การออกแบบระบบกวนเร็วแบบ Static Mixer(PWA)

สำหรับโรงงานผลิตน้ำประปาขนาด 5,000 ลูกบาศก์เมตรต่อวัน

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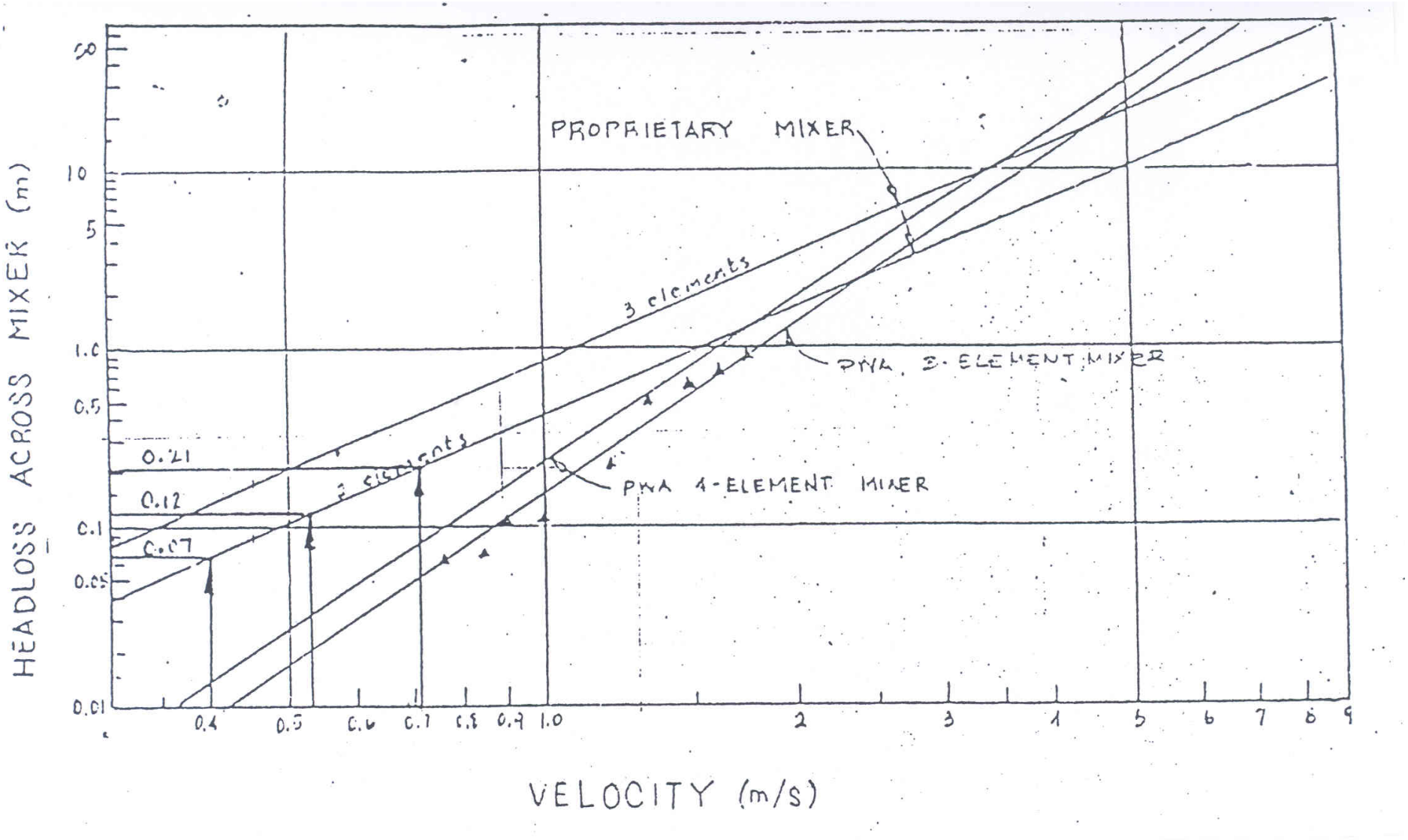
Design Criteria

$$350 < Gxt < 1{,}700 \qquad (Kawamura)$$

$$1S < t < 5S$$


HEADLOSS ACROSS MIXER (m)
50
10
5
1.0
0.5
0.21
0.12
0.1
0.07
0.05
0.01
PROPRIETARY MIXER
3 elements
PWA 3-ELEMENT MIXER
4 elements
PWA 4-ELEMENT MIXER
0.4
0.5
0.6
0.7
0.8
0.9
1.0
2
3
4
5
6
7
8
9
VELOCITY (m/s)

1. PWA Static Mixer Design

1.1 Raw Water Pipe

Design Flow (Q Design) = 5,000 m^3/day

Velocity in Pipe = 1.8 - 2.0 m/s (Kawamura)

Use = 1.8 m/s

$\therefore$ Pipe Diameter (D) = $\sqrt{\frac{4Q}{\pi v}}$

$$= \sqrt{\frac{4x5{,}000}{3.14x1.8x3600x24}}$$

= 0.2023751 m.

Use Pipe Diameter (D) = 0.2 m. = 8 in

$\therefore$ Acture Velocity = $\frac{Q}{A}$

= 1.8420711 m/s

1.2 Rapid Mixing = Hydraulic Type

Type = Static Mixer

Design Criteria

- Detention Time = 1 - 3 sec
- G - Value = 500 - 700 sec^{-1}
- GT = 350 - 1500

1.3 Calculation

Theory : Rule of Thumb - estimateing the Length of one element is to designated the length as 1.5 - 2.5 times the pipe diameter the base on this criteria,the length of one element is in the range of 3 - 5 ft (Kawamura, page no. 88)

- 2 stage = 2 element

$$Static\ Mixer\ Length = 1.5xDiameter(m)x2(element) - 0.5xDiameter(m)$$

- 3 stage = 3 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x3(element) - Diameter(m.)$$

- 4 stage = 4 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x4(element) - 1.5xDiameter(m.)$$

- 5 stage = 5 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x5(element) - 2.0xDiameter(m.)$$

- 6 stage = 6 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x6(element) - 2.5xDiameter(m.)$$

- 7 stage = 7 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x7(element) - 3.0xDiameter(m.)$$

- 8 stage = 8 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x8(element) - 3.5xDiameter(m.)$$

- 9 stage = 9 element

$$Static\ Mixer\ Length = 1.5xDimerter(m.)x9(element) - 4.0xDiameter(m.)$$

Try Static Mixer Diameter = 300 mm. = 12 in

Use 2 stage = 2 element

$$Static\ Mixer\ Length = 1.5xDiameter(m)x2(element) - 0.5xDiameter(m)$$

$\therefore$ Static Mixer Length (L) = 0.75 m.

$\therefore$ Acture Velocity = $\frac{Q}{A}$

= 0.819 m/s

$\therefore$ Detention Time (t) = 0.9160884 sec.

∴ Bring Acture velocity to Find Head loss from PWA Graph

∴ Head Loss Across Static Mixer = 0.25 m.

ρ_L = 997.1 kg/m^3 at 25 ^{o}C

μ = 0.000895 kg/m.s (N.s/m^2) at 25 oC

Theory

$$G = \sqrt{\frac{h_f x g x \rho}{\mu x t}}$$

= 1727.0052 sec^{-1} too hight

Gxt = 1582.0895 too hight

Try Static Mixer Diameter = 400 mm. = 16 in

Use 2 stage = 2 element

$$Static\ Mixer\ Length = 1.5xDiameter(m)x2(element) - 0.5xDiameter(m)$$

∴ Static Mixer Length (L) = 1 m.

∴ Acture Velocity = $\frac{Q}{A}$

= 0.461 m/s

∴ Detention Time (t) = 2.1714688 sec.

∴ Bring Acture velocity to Find Head loss from PWA Graph

∴ Head Loss Across Static Mixer = 0.08 m.

ρ_L = 997.1 kg/m^3 at 25 ^{o}C

μ = 0.000895 kg/m.s (N.s/m^2) at 25 oC

Theory

$$G = \sqrt{\frac{h_f x g x \rho}{\mu x t}}$$

= 634.54224 sec^{-1} OK

Gxt = 1377.8887 OK

1. PWA Static Mixer Design

1.1 Raw Water Pipe

Design Flow (Q Design) = 5,000 m^3/day

Velocity in Pipe = 1.8 - 2.0 m/s (Kawamura)

Use = 1.8 m/s

$\therefore$ Pipe Diameter (D) = $\sqrt{\frac{4Q}{\pi v}}$

$$= \sqrt{\frac{4x5{,}000}{3.14x1.8x3600x24}}$$

= 0.2023751 m.

Use Pipe Diameter (D) = 0.2 m. = 8 in

$\therefore$ Acture Velocity = $\frac{Q}{A}$

= 1.8420711 m/s

1.2 Rapid Mixing = Hydraulic Type

Type = Static Mixer

Design Criteria

- Detention Time = 1 - 3 sec
- G - Value = 500 - 700 sec^{-1}
- GT = 350 - 1500

1.3 Calculation

Theory : Rule of Thumb - estimateing the Length of one element is to designated the length as 1.5 - 2.5 times the pipe diameter the base on this criteria,the length of one element is in the range of 3 - 5 ft (Kawamura, page no. 88)

- 2 stage = 2 element

$$Static\ Mixer\ Length = 1.5xDiameter(m)x2(element) - 0.5xDiameter(m)$$

- 3 stage = 3 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x3(element) - Diameter(m.)$$

- 4 stage = 4 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x4(element) - 1.5xDiameter(m.)$$

- 5 stage = 5 element

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- 6 stage = 6 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x6(element) - 2.5xDiameter(m.)$$

- 7 stage = 7 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x7(element) - 3.0xDiameter(m.)$$

- 8 stage = 8 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x8(element) - 3.5xDiameter(m.)$$

- 9 stage = 9 element

$$Static\ Mixer\ Length = 1.5xDimerter(m.)x9(element) - 4.0xDiameter(m.)$$

Try Static Mixer Diameter = 250 mm. = 10 in

Use 3 stage = 3 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x3(element) - Diameter(m.)$$

$\therefore$ Static Mixer Length (L) = 0.875 m.

$\therefore$ Acture Velocity = $\frac{Q}{A}$

= 1.179 m/s

$\therefore$ Detention Time (t) = 0.7422013 sec.

∴ Bring Acture velocity to Find Head loss from PWA Graph

∴ Head Loss Across Static Mixer = 1 m.

ρ_L = 997.1 kg/m^3 at 25 ^{o}C

μ = 0.000895 kg/m.s (N.s/m^2) at 25 oC

Theory

$$G = \sqrt{\frac{h_f x g x \rho}{\mu x t}}$$

= 2848.0866 sec^{-1} too hight

Gxt = 2113.8535 too hight

1. PWA Static Mixer Design

1.1 Raw Water Pipe

Design Flow (Q Design) = 5,000 m^3/day

Velocity in Pipe = 1.8 - 2.0 m/s (Kawamura)

Use = 1.8 m/s

$\therefore$ Pipe Diameter (D) = $\sqrt{\frac{4Q}{\pi v}}$

$$= \sqrt{\frac{4x5{,}000}{3.14x1.8x3600x24}}$$

= 0.2023751 m.

Use Pipe Diameter (D) = 0.2 m. = 8 in

$\therefore$ Acture Velocity = $\frac{Q}{A}$

= 1.8420711 m/s

1.2 Rapid Mixing = Hydraulic Type

Type = Static Mixer

Design Criteria

- Detention Time = 1 - 3 sec
- G - Value = 500 - 700 sec^{-1}
- GT = 350 - 1500

1.3 Calculation

Theory : Rule of Thumb - estimateing the Length of one element is to designated the length as 1.5 - 2.5 times the pipe diameter the base on this criteria,the length of one element is in the range of 3 - 5 ft (Kawamura, page no. 88)

- 2 stage = 2 element

$$Static\ Mixer\ Length = 1.5xDiameter(m)x2(element) - 0.5xDiameter(m)$$

- 3 stage = 3 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x3(element) - Diameter(m.)$$

- 4 stage = 4 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x4(element) - 1.5xDiameter(m.)$$

- 5 stage = 5 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x5(element) - 2.0xDiameter(m.)$$

- 6 stage = 6 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x6(element) - 2.5xDiameter(m.)$$

- 7 stage = 7 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x7(element) - 3.0xDiameter(m.)$$

- 8 stage = 8 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x8(element) - 3.5xDiameter(m.)$$

- 9 stage = 9 element

$$Static\ Mixer\ Length = 1.5xDimerter(m.)x9(element) - 4.0xDiameter(m.)$$

Try Static Mixer Diameter = 250 mm. = 10 in

Use 4 stage = 4 element

$$Static\ Mixer\ Length = 1.5xDiameter(m.)x4(element) - 1.5xDiameter(m.)$$

$\therefore$ Static Mixer Length (L) = 1.125 m.

$\therefore$ Acture Velocity = $\frac{Q}{A}$

= 1.179 m/s

$\therefore$ Detention Time (t) = 0.9542588 sec.

∴ Bring Acture velocity to Find Head loss from PWA Graph

∴ Head Loss Across Static Mixer = 0.5 m.

ρ_L = 997.1 kg/m^3 at 25 ^{o}C

μ = 0.000895 kg/m.s (N.s/m^2) at 25 oC

Theory

$$G = \sqrt{\frac{h_f x g x \rho}{\mu x t}}$$

= 2283.5495 sec^{-1} too hight

Gxt = 2179.0971 too hight