Investigating An Anemometer

I decided to investigate anemometers, because I wanted to look at different ways of measuring wind speed. I decided to build two different types of anemometers and test them to see which one was more accurate and which one would work better at different wind speeds. I looked on the internet and decided to look at cup and propeller anemometers.

My first task was to look at how to build a cup anemometer and what is the best way of designing and building it.

1. “The three cup anemometer is recommended; this design has been shown to exert a more uniform torque throughout a revolution. The rate of rotation of the cups is essentially linear over the normal range of measurements, with the linear wind speed being about 2 to 3 times the linear speed of a point on the center of a cup, depending on the dimensions of the cup assembly and the materials from which the sensor is made.”

I chose to build my cup anemometer our of a cork, two metal polls going through the center of the cork and 4 half table tennis balls glued to the end of the two metal rods. I then attached the cork onto a motor, which I would use to measure the amount of volts produced by the cup anemometer. I used a hair dryer to produce the wind, which would turn the cup anemometer. I first tried this just in an open space, however I found that wind from outside the hair dryer was affecting my results and therefore they were not reliable.

I had to design a wind tunnel that would stop any air from the room affecting my results so I built a small tunnel out of cardboard and put it over the end of the hair dryer so that the air would travel straight down the tube towards the cup anemometer. However I couldn’t get the wind to blow over all of the cup anemometer, this was a problem as in out in natural wind all of the sides of the cup anemometer would be affected by the wind, whilst my cup anemometer was only blown on one side. In my experiment there was no wind resistance by the side that was not facing the hair dryer. This meant that the anemometer was rotating faster than it would have in natural wind.

This is a picture of how I set up my propeller project. I then plugged in a voltmeter into the motor that the propeller was attached to and measured the amount of volts given off by the motor as the propeller turned.

This picture shows how I set up the cup anemometer that I built. I recorded my results straight into a laptop to save me time. I varied the wind speed by plugging the hair dryer into a rheostat. This enabled me to change the amount of volts going into the hair dryer, which allowed me to change the wind speed. I did the experiment 3 times, once with the cup anemometer, once with the propeller anemometer and once with the real anemometer.

Wind Speed in
m/s
Cup Anemometer
Volts Output
Propeller Anemometer
Volts Output
2.01
0.114
0.043
2.15
0.233
0.052
2.4
0.348
0.06
2.6
0.462
0.067
2.75
0.548
0.073
2.94
0.63
0.08
3.08
0.7
0.086
3.2
0.765
0.091
3.36
0.836
0.098
3.49
0.9
0.103
3.6
0.96
0.107
3.72
1.024
0.113
3.87
1.074
0.119
3.95
1.145
0.121
4.11
1.198
0.125
4.23
1.251
0.129
4.4
1.294

0.133

2."There are several propeller anemometers which employ lightweight molded plastic or polystyrene foam for the propeller blades to achieve threshold speeds of 0.5 m/s. This type of anemometer may be applied to collecting mean wind speeds for input to models to determine dilution estimates and/or transport estimates. Because of their relatively quick response times, some having distance constants of about one meter, these sensors are also suitable for use in determining the standard deviation of the along-wind-speed fluctuations, u . Care should be taken, however, in selecting a sensor that will provide an optimal combination of such characteristics as durability and sensitivity for the particular application."

I also looked at my project on Picoscope on the computer, which helped me understand what the propeller was doing as it spun around. I produced this picture from the Picoscope. This shows the amount of volts being produced in 1 second. I blew the propeller just as I marked 1 second on the Picoscope.

From the results of the 3 different anemometers I managed to produce this graph on excel. This shows both the cup and the propeller anemometers.

From this graph you can see that the cup anemometer which is in pink produced very little volts from the same amount of wind as the propeller anemometer. You can see from this graph that the cup anemometer has a much straighter line, this means that it is more reliable as there is no deviation in its straightness. However the propeller anemometer did produce many more volts, but was less accurate as its line of results was not straight. It also failed to work as lower wind speeds, whilst the cup anemometer would have continued to work at low wind speeds. The cup anemometer had a very linear line as all the points lie on a straight line that I produced, whilst the propeller anemometer is not very linear as only 2 points lie on the straight line I produced using excel.

When I looked at the propeller anemometer I could see that as the wind speed increased the motor increased its volts much more efficiently.

This graph shows that as the wind speed increased the propeller became much more efficient and started to produce many more volts than it was at the beginning. This means that this propeller anemometer that I made would be far more effective at higher wind speeds.

" There are several mechanisms that can be used to convert the rate of the cup or propeller rotations to an electrical signal suitable for recording and/or processing. The four most commonly used types of transducers are the DC generator, the AC generator, the electrical-contact, and the interrupted light beam. Many DC and AC generator types of transducers in common use have limitations in terms of achieving low thresholds and quick response times. Some DC generator transducers are limited because the combined effect of brush and bearing friction give a threshold speed above 0.5 m/s (above 1.0 mph). However, some anemometers employ miniaturized DC generators which allow thresholds below 0.5 m/s to be achieved. The AC generator transducers eliminate the brush friction, but care must be exercised in the design of the signal conditioning circuitry to avoid spurious oscillations in the output signal that may be produced at low wind speeds. Electrical-contact transducers are used to measure the “run-of-the-wind”;i.e., the amount of air (measured as a distance) passing a fixed point in a given time interval; wind speed is calculated by dividing run-of-the-wind measurements by the time interval"(3)

This extract explains how it is possible to measure a turning object such a propeller. You can do it in a number of ways such as using an LDR (light sensitive resistor) and measure the amount of pulses it gives off. however for my project I looked at using a voltmeter to measure the amount of volts given off, because I found this the easiest way and the most accurate way of getting results without them being too difficult to obtain.

I also investigated different ways of measuring wind speed such as a weather vain that u could put into the wind and measure the change in angle using either a LDR or a strain gauge that could measure the amount of strain being put on the vain by the wind. A wind sock can also be used to see the intensity of the wind, however this is very inaccurate and it is only possible to see if there is no wind or lots of wind. A wind sock can also be used to tell the direction of the wind which is an added advantage.