การออกแบบถัง *Solid Contact Clarifier Tank*

สำหรับน้ำประปาขนาด 150 ลูกบาศก์เมตรต่อชั่วโมง

โดย

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DESIGN CALIFIER TANK
(SLUDGE BLANKET CLARIFIER TYPE : VERTICAL SLUDGE BLANKET)

1. Flow Rate

Q = 150 m^3/hr

2. Raw Water Quality input

1	Turbidity	=	NTU
2	pH	=	
3	Alkalinity	=	mg/l as $CaCO_3$
4	Temperature	=	^oC
5	Fe		mg/l
6	Mn		mg/l
7	Total Hardness		mg/l as $CaCO_3$

17 Power Requirement

Give Shaft rotation speed = 3 rpm (Design criteria = 2 - 3 rpm.)

17.1 At depth level = 1.5 m.

Radius of Paddle = 1.365 m.

The rotation speed of paddle = $2\pi rN$

= 0.428827 m/s

Design Criteria $\leq$ 0.9 m/s (Horizontal Shaft with Paddles)

17.2 At depth level = 3.5 m.

Radius of Paddle = 1.785 m.

The rotation speed of paddle = $2\pi rN$

= 0.560774 m/s

Design Criteria $\leq$ 0.9 m/s (Horizontal Shaft with Paddles)

17.3 At depth level = 4.7 m.

Radius of Paddle = 2.037 m.

The rotation speed of paddle = $2\pi rN$

= 0.639942 m/s

Design Criteria $\leq$ 0.9 m/s (Horizontal Shaft with Paddles)

18 Calculation Relative of Paddle with respect to water

$V = 0.75V_{paddle}$ m/s

18.1 At depth level = 1.5 m. V_{paddle} = 0.428827 m/s

V = 0.321621 m/s

18.2 At depth level = 3.5 m. V_{paddle} = 0.560774 m/s

V = 0.420581 m/s

18.3 At depth level = 4.7 m. V_{paddle} = 0.639942 m/s

V = 0.479957 m/s

19 Calculation Power requirement

Theory $P = \frac{1}{2} C_D \Sigma A_p \alpha (\Sigma v)^3$

Where :

P	=	Power requirement of Mixing (watt) or N.m/s			
C_D	=	Coefficient of drang of Paddle	=	1.8	
A_p	=	Area of Paddle (m^2)			
α	=	mass fluid density (kg/m^3)	=	1,000	kg/m^3
v	=	Relative velocity of Paddle with respect to water (m/s)			

Then

P = 437.27 watt or N.m/s

Efficiency Motor at 60 % = 728.78 watt or N.m/s

(From 1 HP = 0.7457 Kilowatt)

Then P = 0.97730575 HP ≈ 1 HP

20 Calculation Velocity Gradient (G)

Theory $G = \sqrt{\frac{P}{\mu V}}$

Where :

G = mean velocity gradient (sec^{-1})

P = power requirement for mixing (watt) or N.m/s

μ = dynamic viscosity ($N.s/m^2$, 0.001 $N.s/m^2$

V = volume of the tank (m^3)

$$G = \sqrt{\frac{1{,}933\ N.m/s}{10^{-3}\ N.s/m^2 x 82.49\ m^3}}$$

G = 94.00646 sec^{-1}

21 Outlet Clarifier Tank

Weir Loading	=	7.3 - 15	m^3/m.hr
From Diameter D_3	=	13.28177137	m.
Minus outlet hole 2 side	=	1	m.
$\therefore$ *Length of weir*	=	12.28177137	m.

Theory

$$Length\ of\ weir = \frac{Q(m^3/hr)}{Weir\ Loading\ (m^3/m.hr)}$$

Weir Loading = 12.21322198 m^3/m.hr OK.

Give Diameter of Orifice = 1 in. = 0.0254 m.

Give 1 m. of outlet weir have orifice = 25 pores/side

$\therefore$ 2 side = 50 pores

Length of Orifice = 1.27 m./ 1 m. weir

$\therefore$ 1 side = 0.635 m./ 1 m. weir

Then Free Space of weir = 0.365 m./ 1 m. weir

∴ Space between orifice to orifice = 0.0146 m.

= 1.46 cm.

Give 1 m. of outlet weir have orifice = 25 pores/side

∴ 2 side = 50 pores

Then total orifice = 614 pores

Then sum area of orifice = 0.31 m^2

22 Flow Rate pass through 1 orifice = 0.244 m^3/hr

Each of orifice area = $\frac{\pi D^2}{4}$

∴ Each of orifice area = 0.0005067 m^2

Theory $Q = Av$

∴ Velocity pass through each orifice = 0.133906 m/s

23 Inlet Structure

From Static Mixer Design criteria velocity pass through static mixer = 1 - 2 m/s

Select velocity = 1.5 m/s

Theory $Q = Av$

Area = $\frac{Q}{v}$ m^2

= 0.027778 m^2

Circular pipe area = $\frac{\pi D^2}{4}$

D^2 = 0.035368

D = 0.188063 m.

= 7.404063 in. ≈ 7 in.

24 Calculation Surface Loading (Sedimentation Zone)

Surface Area at Sedimentation Zone = $\frac{\pi D_{outside}^{\ 2}}{4} - \frac{\pi D_{inside}^{\ 2}}{4}$

$D_{outside}$ = 13.28177 m.

D_{inside} = 3 m.

∴ Surface Area at Sedimentation Zone = 131.4799 m^2

∴ Surface Loading = $\frac{Q}{A}$

= 1.140859 m/hr.

Design Criteria 1.3 - 1.9 m/hr upflow (radial upflow type)

Text Book (Chularrongkron University < 4.2 m/hr.

Water Works Engineering 0.8333 - 1.6666 m/hr