Rubber Motor Evaluation

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"A twisted rubber band stores energy and can be used to power a model aircraft for example. Investigate the properties of such an energy source and how its power output changes with time."
That is the formulation of problem number 14 that we have been working on for the past few months.

Physics involved

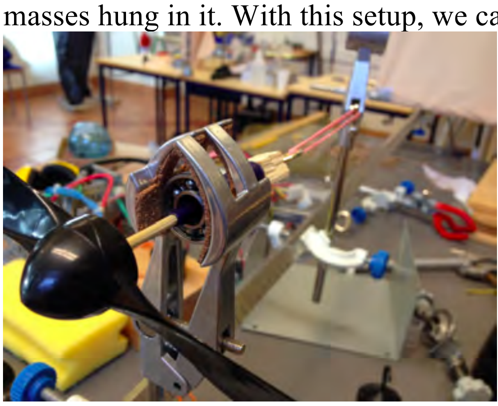
The power is defined as Power = Torque x 2pi x angular velocity, the torque being defined as Torque = radius x force, where the force is perpendicular to the propeller. The angular velocity is defined as Angular velocity = Tangential speed / radius. This means that both angular velocity and torque are related to the tangential speed and static force respectively.

What we've been researching

As the problem states, we have been trying to find out how the energy output of a twisted rubber band changes over time and what factors that affect this. To do this we have examined two things, the static force of the propeller when whined up, and also the velocity of the propeller when released. With these two experiments, we can can calculate the torque and angular velocity, which means that we can calculate the power output.

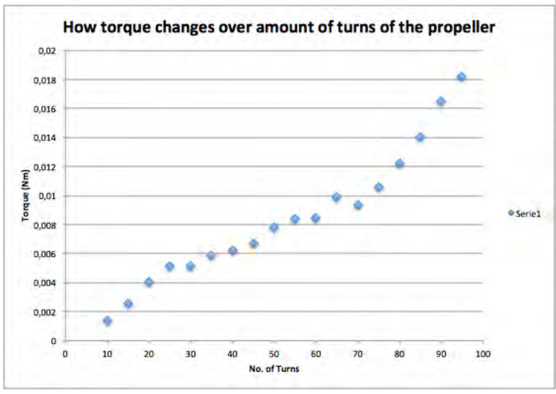
Setup

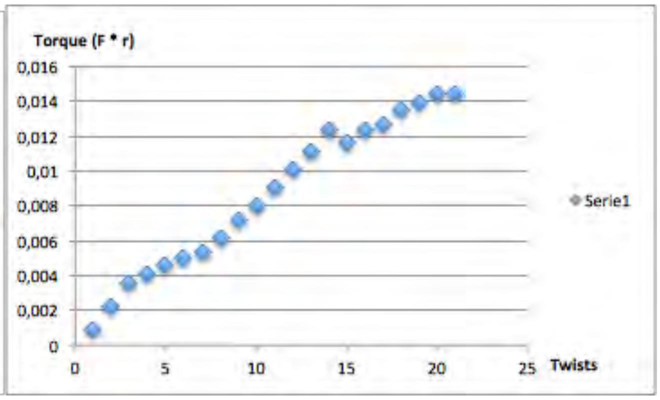
We started out by attaching a propeller to a stick that was placed in ball-bearings to reduce friction. On the blades we drew black dots that we filmed with a high speed camera (480 fps). We used a computer program called Tracker that could track and give us the dots' coordinates that we could use to calculate their velocity. This proved very difficult as the propeller spun so fast that it was almost impossible to find their position. We fixed this by attaching a CD to the propeller. This solved the problem both by slowing down the propeller , as well as providing a flat and less reflective surface to track. We have also measured the force of the twisted rubber band using a digital newtonmeter and the program Logger pro, as well as how stretched a band becomes with masses hung in it. With this setup, we can alter and control different variables.



Conclusions

Our research has concluded that there is a correlation between the velocity of the propeller and the amount of turns the band was twisted, the static pressure and if the band has double or triple coiled, and between the velocity and how much the rubber band has been stretched in relation its original state. An interesting observation that has been made is that, as shown by this graph, the torque "dips" every time the band coils around itself, after which it increases faster than before.

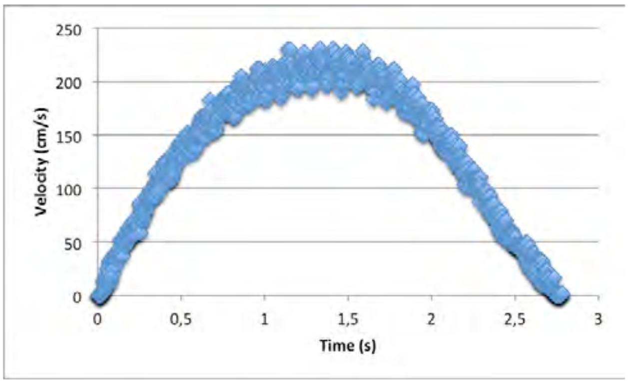




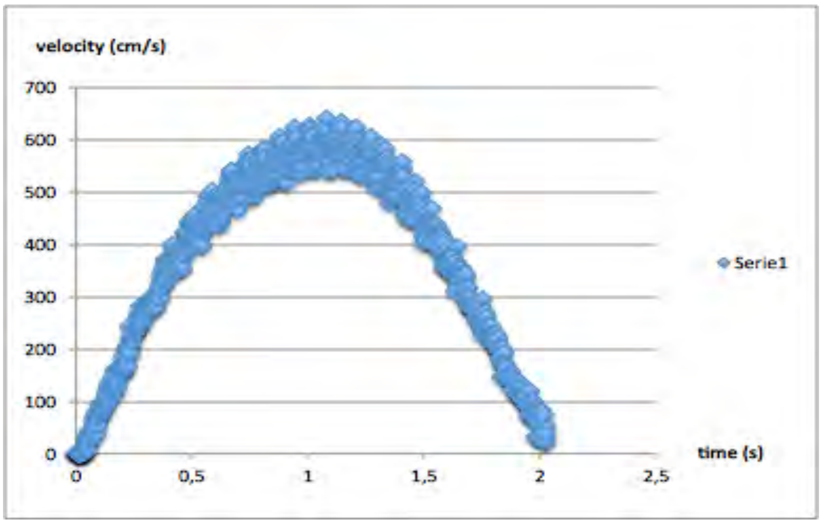
Double twist: 30 turns.
Triple twist: 70 turns

Double twist: 15 turns

We have also seen that the speed of the propeller, and the time of the propeller spinning varied with how much the rubber band was stretched.
In these experiments, the only variable changed was how much the rubber band was stretched.



Rubber band extension: 17 cm



Rubber band extension: 14 cm