CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

S0315

Project Title

The Effect of Air Pressure vs. Constant Pressure on Water Gun Design

Abstract

Objectives/Goals

This project investigated the difference in water guns with air pressure chambers and elastic pressure chambers. I built an air pressure homemade water gun (APH) and a constant elastic pressure homemade water gun (CPH). I hypothesized that the CPH will deliver more water on a target at 50% of its maximum range because it can stay pressurized longer than the APH, which will quickly lose power before it runs low on water.

Methods/Materials

Both water guns were built from PVC pipe, T couplings, 90-degree elbows, check valves, hose barbs as nozzles, hose tubing, hose clamps, pumps salvaged from squirt syringes and old water guns, and brass ball valves. The CPH pressure chamber used latex tubing, while the APH chamber was 76mm diameter PVC pipe. I used a Digital Manometer, timer, and camera to record data, as well as a 350kPa/50Psi pool pressure gauge for rough pressure estimations. The procedure was to fire each gun at a container at 50% the average maximum range (to hold all the water fired at 50% range or above) while recording time and pressure to create a data curve of how the pressure changed over shot time.

Results

The CPH stayed at close to full pressure for approx. 4.5 seconds, while the APH dropped off quickly, going from 220.63kPa to 103.42kPa after just 2 seconds. The CPH is constantly at a lower pressure (typically starting at 127.76kPa), but it holds that pressure for much longer allowing for more water delivered on target. The APH started with a chamber volume of 850 ml and delivered an average of 427.5 ml, while the CPH started with 750 ml and fired an average of 555ml.

Conclusions/Discussion

My hypothesis that the CPH would stay above 50% range longer than the APH was correct. The APH delivered 50.3% of its water on target while the CPH delivered 74% of its water on target. The CPH is 47% more efficient than the APH. The APH did have better range, but only for about 0.5 seconds and the range advantage was only 1.1 meters.

It surprised me how quickly the APH lost power, and also the power surge at the end of the CPH run. I researched why the CPH didn't deliver all its water at the same pressure and I learned that the elastic force is much more complex than I originally thought. Many factors affect water gun performance, however this project has shown that under the test conditions elastic chamber water guns have a significant advantage over air pressure water guns.

Summary Statement

By measuring pressure over time and water delivered on target, this project shows that under the tested conditions, elastic chamber water guns have an advantage over air pressure water guns.

Help Received

My dad helped with parts ordering, building advice, testing support, and photography. Ben Trettel and many of the people on the sscentral.org and waterwar.net forums, created great threads about water gun construction and performance.