⊞ Material and Thickness Selection

REDUCTION WITHOUT KNUCKLE CALCULATIONS

DESIGN PARAMETERS

Material .... :	"S235JR"
Tensile Strength .... :	$\sigma_u = 360$ MPa
Yield Strength .... :	$\sigma_y = 235$ MPa
Safety Factor .... :	$S := 1.5$
Design Strength .... :	$f := \frac{\sigma_y}{S} = 156.667$ MPa
Inside Pressure .... :	$P_i := 8$ bar
Outside Pressure .... :	$P_e := 2$ bar
Welding Factor .... :	$z := 0.85$
Corrosion Allowance ...... :	$c = 2$ mm

REDUCTION DIMENSIONS

Inlet Inside Diameter .... :	$D_i := 2900$ mm
Outlet Inside Diameter ... :	$D_o := 1800$ mm
Reduction Length .... :	$L := 3000$ mm
Plate Thickness .... :	$e_d = 12$ mm

Plate Thickness Calculation

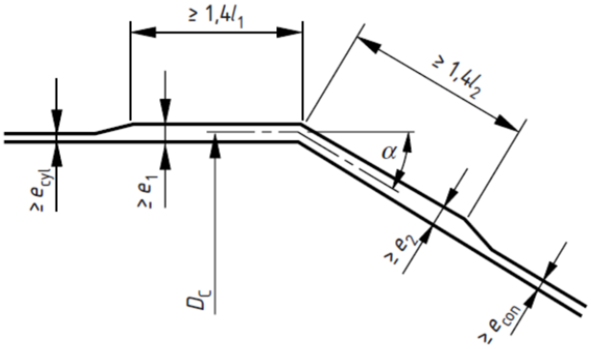
Cone Thickness

$$e_a := e_d - c = 10 \text{ mm}$$

$$\alpha := \operatorname{atan}\left(\frac{D_i - D_o}{2 \cdot L}\right) = 10.3889\ °$$

$$e_{cyl} := \frac{P_i \cdot D_i}{2 \cdot f \cdot z - P_i} = 8.74 \text{ mm}$$

$$e_{con} := \frac{P_i \cdot D_i}{2 \cdot f \cdot z - P_i} \cdot \frac{1}{\cos(\alpha)} = 8.88 \text{ mm}$$



$$\boxed{e_{min\_cyl} := e_{cyl} + c = 10.74 \text{ mm}}$$

$$\boxed{e_{min} := e_{con} + c = 10.88 \text{ mm}}$$

$$\boxed{\sigma_a := \frac{P_i \cdot D_i}{2 \cdot \cos(\alpha) \cdot (e_a) \cdot z} = 138.75 \text{ MPa}}$$

Sanity Checks

$e_{con} < e_a = 1$ Safe

$\sigma_a < f = 1$ Safe

$\alpha \le 75\,° = 1$ Check

$\dfrac{e_a \cdot \cos(\alpha)}{\left(D_c := D_i + e_a\right)} \ge 0.001 = 1$ Check

Joint without Knuckle Calculations

$$\beta := \frac{1}{3} \cdot \sqrt{\frac{D_c}{e_j}} \cdot \frac{\tan(\alpha)}{1 + \dfrac{1}{\sqrt{\cos(\alpha)}}} - 0.15$$

$$e_j := \frac{P_i \cdot D_c \cdot \beta}{2 \cdot f}$$

beta iteration

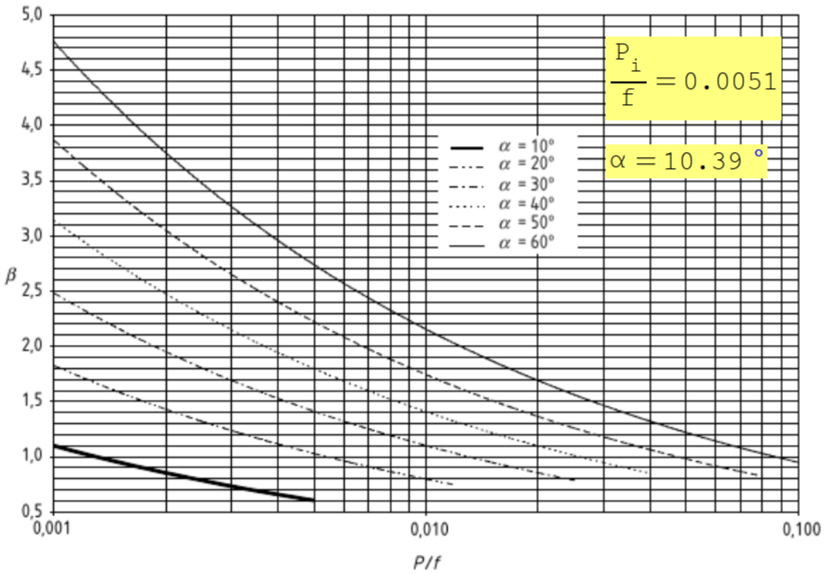
$f_\Delta(x; y) := \left|\dfrac{y - x}{x}\right|$

$e_j := e_{con}$

$\Delta := 1$

while $\Delta > 0.00001$

- $D_c := D_i + e_j$
- $e_{temp} := e_j$
- $\beta := \dfrac{1}{3} \cdot \sqrt{\dfrac{D_c}{e_j}} \cdot \dfrac{\tan(\alpha)}{1 + \dfrac{1}{\sqrt{\cos(\alpha)}}} - 0.15$
- $e_j := \dfrac{P_i \cdot D_c \cdot \beta}{2 \cdot f}$
- $\Delta := f_\Delta\left(e_j; e_{temp}\right)$



$\dfrac{P_i}{f} = 0.0051$

$\alpha = 10.39\,°$

$\beta = 0.6168$

$e_j = 4.57\ \mathrm{mm}$

$e_1 := \mathrm{Max}\left(e_{cyl}; e_j\right) + c = 10.74\ \mathrm{mm}$

$e_2 := \mathrm{Max}\left(e_{con}; e_j\right) + c = 10.88\ \mathrm{mm}$

$D_c := D_i + e_1$

$l_1 := \sqrt{D_c \cdot e_1} = 176.79\ \mathrm{mm}$ -----> $l_1 \cdot 1.4 = 247.5\ \mathrm{mm}$

$D_c := D_i + e_2$

$l_2 := \sqrt{\dfrac{D_c \cdot e_2}{\cos(\alpha)}} = 179.46\ \mathrm{mm}$ -----> $l_2 \cdot 1.4 = 251.25\ \mathrm{mm}$