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Student declaration:

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Abstract

In this report, the fundamental thought of doing this experiment will be clarified and confirmed the integral momentum equation. This experiment will be about the impact of jet forces against stationary deflector by using deflectors with $(180^\circ, 120^\circ, 90^\circ)$ plate. A hypothesis will be mentioned with a brief introduction. Also, the steps of the experiment and hand calculation will be clarified and detailed. The conclusive outcome will be furnished with a talk looking at the hypothetical and experiential outcome.



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Introduction:

In this experiment, we will use the impact of the jets device to create a reaction force produced on plates when the water impacts the plates. Studying the reaction of the forces is an important step in the mechanics of fluids which applied to hydraulic machinery and a good example of that is Francis's turbine.

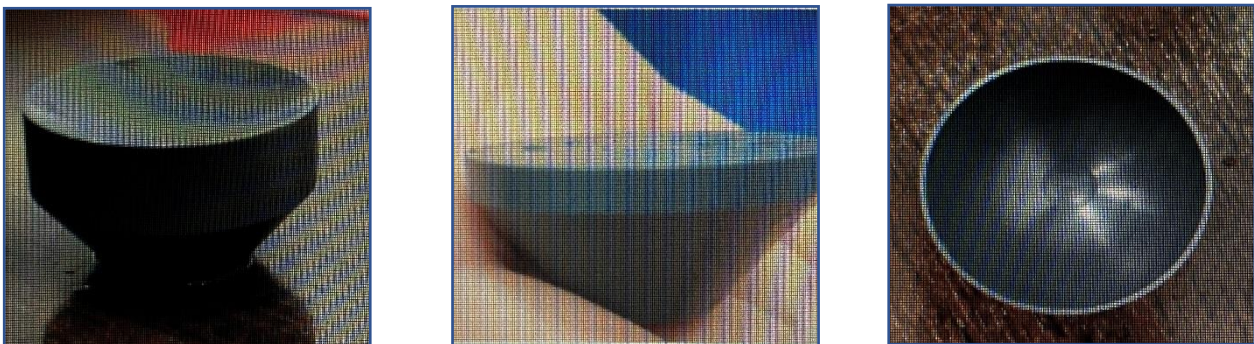


Figure 1: Plate (90 - 120 - 180) (degree)

1.Theory:

When we have a turbine that are work as a jet of water, we can calculate the flow rate easily.

When the water strikes the solid surface with a constant speed, and considering that there is no losses of energy by the friction, the volume of the water will not change.

The surface that the jet strike, can change the direction of the water jet, the velocity of the water along the surface will not change if we considered that there is no friction.

$$F = \rho Q \cdot (V_{\text{jet}} - V_{\text{jet}} \cos \alpha)$$

F: is the force from the jet. In (N)

P: is the density of the liquid >> water.

In (kg/m³)

Q: is the volumetric flow rate. In (m³ / s)

V jet: velocity of the jet. In(m/s)



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α : is the angle of changing direction.

Jet speed can be found by this equation:

$$V_{jet} = Q/A$$

Where A is our area of the nozzle.

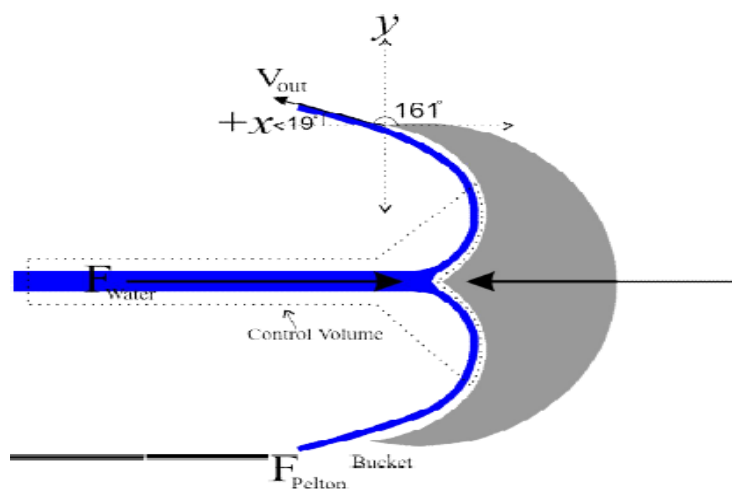


Figure 3: Diagram of pelton bucke

The objective of this experiment is how to measure the pursues loss and the friction factor f :

- By Rough pipe (PVC covered in sand) with an internal diameter of 23 mm (3).
- Smooth pipe (PVC) with an internal diameter of 26.5 mm (6).

The loss coefficient of the two valves is determined as well, namely:

- Angle seat valve (7).
- Gate valve (8).



3. Procedure:

During this experiment we should do some steps to make sure that our results is correct. At first, we should remove the cover and we should use the flat surface which will make the angle of deflection 90.

Then we should install the cover again. After that we should make sure that the experiment surface is horizontal by using the spirit level. Then we have to adjust the gage level to the flat surface. Then we turn on the bump on any law flow. The plate will rise we should use some masses to return it to its original condition. To get the flow rate we should close the valve and wait for the scale to reach 4 then turn on the stopwatch and stop it again when it reaches 8. Then we should increase the flow and return the experiment two more times for the same plate. After doing that return all these steps for other plates.

4. Result and discussions:

Table 1: Result from Experiment 90

	Mass (Kg)	Time (s)
1	20×10^{-3}	19
2	80×10^{-3}	14
3	180×10^{-3}	11

The volumetric flow rate in m^3/s :

- $Q = \text{Volume}/\text{time} = (4 \times 10^{-3})/19 = 2.105 \times 10^{-3} \text{ (m}^3/\text{s)}$
- $Q = \text{Volume}/\text{time} = (4 \times 10^{-3})/14 = 2.857 \times 10^{-3} \text{ (m}^3/\text{s)}$
- $Q = \text{Volume}/\text{time} = (4 \times 10^{-3})/11 = 3.636 \times 10^{-3} \text{ (m}^3/\text{s)}$



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The jet speed in m/s, $A = \frac{\pi}{4} x (8x10^{-3})^2 = 5.03x10^{-5} \text{ m}^2$

- $V_{jet} = Q/A = 2.105x10^{-3} / 5.03x10^{-5} = 4.187 \text{ m/s}$
- $V_{jet} = Q/A = 2.857x10^{-3} / 5.03x10^{-5} = 5.68 \text{ m/s}$
- $V_{jet} = Q/A = 3.636x10^{-3} / 5.03x10^{-5} = 7.233 \text{ m/s}$

Theoretical Force $F_j = \rho Q \cdot (V_{jet} - V_{jet} \cos \alpha)$:

- $F_{th} = 1000 \cdot (2.105x10^{-3}) \cdot (4.187 - 4.187 \cos 90) = 0.881 \text{ N}$
- $F_{th} = 1000 \cdot (2.857x10^{-3}) \cdot (5.68 - 5.68 \cos 90) = 1.622 \text{ N}$
- $F_{th} = 1000 \cdot (3.636x10^{-3}) \cdot (7.233 - 7.233 \cos 90) = 2.629 \text{ N}$

Force experimental ($F = mg$):

- $F_{exp} = (20x10^{-3}) \cdot 9.81 = 0.1962 \text{ N}$
- $F_{exp} = (80x10^{-3}) \cdot 9.81 = 0.785 \text{ N}$
- $F_{exp} = (180x10^{-3}) \cdot 9.81 = 1.765 \text{ N}$

%Error:

Relative Error = (Measured Value – Actual Value) / Actual Value

Percent Error = $| \text{Relative Error} | \times 100$

- Relative Error = $(0.881 - 0.1962) / 0.1962 = 0.777$

Percent Error = $| 0.777 | \times 100 = 77.7\%$

- Relative Error = $(0.785 - 1.622) / 1.622 = -0.516$

Percent Error = $| -0.516 | \times 100 = 51.6\%$

- Relative Error = $(1.765 - 2.629) / 2.629 = -0.327$

Percent Error = $| -0.327 | \times 100 = 32.7\%$



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Table 2: 90 surfaces

Mass (Kg)	Flow rate (m ³ /s)	Jet speed V _{jet} (m/s)	Experimental Force (N)	Theoretical Force (N)	% Error
20*10e-3	2.105*10e-4	4.187	0.1962	0.881	77%
80*10e-3	2.857*10e-4	5.68	0.785	1.622	51.60%
180*10e-3	3.636*10e-4	7.233	1.765	2.629	32.80%

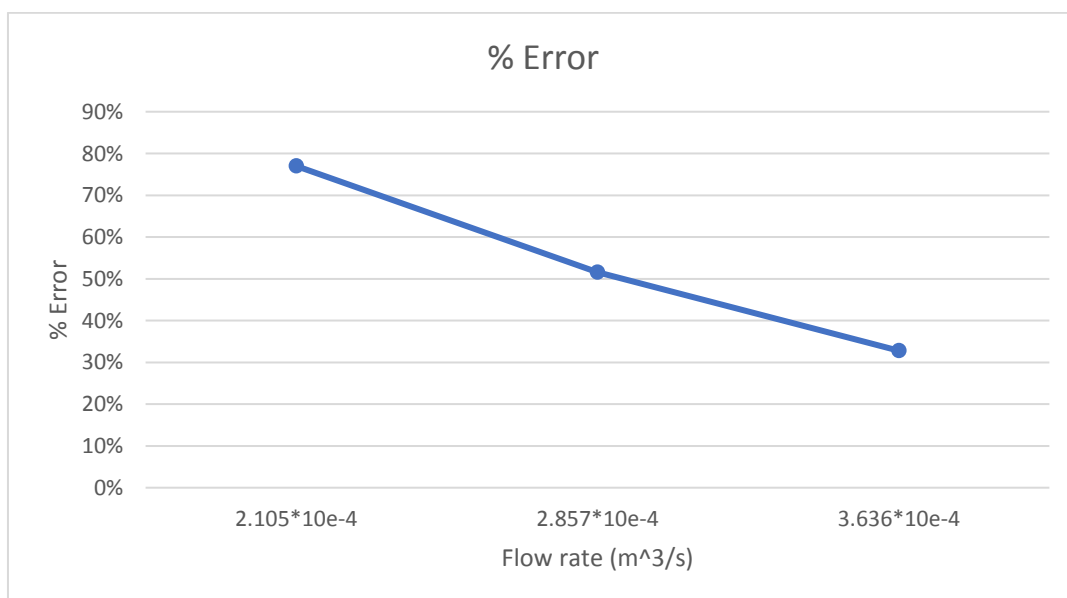
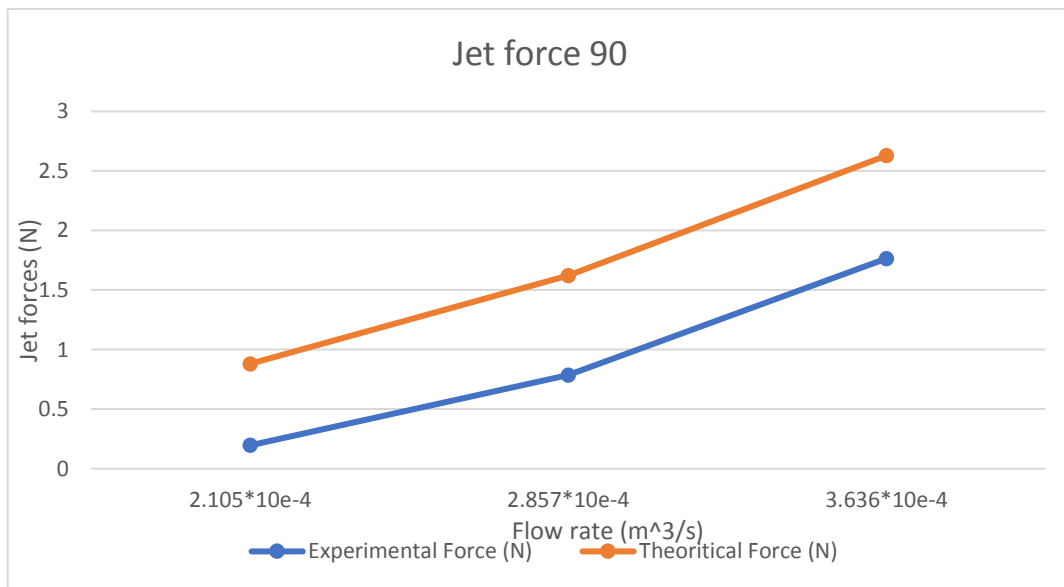




Table 3: Result from Experiment 120

	Mass (Kg)	Time (s)
1	30×10^{-3}	19.5
2	145×10^{-3}	13.5
3	485×10^{-3}	10.5

The volumetric flow rate in m^3/s :

- $Q = \text{Volume}/\text{time} = (4 \times 10^{-3})/19.5 = 2.05 \times 10^{-3} \text{ (m}^3/\text{s)}$
- $Q = \text{Volume}/\text{time} = (4 \times 10^{-3})/13.5 = 2.963 \times 10^{-3} \text{ (m}^3/\text{s)}$
- $Q = \text{Volume}/\text{time} = (4 \times 10^{-3})/10.5 = 3.809 \times 10^{-3} \text{ (m}^3/\text{s)}$

The jet speed in m/s , $A = \frac{\pi}{4} \times (8 \times 10^{-3})^2 = 5.03 \times 10^{-5} \text{ m}^2$

- $V_{\text{jet}} = Q/A = 2.05 \times 10^{-3} / 5.03 \times 10^{-5} = 4.08 \text{ m/s}$
- $V_{\text{jet}} = Q/A = 2.963 \times 10^{-3} / 5.03 \times 10^{-5} = 5.894 \text{ m/s}$
- $V_{\text{jet}} = Q/A = 3.809 \times 10^{-3} / 5.03 \times 10^{-5} = 7.577 \text{ m/s}$

Theoretical Force $F_j = \rho Q (V_{\text{jet}} - V_{\text{jet}} \cos \alpha)$:

- $F_{\text{th}} = 1000 \times (2.05 \times 10^{-3}) \times (4.08 - 4.08 \cos 120) = 1.255 \text{ N}$
- $F_{\text{th}} = 1000 \times (2.963 \times 10^{-3}) \times (5.894 - 5.894 \cos 120) = 2.619 \text{ N}$
- $F_{\text{th}} = 1000 \times (3.809 \times 10^{-3}) \times (7.577 - 7.577 \cos 120) = 4.329 \text{ N}$

Force experimental ($F = mg$):

- $F_{\text{exp}} = (30 \times 10^{-3}) \times 9.81 = 0.294 \text{ N}$
- $F_{\text{exp}} = (145 \times 10^{-3}) \times 9.81 = 1.422 \text{ N}$
- $F_{\text{exp}} = (485 \times 10^{-3}) \times 9.81 = 4.757 \text{ N}$



%Error:

Relative Error = (Measured Value – Actual Value) /Actual Value

Percent Error = | Relative Error | × 100

- Relative Error = (0.294-1.255) /1.255 = 0.765

Percent Error = | 0.765 | × 100 = 76.5%

- Relative Error = (1.422-2.619) /2.619 = 0.457

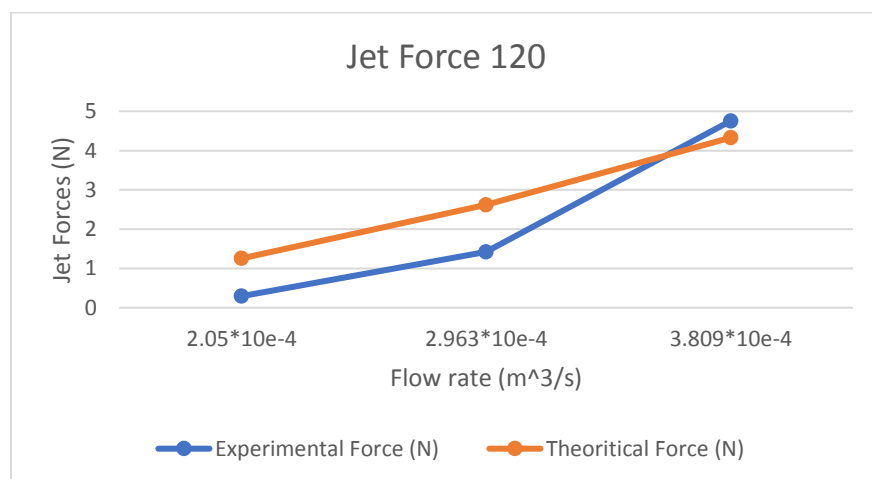
Percent Error = | 0.457 | × 100 = 45.7%

- Relative Error = (4.329-4.757) /4.757 = 0.0988

Percent Error = | 0.0988 | × 100 = 9.88%

Table 4: 120 surfaces

Mass (Kg)	Flow rate (m ³ /s)	Jet speed Vjet (m/s)	Experimental Force (N)	Theoretical Force (N)	% Error
30*10e-3	2.05*10e-4	4.08	0.294	1.255	77%
145*10e-3	2.963*10e-4	5.894	1.422	2.619	45.70%
485*10e-3	3.809*10e-4	7.577	4.757	4.329	9.88%



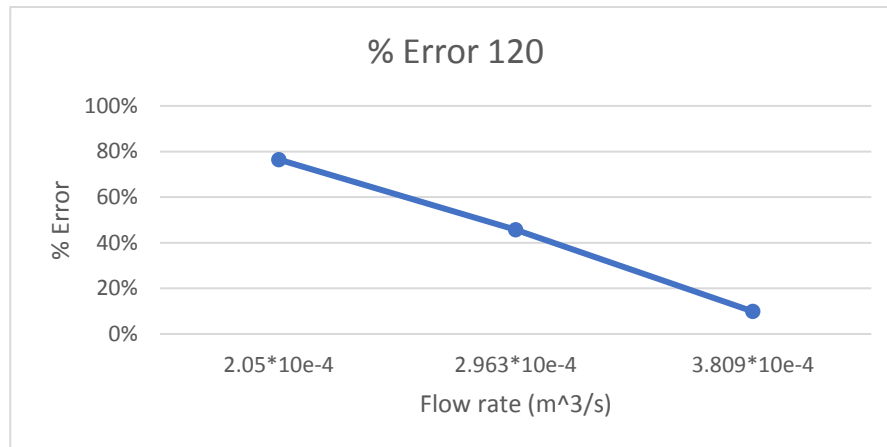


Table 5: Result from Experiment 180

	Mass (Kg)	Time (s)
1	470×10^{-3}	10.5
2	650×10^{-3}	9
3	830×10^{-3}	10

The volumetric flow rate in m³ /s:

- $Q = \text{Volume/time} = (4 \times 10^{-3})/10.5 = 3.809 \times 10^{-4} \text{ (m}^3/\text{s)}$
- $Q = \text{Volume/time} = (4 \times 10^{-3})/9 = 4.44 \times 10^{-4} \text{ (m}^3/\text{s)}$
- $Q = \text{Volume/time} = (4 \times 10^{-3})/10 = 4 \times 10^{-4} \text{ (m}^3/\text{s)}$

The jet speed in m/s, $A = \frac{\pi}{4} (8 \times 10^{-3})^2 = 5.03 \times 10^{-5} \text{ m}^2$

- $V_{\text{jet}} = Q/A = 3.809 \times 10^{-4} / 5.03 \times 10^{-5} = 7.577 \text{ m/s}$
- $V_{\text{jet}} = Q/A = 4.44 \times 10^{-4} / 5.03 \times 10^{-5} = 8.83 \text{ m/s}$
- $V_{\text{jet}} = Q/A = 4 \times 10^{-4} / 5.03 \times 10^{-5} = 7.957 \text{ m/s}$



Theoretical Force $F_j = \rho Q \cdot (V_{jet} - V_{jet} \cos \alpha)$:

- $F_{th} = 1000 \cdot (3.809 \times 10^{-3}) \cdot (7.577 - 7.577 \cos 180) = 5.772 \text{ N}$
- $F_{th} = 1000 \cdot (4.44 \times 10^{-3}) \cdot (8.83 - 8.83 \cos 180) = 7.841 \text{ N}$
- $F_{th} = 1000 \cdot (4 \times 10^{-3}) \cdot (7.957 - 7.957 \cos 180) = 6.365 \text{ N}$

Force experimental ($F = mg$):

- $F_{exp} = (470 \times 10^{-3}) \cdot 9.81 = 4.6107 \text{ N}$
- $F_{exp} = (650 \times 10^{-3}) \cdot 9.81 = 6.376 \text{ N}$
- $F_{exp} = (830 \times 10^{-3}) \cdot 9.81 = 8.142 \text{ N}$

%Error:

Relative Error = (Measured Value – Actual Value) / Actual Value

Percent Error = | Relative Error | $\times 100$

- Relative Error = $(4.61 - 5.77) / 5.77 = 0.2012$

Percent Error = | 0.2012 | $\times 100 = 20.12\%$

- Relative Error = $(6.376 - 7.841) / 7.841 = 0.1868$

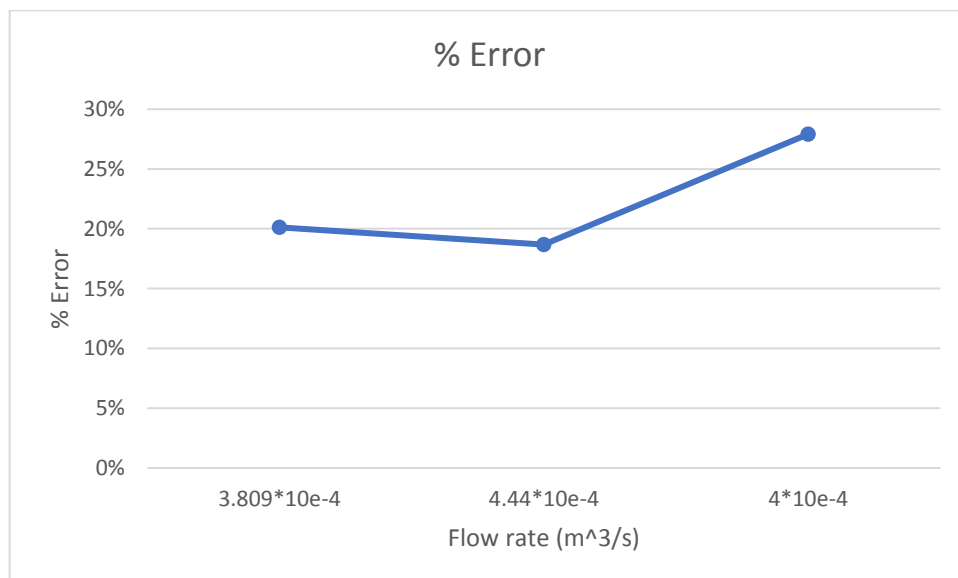
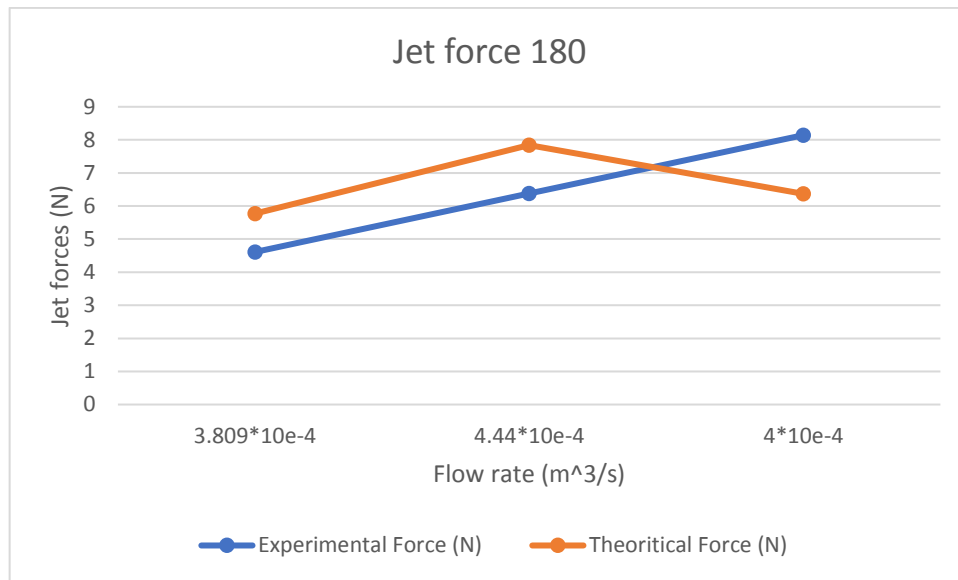
Percent Error = | 0.1868 | $\times 100 = 18.68\%$

- Relative Error = $(8.142 - 6.365) / 6.365 = 0.2791$

Percent Error = | 0.2791 | $\times 100 = 27.91\%$

Table 6: 180 surfaces

Mass (Kg)	Flow rate (m^3/s)	Jet speed V_{jet} (m/s)	Experimental Force (N)	Theoretical Force (N)	% Error
$470 \cdot 10^{-3}$	$3.809 \cdot 10^{-4}$	7.577	4.6107	5.772	20%
$650 \cdot 10^{-3}$	$4.44 \cdot 10^{-4}$	8.83	6.376	7.841	18.68%
$830 \cdot 10^{-3}$	$4 \cdot 10^{-4}$	7.957	8.142	6.365	27.91%





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Sources of errors:

In this experiment we trying to avoid any error in our calculations, so we faced alot of errors that can do it a mistake in our calculations. For example, the errors in this experiment it should be stable and parallel view. Also, the jet should be exact in the center. Moreover, there is a fraction that can do a mistake in all reading. Finally, we should to be carefully while we put the mass.

Conclusion:

At the end, our goal was to decide the stream affecting powers. Besides, by following the methodology, test steps and applying the trials condition that is notice above (hand estimations) it ends up with a conclusive outcome. Moreover, a diagram posted over that are contrasting the F (fly) hypothetical and F exploratory for every volume stream rate. Likewise, a talk was notice up word clarifying the figuring and having tables of blunders.



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References:

[1] Impact of a Jet of Water. (n.d.). Retrieved from

<https://www.scribd.com/doc/48248022/Impact-of-a-Jet-of-Water>.

[2] Hussain, T. (2014, June 3). Experiment no 7-fluid mechanics lab. Retrieved from

<https://www.slideshare.net/TanveerHussain14/experiment-no-7-fluid-mechanics-lab>.