

Wind turbine speed against distance from hoover



**ASSIGN
BUSTER**

Wind turbines are built to catch the wind's kinetic (motion) energy using airfoils. Different amounts of air can be captured depending on what you vary. From what I know, a blade acts much like an airplane wing. When the wind blows, a pocket of low pressure air forms on the downwind side of the blade. The low-pressure air pocket then pulls the blade toward it, causing the rotor to turn. This is called lift. The force of the lift is actually much stronger than the wind's force against the front side of the blade, which is called drag. The combination of lift and drag causes the rotor to spin like a propeller, and the turning shaft spins a generator to make electricity.

Preliminary Work

The things I need for the experiment are firstly a Hoover that blows air out. This represents the wind. I will need the following to make a small fan. Four cardboard long pieces of paper. All four need to be accurately measured. All need to be the same shape and size and they need to be aerofoil to let air pass through quickly. Whether it is building wind turbines or helicopters, taking the strength, the dynamic behavior, and the fatigue properties of the materials and the entire assembly need to be thought through.

When designing a wind turbine rotor, the angle will depend on the angle of the apparent wind. Lift and drag need to be controlled. The blades should be tilted up slightly for air to pass and also build up pressure like this.

The wind passes over both surfaces of the airfoil shaped blade. It passes more rapidly over the upper side of the airfoil. This creates a lower-pressure area above the airfoil. The pressure between the top and bottom surfaces results in a force, called aerodynamic lift. In an aircraft wing, this force

causes the airfoil to lift the aircraft off the ground. The opposite force is drag which decreases the speed. Wind turbine design of the blade has to have high lift-to-drag ratio. This ratio can be varied by different variables for example the length of the blade needs to optimize with the turbine's energy output at various wind speeds.

The turbines will be made out of cardboard. Cardboard is a nice, light material which is good. A long needle will be needed so the turbines are supported and can rotate easily. I'll also need a stopwatch and a ruler for results. Everything needs to be the same to keep the experiment fair except for the variables I want to use. The variable I'd vary is the distance of the fan to the hoover and the size of all the turbines. I will record the distance of the hoover and the fan and the time on the stopwatch every 30 cycles that will be recorded by the black mark on one of the turbines. Also, I'd record the speed with different turbine sizes. The speed of the air blowing out of the hoover should stay the same and not varied. The variac should stay the same.

This is how I set up the investigation

Variables

There are many different variables that can be affected somehow in this experiment.

1. Speed of air blowing out.

A. Changing the speed of air blowing out will affect the experiment by causing the fan to go faster.

<https://assignbuster.com/wind-turbine-speed-against-distance-from-hoover/>

B. Disturbances in the air between the fan and the hoover.

C. Other breezes or wind could pass through the room and join the blowing air of the hoover causing it to go a little faster

2. Weather.

A. The weather might cause dense air and fan's air pressure to increase causing it to be slow.

3. Distance between hoover and fan.

A. Measuring the distance between the Hoover and the fan with a ruler is a very rough way of measuring.

B. Kinetic energy of moving wind is transferred to Kinetic Energy of rotating fan therefore if the distance is increased, then some kinetic energy will be transferred to the air which doesn't hit the fan.

4. Relative positions of hoover and fan.

A. The position of the turbines needs to be correctly adjusted for great performance.

B. They need to stay in this position for all results otherwise it will be unfair.

C. Positions of both fan and the Hoover need to stay the same.

5. Size of fan blades - bigger area traps more kinetic energy

6. The number of fan blades - more blades intercepts more moving air.

Prediction

I already know that the small fan will turn and because this is true, I want to find out how quickly it rotates and what position it will spin faster. How much air needs to be trapped into the turbines in order for them to move. I think the further away the fan from the air, the faster it will turn because more air coming out of the hoover, the more air will push the turbines to rotate.

If the fan was closer to the fan (in the middle) then the air will move faster but will not spread out. Will the fan rotate?

I believe it will not rotate as fast because the air is going straight into the middle of the fan, not on the turbines.

The further away the fan from the hoover,
the faster the speed of rotation. This keeps
constant until the fan is too far away

As an extra investigation, I will ask the question:-

What will happen if I cut a 1 mm of the turbines? Will it go any faster?

I believe not because the big turbines take more air so it's more likely to rotate faster. Larger blades will trap more of the moving air's kinetic energy.

Method

I set up the experiment (see picture on top page) and tested these ideas to see whether I was right or not. I held my fan a certain distance away from the Hoover. I measured the distance in centimeters.

To record the speed of rotation, I would mark one turbine with a large black felt tip pen. I will wait till the black mark has gone round 30 times and then stop the timer. This then tells me how fast the fan is going.

Initial Experiment - diameter of fan

The first thing to do was to hold the fan in one position. All measurement has to be exactly 15 cm away from the Hoover otherwise the experiment would be unfair. I will next measure each turbine then let it rotate 30 times. I repeated this except I cut 1 mm of each turbine again and again and recorded the results for each mm cut. They should be fixed in the same position as the previous one otherwise its no fair. In the beginning, the turbines were 8mm. I cut them down each mm so went down, 8mm, 7mm, 6mm, etc.

Results

Size of the turbine Speed

8mm 30 cycles / 14 seconds (128 cycles/ min)

7mm 30 cycles / 20 seconds (90 cycles/ min)

6mm 30 cycles / 23 seconds (78 cycles / min)

The results have a pattern. The bigger the turbine, the more air enters into it and faster it goes. The shorter the turbine, the less air gets trapped into the turbines.

Main Experiment - distance of hoover from fan

I tested to see whether the fan would rotate faster if I moved it near or far away from the hoover. I measure it from every 2cm. I recorded how long it took to go through 30 cycles.

Results

Distance from Hoover (cm) Speed in cycles per minute

2 cm barely moved

4 cm Very slow

6 cm 66 seconds / 30 cycles (27 cycles / min)

8 cm 60 seconds / 30 cycles (30 cycles / min)

10 cm 62 seconds / 30 cycles (29 cycles / min)

12 cm 51 seconds / 30 cycles (35 cycles / min)

14 cm 44 seconds / 30 cycles (40 cycles / min)

16 cm 25 seconds / 30 cycles (72 cycles / min)

18 cm too fast too count

20 cm too fast too count

<https://assignbuster.com/wind-turbine-speed-against-distance-from-hoover/>

This proves that the more space there is for all the air from the Hoover to spread) more air will flow in to the turbines causing movement of the air's kinetic energy. Further away the fan is from the Hoover, the more air gets trapped in the turbines. The closest, there is a pressure (between the fan and the Hoover) of the air which is only going into the middle of the fan.

To make sure the results are accurate, I will repeat this experiment using the following changes to the method.

- more turbines will be used on the fan
- They will be positioned on the propeller hub so little KE can pass through each turbine.

Repeated Results

Distance from Hoover (cm) Speed in cycles per minute

2 cm didn't move

4 cm didn't move

6 cm 77 seconds / 30 cycles (23 cycles per minute)

8 cm 58 seconds / 30 cycles (31 cycles per minute)

10 cm 34 seconds / 30 cycles (52 cycles per minute)

12 cm 28 seconds / 30 cycles (64 cycles per minute)

14 cm 31 seconds / 30 cycles (58 cycles / minute)

16 cm too fast

18 cm too fast

20 cm too fast

The repeated results say that the fan still moves faster when the fan is moved away from the Hoover. There are one or two odd results such as 14 cm maybe affected by my lack of counting each time a black dot goes round.

Average of both results

Distance from Hoover (cm) Speed in cycles per minute (cycles per minute)

2 cm no result

4 cm no result

6 cm 25 cycles per minute

8 cm 30.5 cycles per minute

10 cm 40.5 cycles per minute

12 cm 44.5 cycles per minute

14 cm 49 cycles per minute

16 cm 72 cycles per minute

18 cm no result

20 cm no result

Average set of results are very accurate. They are the basic summary results of what I got for both experiments.

Conclusion

The further away the fan is from the hoover, the faster it will go.

The shorter the turbines, the slower it will go.

Looking at the first graph (Distance VS Speed) suggests that at 0 cm it will go 20 cycles per minute.

If I keep going away from the hoover, the fan will eventually go slower because air spreads out of the hoover and moves to a lower concentration. Kinetic energy spreads out over bigger areas. Looking at the second graph, (Distance VS Speed) I can see that longer blades must be worse because longer blades could give more drag and slow the fan down. Also, the end bit of the turbine is weak and flimsy and this could have something to do with it.

.

Evaluation

The results that I got may be inaccurate. This is because I had to rely on the naked eye to tell me how many times a black dot went round. Also, the turbines should be correctly fixed and positioned in the same place. I had to take the turbines off to cut a millimeter of and then put them back on. I had to measure with a ruler, the distance between the fan and the hoover. The distance may have been a little bigger or shorter than normal which won't affect the results terribly but will affect them in some way.

<https://assignbuster.com/wind-turbine-speed-against-distance-from-hoover/>

Looking at the graph of distance between fan & hoover against speed all the number was going down until the 8 mm measurement one. It was going 66, 60 and then 62. The 62 second one might have been affected by my lack of counting.

To improve the reliability of the results:

- Repeating the experiment several times will make the results even more reliable. Then take average of all the results.
- Instead of relying on the naked eye on counting how many times the black dot goes round, I would have to rely on some kind of device or something for that because they're more reliable than the naked eye.
- I would get the blades as aerofoil as possible. They should all be the same shape and height in order for a fair test. The angle of the blades connected to the propeller should be the same.