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**ENGINEERING MECHANICS 341 – FLUID MECHANICS LABORATORY**

**Name of Experiment:** Flow Through an Orifice

**Objective:** To examine vertical flow of water from a reservoir through an orifice and to compare results obtained by two methods with each other and with an accepted empirical value.

**How well do the experimental results agree with theory?**

The last experiment performed by group D was severally flawed. Most measurements were taken by human eye, and more importantly, each trial was run and measured by each individual of group D, yielding a variety of results on each trial. Results of the experiment in tabular form are shown below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **CD (average)** | **Cu \* Cc** | **CD (slope)** | **CD (accepted)** |
| **C values** | 1.10746 | .60801 | .59577 | .596 |
| **% Error** | 85.82 | 2.01 | .04 | 0 |

**Table 1.0**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Scatter Points** | **Slope** | **Bias** |
| **Value** | 10, 12, 14 | Forced to 1/2 | .596e-4 (theoretical)  .5957e-4 (experimental) |
| **Percent Error (%)** | 35%, 35%, 15% | 0 | .04% |

**Table 1.1**

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By observing the data shown tabulated, we can notice a very significant percent error that would not be accepted in almost any engineering experiment, and as any good engineering student would have done, our team decided to re-do the experiment that same day. The data numbers obtained on the second experiment only changed by negligible significant figures. Our CD average calculation yielded a percent error of almost 86. What this tells us is that not only human error was present in this experiment, but faulty equipment also played a big role in the data that our team acquired. Even though the other obtained CD values demonstrate significantly lower percent errors, it still can be observed that our experiment was build upon errors. As always, human error must have been the main reason of our flawed results. First of all, we were not provided with a proper time measuring device (stopwatch), all time measurements were taken by hand. While measuring the height of the water in the tubes, due to poor lighting, most of the team members had a difficulty reading out exact numbers. We also rounded up the numbers most of the time. Faulty equipment was the other major factor that contributed in obtaining such erroneous data numbers. First of all, the hydraulic bench had massive leaks from 2 different sources; the main valve and the bottom hose that recycles the water. It made it dangerous for team members because the floor got really wet and slippery, thus not letting us work as we would’ve liked for safety reasons. Although Dr. Narang (instructor) said it was a steady leak, all of the team members differed from this theory. We observed that the leak increased and decreased for no apparent reason throughout the whole experiment and concluded that it was an immeasurable leak; at least not with the equipment provided and time allotted for the experiment. We also observed that the some of water running down the measuring device splashed outside the hydraulic bench; this was due to the working space, and bench and

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measuring device shapes. This could have contributed to erroneous measurements of time vs. volume. We didn’t only observed water leakage; as the experiment was being performed, our team observed that the water that was flowing back into the measuring tank started to turn yellowish/brownish in color, even members of other teams performing the same experiment in different hydraulic benches noticed it and showed their concern. Our team is not certain if this could have really affected our results, but maybe with dirtier water as time passed by, friction due to contaminating particles in the water could have altered overall results. Finally, the tuning of the device was different for every run because of the faulty mechanism of the turning knob we used to measure the radius of water flow in the experiment. The knob felt like if either it was really new and it was breaking in, or if it was very old and it just didn’t work anymore as a precision measuring device. Our team observed metal debris on the threads of the measuring knob and sometimes it got stuck and wouldn’t turn as easily. These conditions made it tedious to set it up properly for each run. Also the tightening knobs (height and angle adjustment) on the sides did not work at all. Towards the end of the experiment, we also notice that the pipe filled with water for ho measurements started to destabilize. Water started to flow down if we didn’t stabilize it manually by opening the water valve a little bit. Now that we have clearly stated all the factors that may have contributed to acquisition of erroneous data and taking into account that our experiment was severely flawed, I can compare our results with theoretical ones. As previously mentioned a percent error of almost 86 was present for our calculated CD (average) value when compared to that of the accepted theory. The obtained values of Cu and Cc had a significant decrease in percent error compared to that of the CD (average) and compared to the accepted theory; only a 2.01 percent error was found. For our bias and CD (slope) we obtained

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even better results. With a found y-intercept of .59577e-4 the percent error compared to that of the theory was of only .04%. We were satisfied because even though acquired numbers changed just a little bit, if we hadn’t run a second experiment, our values would have been worse. Finally, in our graph with forced slope of 1/2 we found only three scatter points; points 10, 12 and 14, yielding percent errors of 35%, 35% and 15% respectively. We again see that human error and faulty equipment made their presence on these results.

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1. **Are any of your three CD values close to the accepted value? Which of your three CD values do you consider the most accurate? Why?**

Yes, even though our obtained CD values fluctuated throughout the experiment, our CD (slope) value, which was of .59577e-4, was very close to that accepted value of .596e-4. It yielded a percent error of only .04%, making it almost error free. I believe the main reason of why we obtained such a close value to the accepted one, is because we forced the slope of the graph to be ½. If we had used a different slope, one calculated from our data per say, chances are that we would have gotten a significantly different result with an increased error percent. Also, it is important to mention that our CD (average) should have been the closest value to the accepted one because ho remained constant in all runs, plus it was the value that went through most experimentation.

1. **In the absence of head loss, what will be the value of (a) Cu and (b) Cc? Use data from run No. 1.**

From the data obtained on run No. 1 and using equations provided, we calculated a value Cu of .99868 and a value Cc of .57994. Please refer to the orange calculations page for the worked out equations.

1. **The overflow pipe was only available for the high ho runs. How could this have affected the decreasing ho runs?**

Contrary to when ho water levels are being decreased, the overflow pipe actually helps to stabilize ho by providing extra pressure and maintain water levels constant. In the event of having an overflow pipe for all runs it might have helped us to obtain more accurate results, especially towards the end of the experiment.

1. **Was the maximum scatter of your Q vs. ho curve within graphic accuracy? If not, give a logical explanation.**

Our maximum scatter point (graphically) was point #12, which yielded a percent error of 35%. In my opinion, it is within graphical accuracy. Even though the point is offset from the rest, it follows the pattern by going downward and to the left, plus considering all the errors that occurred during the experiment we can assume this point to be within graphical accuracy.