

STATIC MIXER DESIGN FOR COAGULATION

$$\text{DESIGN } Q = 350 \text{ m}^3/\text{h}$$

$$\text{ASPECT RATIO} = 1.0$$

$$\text{MIN. WATER TEMP.} = 12^\circ\text{C}$$

FROM APPENDIX A: for $T = 12^\circ\text{C}$

$$\gamma = 9.802 \text{ kN/m}^3$$

$$\mu = 0.001235 \text{ Pa}\cdot\text{s}$$

$$\text{TRYING 3 MIXERS, } Q = \frac{350 \text{ m}^3/\text{h}}{3} = 117 \frac{\text{m}^3}{\text{h}} \text{ per mixer}$$

COMPARED TO EXAMPLE IN BOOK

G WILL BE LARGER BECAUSE VISCOSITY IS SMALLER
AND v AND t WILL BE SMALLER BECAUSE
ASPECT RATIO IS SMALLER.

I DECIDED TO TRY 3 ELEMENT (COV = 10%)

$$\text{AND } \phi = 400 \text{ mm} = 0.4 \text{ m.}$$

$$\text{THIS GAVE } G = 280 \text{ s}^{-1}$$

$$\text{AND } t = 4.64 \text{ s}$$

$$\text{AND } Gt = 1299$$

(NOT BAD)

THE CALCULATIONS ARE OK THE NEXT PAGE.

AN EFFICIENCY OF $\eta = 1.0$ IS ASSUMED.

FOR 3 MIXERS $Q = 117 \text{ m}^3/\text{R}$

AND $\phi = 400 \text{ mm} = 0.4 \text{ m}$.

TRY 3 ELEMENTS PER MIXER

$$L = (3 \text{ elements})(1.0)(0.4 \text{ m}) = 1.2 \text{ m}$$

$$V = \pi R^2 L = \pi (0.2^2 \text{ m}^2)(1.2 \text{ m}) = 0.1508 \text{ m}^3$$

MAX. $H_L = 0.6 \text{ to } 0.9 \text{ m}$ OR $5.88 \text{ to } 8.82 \text{ kPa}$
as 0.102 m/kPa is conversion factor

MAX H_L per element = $1.96 \text{ to } 2.94 \text{ kPa}$

FIG. 3-16 and $Q = 117 \text{ m}^3/\text{R}$ give $\frac{H_L}{\text{element}} = 0.15 \text{ kPa}$.

$$H_L \text{ for 3 elements} \\ = (0.15 \text{ kPa}) \left(\frac{0.102 \text{ m}}{\text{kPa}} \right) (3 \text{ elements}) = 0.0459 \text{ m}$$

$$P = \frac{\gamma Q H}{\eta} = \frac{(9.802 \text{ kN/m}^3)(117 \text{ m}^3/\text{R})(0.0459 \text{ m})}{1 \times 3600 \text{ s/R}} = \frac{0.01462 \text{ kPa}}{\text{kPa}} \\ = 14.62$$

$$G = \sqrt{\frac{P}{\mu V}} = \sqrt{\frac{14.62 \text{ W}}{(0.001235 \text{ Pa}\cdot\text{s})(0.1508 \text{ m}^3)}} = 280 \text{ s}^{-1}$$

$$t = \frac{V}{Q} = \frac{0.1508 \text{ m}^3}{117 \text{ m}^3/\text{R}} \times \frac{3600 \text{ s}}{\text{h}} = 4.64 \text{ s} \text{ not bad}$$

$$Gt = \frac{280}{\text{s}} \times 4.64 \text{ s} = 1299 \quad \text{Good} \\ \text{(within range of } 350 \text{ to } 1700)$$

THIS DESIGN WOULD REQUIRE

3 + 1 = 4 STATIC MIXERS AS ONE

EXTRA MIXER IS REQUIRED DURING MAINTENANCE

ANOTHER TRIAL WILL BE MADE TO IMPROVE THE DESIGN

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$$\text{TRY 4 MIXERS SO } Q = \frac{350 \text{ m}^3}{\text{h} \cdot 4} = 87.5 \text{ m}^3/\text{h}$$

$$\text{TRY } \phi = 350 \text{ mm} = 0.35 \text{ m}$$

USE 3 ELEMENTS

$$\text{FOR } 350 \text{ mm } \phi \text{ AND } Q = 87.5 \text{ m}^3/\text{h}$$

$$\text{HL per element} = 0.095 \text{ kPa}$$

$$L = (3 \text{ elements})(1.0)(0.35 \text{ m}) = 1.05 \text{ m}$$

$$V = \pi R^2 L = \pi (0.175^2 \text{ m}^2)(1.05 \text{ m}) = 0.101 \text{ m}^3$$

$$\begin{aligned} \text{HL for 3 elements} &= (0.095 \text{ kPa})(0.102 \text{ m/kPa})(3 \text{ elements}) \\ &= 0.02907 \text{ m} \end{aligned}$$

$$P = \frac{\rho Q H}{\eta} = \frac{(9.802 \text{ kN/m}^3)(87.5 \text{ m}^3/\text{h})(0.02907 \text{ m})}{(1)(3600 \text{ s/h})}$$

$$= 0.006926 \text{ kW} = 6.92 \text{ W}$$

$$G = \sqrt{\frac{P}{\mu V}} = \sqrt{\frac{6.92 \text{ W}}{(0.001235 \text{ Pa}\cdot\text{s})(0.101 \text{ m}^3)}} = 235.5 \text{ s}^{-1}$$

$$t = \frac{V}{Q} = \left(\frac{0.101 \text{ m}^3}{87.5 \text{ m}^3/\text{h}} \right) \times \frac{3,600 \text{ s}}{\text{h}} = 4.15 \text{ s (not bad)}$$

$$Gt = (236 \text{ s}^{-1})(4.15 \text{ s}) = 979.4 \text{ GOOD}$$

THIS DESIGN HAS A SLIGHTLY HIGH t

4 MIXER + 1 MIXER = 5 MIXERS TOTAL
REQUIRED.

ANOTHER TRIAL WILL BE MADE TO
IMPROVE t .

TRY 4 MIXERS WITH $\phi = 300 \text{ mm} = 0.3 \text{ m}$.

FOR 0.3 m pipe and $Q = 87.5 \text{ m}^3/\text{h}$
 H_L per element = 0.2 kPa

FOR 3 elements $H_L = (0.2 \text{ kPa}) (0.102 \text{ m/kPa}) (3 \text{ elements})$
 $= 0.0612 \text{ m}$

$L = (3 \text{ elements}) (1.0) (0.3 \text{ m}) = 0.9 \text{ m}$

$V = \pi R^2 L = \pi (0.15^2 \text{ m}^2) (0.9 \text{ m}) = 0.0636 \text{ m}^3$

$P = \frac{\rho g H}{\eta} = \frac{(9.802 \text{ kN/m}^3) (87.5 \text{ m}^3/\text{h}) (0.0612 \text{ m})}{(1) (3600 \text{ s/h})}$

$= 0.01458 \text{ kW} = 14.5 \text{ W}$

$Q = \sqrt{\frac{P}{\mu f}} = \sqrt{\frac{14.58 \text{ W}}{(0.001235 \text{ Pa}\cdot\text{s}) (0.0636 \text{ m}^3)}} = 430.8 \text{ s}^{-1}$

$t = \frac{V}{Q} = \frac{0.0636 \text{ m}^3}{87.5 \text{ m}^3/\text{h}} \left(\frac{3600 \text{ s}}{\text{h}} \right) = 2.62 \text{ s}$ good

$Qt = (430.8 \text{ s}^{-1}) (2.62 \text{ s}) = 1127$ good.

THIS IS THE BEST DESIGN SO FAR.

4 MIXERS + 1 MIXER STANDBY = 5 MIXERS TOTAL.

A LARGE NUMBER OF STATIC MIXERS USED ALLOW MORE FLEXIBILITY IN ADJUSTING TO LOWER FLOWS.

MORE MIXERS AND SMALLER PIPE COULD ALSO BE TESTED.

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