

**Faculty of Engineering and Technology**

**Mechanical Engineering Department**

**Fluid Mechanics laboratory**

**ENME312**

**Experiment #5**

**Impact of Water Jet**

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**Abstract**

A water jet can control flow turbines between the high-velocity jet and the vane. So, in this experiment a jet was used to produce a vertical water flaw into a vane with appropriate set up that can approximate forces. Mass flow rate was calculated by A Hydraulic Bench connected to the apparatus in order to find the experimental values. Also, this bench was our supplier of water.

The **Aim** of this experiment was to find out the efficiency and bitterness of multiple vanes (reflectors) with different reflecting degrees. Efficiency was determined by finding both theoretical and experimental forces of each vane alone while being connected to the system. Afterwards, values of forces at similar flow rates for different vanes are compared and the larger one is preferred.

The experiment revolves about changing the flow rate through the hydraulic bench side valve and trying to find the force the spring needs each equalize the jet force. So, a Jockey weight is put at a variable distance (y) to find the force exerted by it downwards against water. Whereas the force done by water was found through mass flow rate by recording mass and time using the hydraulic bench. Hence, two main **principles** were used in this experiment which are Newton’s 1st Law and Newton’s 2nd Law.

As a **result**, Theoretical and experimental values were found for each vane apart and then plotted on a graph to show which one performs better and can handle bigger pressure done by a certain jet. And Efficiency was calculated.

**Objectives**

To Measure:

* Mass of the pieces put to hold up the water tank and the arm length.
* The time for water to equalize the mass \* arm length.
* The Jockey weight mass and distance from the arm.
* Inner values of the Jockey set-up used to support the vane.

To Analyze:

* How the readings change with the change of flow rate.
* How the time needed to fill the tank changes as flow rate changes.
* Different arm length gives different time reading.
* The efficiency of each vane alone.
* Newton’s laws application and representation.

To Determine:

* Experimental and Theoretical Forces for each vane in each run.
* The Fexp vs Fth graph for each vane(Efficiency).
* The Velocity before and after reflection values.

**Results:**

**For the Flat Plate:**

**Table (1): Values of Time, y, mass flow rate, u, u0, Fth, Fexp, efficiency of Flat Plate**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| run | t (sec) | y (mm) | mexp (kg/s) | u (m/s) | u0 (m/s) | Fth (N) | Fexp | Efficiency |
| 1 | 23.28 | 60 | 0.515463918 | 6.608512 | 6.580992 | 3.392264 | 2.3544 | 0.69405 |
| 2 | 24.56 | 55 | 0.488599349 | 6.264094 | 6.235055 | 3.046444 | 2.1582 | 0.708433 |
| 3 | 25.65 | 50 | 0.467836257 | 5.997901 | 5.967566 | 2.791844 | 1.962 | 0.702761 |
| 4 | 26.28 | 43 | 0.456621005 | 5.854115 | 5.823032 | 2.658919 | 1.68732 | 0.634589 |
| 5 | 29.03 | 36 | 0.413365484 | 5.299557 | 5.265201 | 2.176452 | 1.41264 | 0.649056 |
| 6 | 30.37 | 30 | 0.39512677 | 5.065728 | 5.029774 | 1.987398 | 1.1772 | 0.592332 |
| 7 | 33.4 | 24 | 0.359281437 | 4.606172 | 4.566602 | 1.640695 | 0.94176 | 0.574001 |
| 8 | 39.8 | 15 | 0.301507538 | 3.865481 | 3.818242 | 1.151229 | 0.5886 | 0.51128 |

**Figure (1): Experimental vs Theoretical values of Force on the Flat Plate.**

**Hemispherical Cup:**

**Table (2): Values of Time, y, mass flow rate, u, u0, Fth, Fexp, efficiency of a Hemispherical Cup**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| run | t (sec) | y (mm) | m exp (kg/s) | u (m/s) | u0 (m/s) | F th | F exp | Efficiency |
| 1 | 22.78 | 120 | 0.526777875 | 6.753563 | 6.726636 | 7.101071 | 4.7088 | 0.663111 |
| 2 | 24.97 | 105 | 0.480576692 | 6.16124 | 6.131713 | 5.907707 | 4.1202 | 0.697428 |
| 3 | 26.19 | 90 | 0.458190149 | 5.874233 | 5.843256 | 5.368838 | 3.5316 | 0.657796 |
| 4 | 28.6 | 75 | 0.41958042 | 5.379236 | 5.345392 | 4.499844 | 2.943 | 0.654023 |
| 5 | 30.27 | 60 | 0.396432111 | 5.082463 | 5.046629 | 4.015497 | 2.3544 | 0.586328 |
| 6 | 36.6 | 45 | 0.327868852 | 4.203447 | 4.160048 | 2.742129 | 1.7658 | 0.643952 |
| 7 | 44.47 | 35 | 0.269844839 | 3.459549 | 3.406686 | 1.852818 | 1.3734 | 0.741249 |
| 8 | 58.12 | 20 | 0.206469374 | 2.647043 | 2.57757 | 1.078723 | 0.7848 | 0.727527 |

**Figure (2): Experimental vs Theoretical values of Force on the Hemispherical Cup**

**Discussion of Results:**

**Conclusion:**

As a result, our aims and objectives are met and satisfied. Since we were able to find the forces both theoretically and experimentally for each vane. And the values of efficiency we got were logical and great to be considered **Accepted**. All values are below 80% and we can notice how they change with changing our vane. However, as discussed below some errors may be present, but they did not affect our values so much.

**Applications:**

Application of this experiment are so plenty and various, since efficiency of those vanes play a great role in multiple fluid systems and tools. For example:

* Determining the appropriate vane with the best force to be used in water Pumps.
* Determining the appropriate vane shape to be used in water-electricity Generator, like those used in wells to generate power out of the flow.

Those two applications are very important, since changing only the vane can upgrade your pump/generator efficiency by a great amount, by only changing the angle of reflection and how water leaves the vane.

Not only those, but water jet force is also important to find in many disciplines like in order to determine the force produced by a certain flow.