STATIC MIXER DESIGN FOR COAGULATION

DESIGN $Q = 350\ m^3/s$

ASPECT RATIO = 1.0

MIN. WATER TEMP. = 12°C

FROM APPENDIX A: for $T = 12°C$

$\gamma = 9.802\ kN/m^3$

$\mu = 0.001235\ Pa \cdot s$

TRYING 3 MIXERS, $Q = \frac{350\ m^3/s}{3} = 117 \frac{m^3}{h}$ 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%)
AND $\phi = 400\ mm = 0.4\ m$.

THIS GAVE $G = 280\ s^{-1}$
AND $t = 4.64\ s$ (NOT BAD)
AND $Gt = 1299$

THE CALCULATIONS ARE ON THE NEXT PAGE.

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

FOR 3 MIXERS $Q = 117\ m^3/h$
AND $\phi = 400\ mm = 0.4\ m$.
TRY 3 ELEMENTS PER MIXER

$L = (3\ \text{elements})(1.0)(0.4\ m) = 1.2\ m$
$\forall = \pi R^2 L = \pi (0.2^2\ m^2)(1.2\ m) = 0.1508\ m^3$

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

MAX H_L per element $= 1.96$ to $2.94\ kPa$

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

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

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

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

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

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

THIS DESIGN WOULD REQUIRE
$3 + 1 = 4$ STATIC MIXERS AS ONE
EXRA MIXER IS REQUIRED DURING MAINTENANCE

ANOTHER TRIAL WILL BE MADE TO IMPROVE THE DESIGN

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

TRY $\phi = 350\ mm = 0.35\ m$
USE 3 ELEMENTS

FOR 350 mm ϕ AND $Q = 87.5\ m^3/h$
H_L per element $= 0.095\ kPA$

$L = (3\ \text{elements})(1.0)(0.35\ m) = 1.05\ m$
$\forall = \pi R^2 L = \pi (0.175^2\ m^2)(1.05\ m) = 0.101\ m^3$

H_L for 3 elements $= (0.095\ kPA)(0.102\ m/kPa)(3\ \text{elements})$
$= 0.02907\ m$

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

$= 0.006926\ kW = 6.92\ W$

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

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

$Gt = (236\ s^{-1})(4.15\ s) = 979.4$ 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 ϕ = 300 mm = 0.3 m.

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

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

$L = (3\ elements)(1.0)(0.3\ m) = 0.9\ m$
$\forall = \pi R^2 L = \pi (0.15^2\ m^2)(0.9\ m) = 0.0636\ m^3$

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

$= 0.01458\ kW = 14.5\ W$

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

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

$Gt = (430.8\ s^{-1})(2.62\ s) = 1127$ 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.