad \beta_{0.06} = 1.331$$

$$\beta_{0.1} := N\cdot(-0.1833\cdot Z^3 + 1.0383\cdot Z^2 - 1.2943\cdot Z + 0.837) \qquad \beta_{0.1} = 0.941$$

$$\beta_{0.06\_0.1} := 25\cdot\left[(0.1 - X)\cdot\beta_{0.06} + (X - 0.06)\cdot\beta_{0.1}\right] \qquad \beta_{0.06\_0.1} = 0.941$$

$$\beta_{0.2} := \text{if}(0.95\cdot(0.56 - 1.94\cdot Y - 82.5\cdot Y^2)>0.5, 0.95\cdot(0.56 - 1.94\cdot Y - 82.5\cdot Y^2), 0.5) \qquad \beta_{0.2} = 0.52$$

$$\beta_{0.1\_0.2} := 10\cdot\left[(0.2 - X)\cdot\beta_{0.1} + (X - 0.1)\cdot\beta_{0.2}\right] \qquad \beta_{0.1\_0.2} = 0.941$$

$$\beta := \text{if}\left(X<0.1, \beta_{0.06\_0.1}, \beta_{0.1\_0.2}\right)$$

$$\beta := \text{if}\left(X=0.06, \beta_{0.06}, \beta\right)$$

$$\beta := \text{if}\left(X=0.2, \beta_{0.1\_0.2}, \beta\right)$$

$$\beta = 0.941$$

$$f_b := \frac{R_{p0.2}}{1.5} \qquad f_b = 130$$

$$e_b := (0.75\cdot R + 0.2\cdot Di)\cdot\left[\frac{P}{111\cdot f_b}\cdot\left(\frac{Di}{r}\right)^{0.825}\right]^{\left(\frac{1}{1.5}\right)} \qquad e_b = 13.45$$

$$e_s := \frac{P\cdot R}{2\cdot f\cdot z - 0.5\cdot P} \qquad e_s = 8.763$$

$$e_y := \frac{\beta\cdot P\cdot(0.75\cdot R + 0.2\cdot Di)}{f} \qquad e_y = 15.646$$

It may be necessary to perform this calculation several times, calculating a new value of Y using the calculated value of e; where e is the maximum value of es,ey,eb.

Ellipsoidal Heads

For this type of head an equivalent Spherical and Knuckle radius must be calculated as follows:-

$D_i := 3000$

$h_i := \frac{D_i}{4}$ $h_i = 750$

$K := \frac{D_i}{2 \cdot h_i}$ $K = 2$

Test

$test := if(1.7<K, 1, 0)$ $test = 1$ $test := if(K<2.2, 1, 0)$ $test = 1$

Equivalent Radii

$r := D_i \cdot \left[\left(\frac{0.5}{K}\right) - 0.08\right]$ $r = 510$

$R := D_i \cdot (0.44 \cdot K + 0.02)$ $R = 2700$

The ellipsoidal head is then treated as a a torispherical head using the above values for R and r