Finding the Optimal Water Fraction for Maximum Launch Height of Compressed-Air Bottle Rockets

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What is the optimal amount of water for the maximum launch height of a compressed-air bottle rocket? A model was calculated to find the maximum velocity rockets would go using equations of adiabatic expansion of air and conservation of kinetic energy and momentum. Compressed-air bottle rockets were launched with 0-2000 mL of water in increments of 200 mL, at least twice each. Then, the flight time and maximum height were measured using videos taken from two locations 100 feet away, and 90 degrees apart. Experimental data were compared to predictions from the model. Because of variations in launch height, trendlines were fitted to the calculated experimental height and flight time data, extracted from videos, to estimate the water level that will give maximum launch height. Any measurement errors and launch height variability were quantified and indicated with error bars. Differences between my model predictions and experimental data were largest at very low and high water levels because of incorrect assumptions in the model. My data supported that the optimal fraction of water to achieve the maximum height of compressed-air bottle rockets is about 910-950 mL of water. Differences between the model and experiment suggested important model improvements related to additional thrust from the air and not just the water.