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Experiment Number (12)

Efflux Time for a Tank with Exit Pipe

Type of the report: short report

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Abstract

The efflux time experiment is simple to construct, simple to operate, and very useful for teaching the fundamentals of fluid flow and friction loss. The experiment was done by filling the tank to a certain level and open the valve to allowed to the fluid glycerol and water to flowed 1L through tube, repeated this procedure with different tubes, once with different length and same diameter and once with different diameter and same length. This experiment was done to show the dependence of the efflux time for a tank with exit pipe on pipe length and diameter.

The main result was obtained and showed that for the pipes with same diameter (0.00535m) and different length when the length increased, the efflux time increased due to the friction with the inert surface of the pipe and for the pipes with same length (0.6234 m) and different diameter when the diameter decreased , the efflux time increased to certain point then start to decreased.

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Results

Table 1: Raw data of the experiment

H_1 (m)	H_1 (m)	Room temperature (°C)	Viscosity (Pa.s)	Density (Kg/m3)	Internal diameter of tank (m)	Internal height of tank (m)	volume of tank (m3)
0.175	0.12	13	0.02	1197.27	0.16054	0.263	0.00533

Table 2:Raw data for the pipes at same diameter (0.00535 m)

Same diameter (D=0.00535 m)	
Length (m)	**Time (s)**
0.0874	2:53
0.1634	3:44
0.3184	4:41

Table 3:Calculated data for the pipes at same diameter (0.00535 m)

Time (s)	Area (m^2)	Volumetric flow rate (Q) (m^3/s)	Velocity (m/s)	Re	t_{eff}	t_E/t_c
173	0.0000225	0.0000308	1.369	438.415	35.242	4.909
224	0.0000225	0.0000238	1.057	338.598	49.682	4.509
281	0.0000225	0.0000190	0.843	269.914	64.509	4.356

Table 4:Raw data for the pipes at same length (0.6234 m)

Same Length (0.6234 m)	
Diameter (m)	**Time (s)**
0.0084	0:37
0.00535	6:10
0.0021	12:07

Table 5:Calculated data for the pipes at same length (0.6234 m)

Time (s)	Area (m^2)	Volumetric flow rate (Q) (m^3/s)	Velocity (m/s)	Re	t_{eff}	t_E/t_c	D_T/d
37	0.0000554	0.0001439	2.596	1305.583	12.551	2.948	19.112
370	0.0000225	0.0000144	0.640	204.989	76.275	4.851	30.007
727	0.0000035	0.0000073	2.114	265.786	3213.089	0.226	76.448

Figures

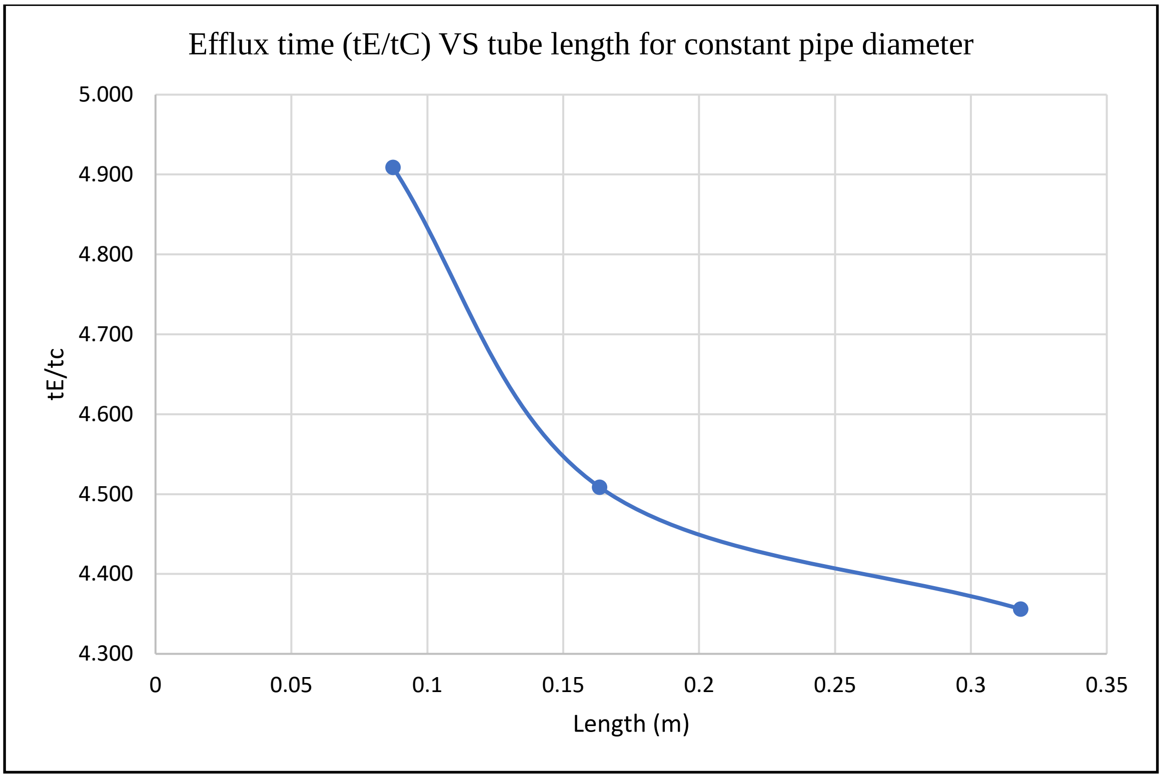

Figure 1:Efflux time (tE/tC) VS tube length for same pipe diameter

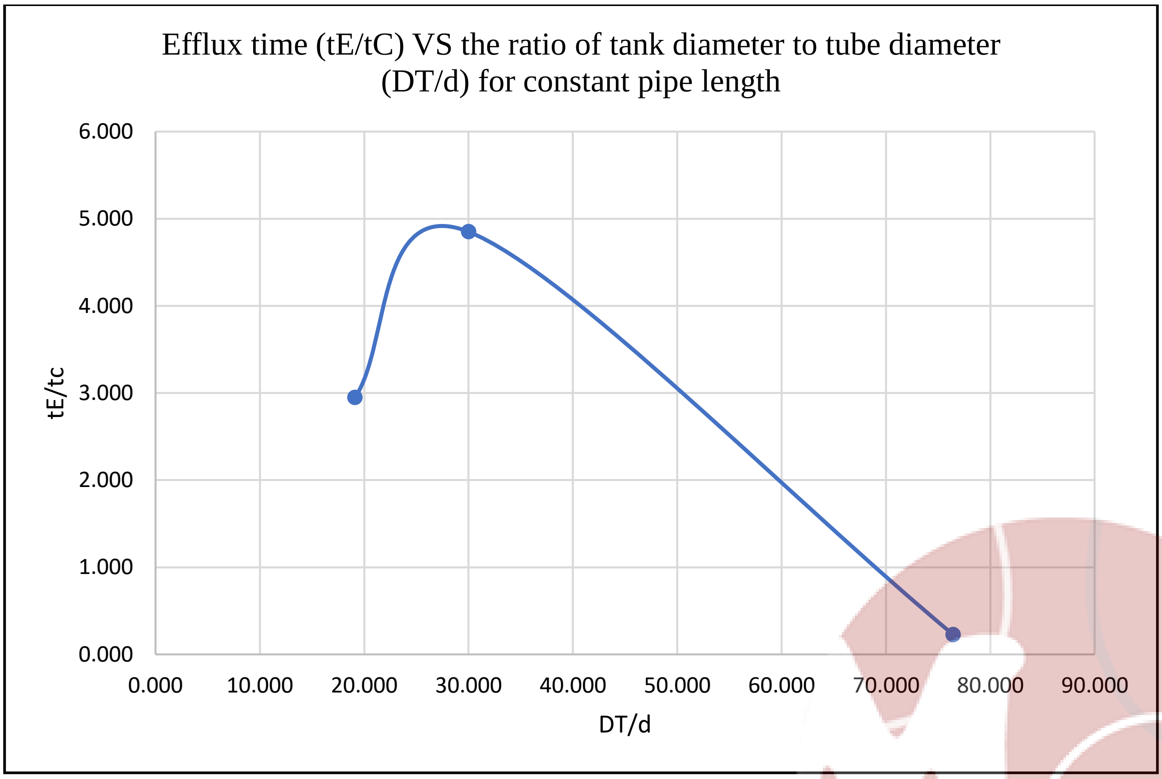

Figure 2:Efflux time (tE/tC) VS the ratio of tank diameter to tube diameter (DT/d) for constant pipe

Discussion

From the results in Table 3 the area of constant diameter is constant, and the flow is laminar due to Re < 2100. Also, while the length of pipe increases, (Re) decrease and that because the decreasing in velocity due to increasing in frictions. In figure 1, it shows that increasing pipe length lead to decrease in the ratio of experimental efflux time to the calculated efflux time. Also, all ratios are greater than 1 that means experimental efflux time is greater than calculated efflux time that is due to not exactly constant cross-sectional area and due to frictions and may be due to presence of deposits inside the pipe and it's may because some of personal error in reading.

In figure 2 the relation is not linear as in figure 1, when the ratio of tank diameter to tube diameter increases the ratio of experimental efflux time to the calculated efflux time increase then decrease.

Conclusions

By conducting the experiment on different length and diameter, it was concluded that:

- The relationship between the length of the pipe and efflux time is directly proportional. When the pipe length with constant diameter increases efflux time increases.
- The relationship between the diameter of the pipes and the efflux time is inversely proportional. When the pipe diameter with constant length increases efflux time decreases.
- The Reynolds number decreases with an increase in the pipe length with constant diameter. Also, Reynolds number decreases with decreases in the pipe diameter with constant length.
- Efflux time is inversely proportional to the velocity with the length, and directly proportional to the velocity with the diameter.

References

1) Chemical engineering laboratory “1” (0915361); University of Jordan; faculty of engineering and Technology; Department of Chemical engineering.

Appendices

❖ Sample of calculations:

For constant diameter = 0.00535 m:

1) Volume of tank = Internal height of tank (m) * $\frac{\Pi}{4}$ *(Internal diameter of tank)^2 = 0.263 * (3.14/4) * (0.16054)^2 = 0.005325825 m^3

2) Area = $\frac{\pi}{4} \times 0.00535^2 = 0.0000225$ m^2

3) Volumetric flow rate = $\frac{\text{Volume of tank}}{\text{Time}} = \frac{0.005325825}{173} = 0.0000308$ m^3/s

4) Velocity = $\frac{\text{Volumetric flow rate}}{\text{Area}} = \frac{0.0000308}{0.0000225} = 1.369$ m/s

5) Re = $\frac{\rho \times \text{velocity} \times \text{diameter}}{\mu} = \frac{1197.27 \times 1.369 \times 0.00535}{0.02} = 438.415$

Re < 2100 → it is laminar flow

1) $t_{eff} = \frac{32 \times \mu \times L \times D^2}{\rho \times g \times d^4} \times \ln(\frac{L \times H1}{L \times H2}) = \frac{32 \times 0.02 \times 0.0874 \times 0.16054^2}{1197.27 \times 9.81 \times 0.00535^4} \times \ln(\frac{0.0874 + 0.175}{0.0874 + 0.12}) = 35.242$

2) $t_E/t_c = \frac{\text{Time}}{t_{eff}} = \frac{173}{35.242} = 4.909$

❖ Data obtained:

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Efflux Time for a Tank with Exit Pipe Data Sheet

	Pipe dimensions	Time (s) Trial number 1	Time (s) Trial number 2
Same diameter	D=5.35mm L=87.4mm		2 : 53
	D=5.35mm L=163.4mm		3 : 44
	D=5.35mm L=318.4mm		4 : 41
Same length	D=8.4mm L=623.4mm		0 : 37
	D=5.35mm L=623.4mm		6 : 10
	D=2.1mm L=623.4mm		12 : 7

H1	17.5 cm
H2	12 cm
Room Temperature	13 ° C
Mass of empty bottle	34 g
Mass of bottle+ water	84.5 g
Mass of bottle + mixture	94.5 g
Viscosity	20 cp