PRITHVI RAJ SURYAVANSHI
20CH30020

Assignment 2

Evaluation of area of compensation of a nozzle from a process vessel.

For the vessel in Assignment 1, Find out the ring pad dimensions (I.D / O.D and thickness).

Nozzle O.D. = 0.25 m

Inside portrusion of nozzle : Not Desired

Length of nozzle above surface: 0.12 m

Sol'n From Assignment 1 we have the following values ⇒

$P = 800 \text{ kPa} \times 1.05$ (5% for safety purposes)

$f = 120 \text{ MPa}$

$J = 0.85$

weld joint efficiency

$D_o = 0.25 \text{ m}$ → (Nozzle Outer Diameter) Given

$$t_r' = \frac{P D_o}{2fJ + P}$$

$$= \frac{800 \times 10^3 \times 1.05 \times 0.25}{2(120 \times 10^6)(0.85) + (800 \times 10^3 \times 1.05)}$$

$t_r' = 0.001025 \text{ m}$

$= 1.025 \text{ mm}$

theoretical nozzle thickness

Now adding corrosion allowance of 2mm

$(1.025 + 2)$ mm

$= 3.025$ mm

Nearest available standard thickness $= 5$ mm

$\therefore \; t_n = 5$ mm

$t_r = 6.15$ mm → from previous assignment 1

theoretical shell thickness

$d = d_o - 2t_n$

$= 0.25 - 2(0.005)$

$\Rightarrow 0.24$ m

Now we have

$H_1 = \sqrt{(d+2c)(t_n - c)}$ corrosion allowance

$H_1 = \sqrt{(0.24 + 2(0.002))(0.005 - 0.002)}$

$H_1 = \sqrt{0.244 \times 0.003}$

$= 0.02705$ m

$= 27.05$ mm

Length of nozzle above surface = 0.12 m (Given in question)

Since , $H_1 = 0.02705 \text{ m} < 0.12 \text{ m}$

$\therefore$ We will consider smaller value

i.e. $H_1 = 0.02705 \text{ m}$

Since inside potrusion is Not Desired we have

$H_2 = 0$

→ A_s = excess area available in the shell within boundary limit acting as reinforcement

$= (d+2c)(t_s - t_r - c)$

$t_s \Rightarrow$ actual shell thickness

$= 9 \text{ mm}$

$= 0.009 \text{ m}$ (from Assignment 1).

$A_s = [0.24 + 2(0.002)][0.009 - 0.00615 - 0.002]$

$= 0.0002074 \text{ m}^2$

$= 2.074 \times 10^{-4} \text{ m}^2$

→ A_o = area of the nozzle external to the vessel available for compensation

$= 2H_1 (t_n - t_r' - c)$

$= 2(0.02705)(0.005 - 0.001025 - 0.002)$

$= 0.0001068 \text{ m}^2$

$\Rightarrow 1.068 \times 10^{-4} \text{ m}^2$

classmate

Date

Page

→ A_i = area of the nozzle inside the vessel available for compensation

$= 2 H_2 (t_n - 2c)$

$\because H_2 = 0$

$\therefore A_i = 0$

→ $A_n = A_o + A_i$ (excess area available in the nozzle for reinforcement)

$A_n = 0.0001068 + 0$

$= 0.0001068 \ m^2$

→ A = basic area being reduced to the opening

$= (d + 2c) \, t_r$

$= [0.24 + (2 \times 0.002)] \, 0.00615$

$= 0.244 \times 0.00615$

$= 0.0015 \ m^2$

$$\overset{A_n}{\downarrow} \qquad \overset{A_s}{\downarrow}$$

Now $A_s + A_n = 0.0001068 + 0.0002074$

$= 0.0003142 \ m^2$

we can see that

since, $A \geq A_s + A_n$

$(0.0015) \quad (0.0003142)$

we can say that external reinforcement is neccessary.

Now, $[A - (A_s + A_n)]$ area is to be provided using Ring Pad & Weldments.

Area to be compensated $= A - (A_s + A_n)$

$= 0.0015 - 0.0003142$

$= \underline{\underline{0.0011858 \ m^2}}$

Now

$A_r \geq 0.0011858$

$= \{2(d + 2c) - (d + 2c + 2 + r')\} t_p$

$= \{2(0.244) - (0.244 + 2(0.001025))\} t_p$

t_p = thickness of ringpad

$t_p = \dfrac{0.0011858}{0.24195}$

$\underline{\underline{t_p = 0.0049 \ m}}$

Now adding corrosion allowance (+2 mm)

$$0.0049 + 0.002$$
$$= 0.0069 \text{ m}$$
$$= 6.9 \text{ mm}$$

Nearest available standard thickness

$$= \boxed{7 \text{ mm}}$$

Inner diameter of Ring pad = Outer diameter of Nozzle

$$d_{inner} = \boxed{0.25 \text{ m}}$$

And we know

$$\text{Outer diameter of Ring Pad} = 2 \times (d + 2c)$$
$$= 2 \times (0.24 + 2(0.002))$$
$$= 2(0.244)$$
$$d_{outer} = \boxed{0.488} \text{ m}$$

Ring Pad Dimensions:

Inner Diameter = 0.25 m = 250 mm

Outer Diameter = 0.488 m = 488 mm

Thickness = 7 mm