Fieldlines.com: The Otherpower discussion board

Author — Topic: 'My' VAWT (Vertical Axis) (Read 8012 times)

MechEngShawn

Newbie

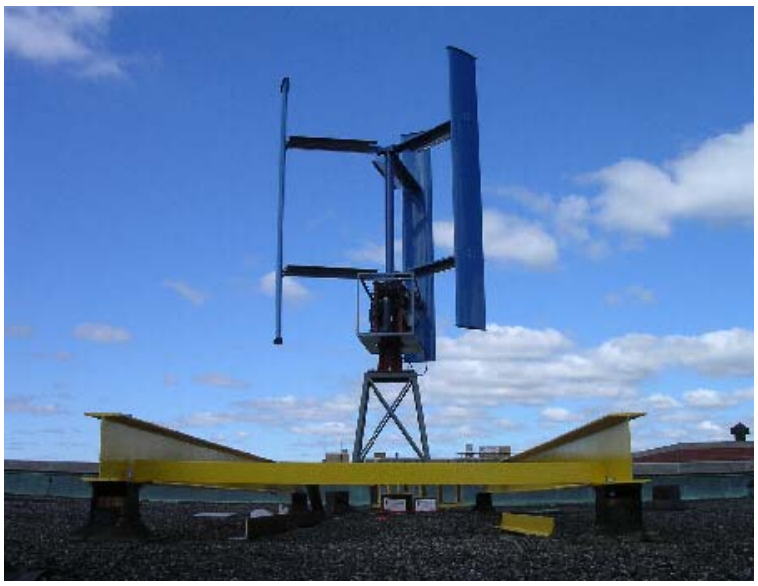
Posts: 8

'My' VAWT (Vertical Axis)

« **on:** September 18, 2006, 07:45:46 PM »

Thought I would share some photos of a demo VAWT for all to see, admire or tear apart!

That Stud standing in front of the turbine is me. I'm not sure which one is more impressive...right...anyway, continuing on...



Another picture of the turbine, just me exercising my camera skills.

Yet another view. This one gives a better perspective of the actual size of the turbine. The blades are 3 m high, approx. 10 ft. The frame its sitting on was designed and construction by myself and Andy, the guy standing behind the turbine near the roof edge. We're both in Mech Eng at McMaster University (Hamilton, Ontario) and this was our summer work.

That's Andy using the centre punch to mark a hole centre in the turbine's brake disc...yes, I said the turbine's brake disc. He's tied himself off to the turbine with a tie-down strap so he doesn't fall (don't show this one to Health & Safety!). He's really only a few feet off the ground, however.

More camera exercise. You'll notice the covers over the struts. The struts were intended to help start the turbine, hence they were triangular in shape, and turned out to do absolutely nothing, except leech power at high speeds due to their high drag. The covers are crude NACA0024 airfoils made of lexan, which significantly reduce the drag at high speeds. I'm currently working on making some much higher quality airfoils to replace the lexan.

Cory & Andy are holding up the turbine here. This is a second demo model we installed on the roof of Cleanfield's rented warehouse space. Cleanfield is the company that is developing the turbines, along with some the engineering expertise from McMaster. This image also shows how the original struts look, note the triangluar profile and cup on the trailing edge.

Here you can see what couples the turbine shaft to the generator (3-ph alternator). You can also see the brake disc & hydraulic servo. The McMaster side of the project is from the coupler up - we deal with aerodynamic, not generators. On our turbine, the blue one, we have a floating caliper on the brake disc that rests against a load cell. This is how we measure torque & power, not via electrical output.

In this picture you can see the start-up motor & belt on the opposite side as the brake servo. Since the turbine won't start itself, we need to give it a kick to get going. A production model would use some power electronics to run the alternator as a motor until startup/lifting begins, usually around 55-60 rpm.

Just another picture of the frame. I was pretty happy when it went together. It was designed & manufactured off the roof, and assembled on the roof top where it had to match an existing hole pattern from an old air conditioning unit.

More of the sexy joints on the frame. I think my heart may have stopped a few times until the whole thing was assembled, in anticipation that there would be some catastrophic misalignment. Thankfully, only one hole was off (thats why assembly holes should always be clearance holes, 'cause things don't assemble the same in real life as they do on paper or the computer screen!). We were able to get that hole aligned due to the clearance on the assembly holes, but it did take a little convincing.

The turbine will produce about 2.5 kW in gale force winds, well, winds around 12 m/s, 43 km/h, 28 mph, and runs about 120-150 rpm under the same conditions. Blades are two fibreglass shells joined at seams along the leading and trailing edges. NACA0012's, but the trailing edge is rounded off, not sharp, which changes the airfoil characteristics a bit. Other than that, lots of steel. The top of the central vertical shaft wanders quite a bit when the turbine is running and the blades do flex, but nothing has blown up...yet.

Check out the company at: www[dot]cleanfieldenergy[dot]com

I'm working on a few HAWT's of my own, but time is limited during the year with classes & the like. I'd love to get some feedback & questions!

Shawn

« Last Edit: September 18, 2006, 07:45:46 PM by (unknown) » Logged

vawtman

Hero Member

Posts: 1425

Re: 'My' VAWT (Vertical Axis)
« **Reply #1 on:** September 18, 2006, 04:09:59 PM »

Has far has studs go the turbine wins sorry.Nice job

What hp motor is that?

Why the need for helper?

Curving the foils will help startup.

Is the need for a brake to maintain speed?

Floating caliper on a disk brake that rests on a load cell to measure measure torque.How?

Ever think of using the axial design for the alt to grab low winds?

Ive found that slight resistance on these lift based turbines really can hamper startup.

Whats the gear ratio?

Thanks and good job

V.....:.)

« *Last Edit: September 18, 2006, 04:09:59 PM by vawtman* » Logged

Ungrounded Lightning Rod

SuperHero Member

Posts: 2727

Re: 'My' VAWT (Vertical Axis)
« **Reply #2 on:** September 18, 2006, 05:11:06 PM »

I understand some people put a small savonius near the hub (or as a "top hat" or "base") to provide a bit of startup torque.

Just build the savonius so the ratios of its diameter to that of the darrius is roughly the ratio of their TSRs and drag shouldn't be a big issue. As a top hat (or base) the savonius will even be generating a power for you at operating speed (though maybe a third to half as effiently as the darrieus, meaning more drag and disturbed air per watt).

It only needs to be tall enough to make enough torque to overcome the bearing friction of the machine. Then the total mill will self-start.

(Or so I hear...)

« *Last Edit: September 18, 2006, 05:11:06 PM by Ungrounded Lightning Rod* » Logged

MechEngShawn

Newbie

Posts: 8

Re: 'My' VAWT (Vertical Axis)
« **Reply #3 on:** September 18, 2006, 06:09:43 PM »

Hi vawtman,

The motor on the 'green' turbine is a 2 HP and operates on 220-240 VAC. However, the motor on the 'blue' machine is only 1 HP and operates on 110-120 VAC. I shouldn't really say VAC because they are DC motors, and we have a DC speed controller that is fed by the main AC power. The motor is only used for starting (since, as you know, VAWT's don't self start), in fact, the pully attached to the motor spindle has a ratchet mechanism so the turbine

won't drive the motor while in operation and hence won't leech power from the turbine. Kind of like the freewheel on a bicycle. Plus we're lazy so we don't feel like spinning it up by hand, which could potentially be hazardous to our limbs.

The brake is our only means of control for the turbine, at the moment, since we aren't drawing any electrical power out of the generator. We do have a short circuit switch for 'Emergency Stops' and a set of three baseboard heaters in case we want to try drawing some electrical power just to see how it performs. But the primary control mechanism is the brake disc. Let me see if I can describe the calliper setup better...

```
    |
+   )C   (Top View)
    |
    L
```

The '+' represents the centre of the disc, the ')' is the outer radius of the disc, 'L' is the load cell, 'C' is the calliper and '|' represents the linear bearing that the calliper slides along. Take rotation to be clockwise about '+'. Our controlling software is calibrated to maintain the turbine at a user-defined operating speed, in RPM, by pulsing the brake at a user-defined duty cycle, in %. Until the brake is applied, C is free to slide along the linear bearing. However, once activated, C clamps onto the disc, rotating clockwise, which pushes it along the bearing until it hits L, the load cell. The load cell is essentially a stop, so once it hits L, C can't travel any farther and the system starts to act like a regular brake slowing the turbine (and taking out energy...). The load cell actually isn't a rigid stop, it deforms a bit under the force of C, an internal strain guage deforms changing its electrical resistance and we can measure that as a change in voltage drop (or rise) across the load cell. That electrical signal can then be converted into a force. Since we can measure the distance the load cell and calliper are from the centre of the circle, we can determine the torque (Dist*Force) generated by the turbine on the brake(or brake on the turbine). Multiply torque by the operating speed (and a few conversion constants) and we get the power being produced/taken out of the turbine.

As for using an axial-type alternator, it was probably never considered. Cleanfield, the company who hopes to produce these turbines, is a spin-off from a generator company, they do generators, motors, etc. Not aerodynamics. Thats where McMaster Univeristy and I come in. Our responsibility is from the generator coupler and up (that will likely include redesign of the coupler too...nightmare in itself). If I'm not mistaken, any generator, axial, radial or something in between, could be configured to perform well under low RPM conditions. The key factor is getting the frequency of magnetic pole alternations higher. This could be accomplished simply by using twice as many magnets with half the width as the original magnets and operating at the same speed ->

```
| N | S | N | S |  original freq = k Hz

|N|S|N|S|N|S|N|S|  new freq = 2k Hz
```

So either spin it faster or change the physical layout/spacing of the poles, whether permanent magnets or otherwise. Of course there are other options/considerations, but you get my point.

The other thing about low winds, which you are probably aware of, is that VAWT's don't like them. Depending on the design, they need a minimum wind speed just to sustain operation, forget about producing power. I'm not sure how far you've gone into their operation, I'm guessing by the name however you may have, but these turbines work in an entirely different aerodynamic manner than HAWT's. There needs to be a sufficient wind to get the velocity triangles oriented correctly so that the blades actually lift in the right direction and with enough force to drive the turbine. Even then, the blades are only lifting during parts of their cycle, and are either stalled or dragging the rest of the time. Most of the force is acually generated radially and does no useful work, but does cyclically load the blades and struts (compression, tension, compression,...) and fatigues the materials.

You're totally right on the resistance, or drag, issue though. Especially bad at high speeds, 'cause its proportional to the speed squared (or was it cubed?). Thats why we put the airfoils on the struts, try and reduce their drag.

Gear ratio: 1:1, bolted straight to the generator!

What did you mean by 'curving the foils to help startup?' Airfoils on the struts or the blades themselves?

Shawn

« *Last Edit: September 18, 2006, 06:09:43 PM by MechEngShawn* » Logged

MechEngShawn

Newbie

Posts: 8

Re: 'My' VAWT (Vertical Axis)

« **Reply #4 on:** September 18, 2006, 06:44:10 PM »

I was wondering if this issue might be brought up.

A savonius, or any other drag-type turbine can only spin as fast as the wind, ie TSR = 1. This is actually never achieved since one cup (for 2-cup savonius, generalize for 3-, 4-,...) is being pushed by the wind on one side, while the other cup is being pushed against the wind. That drag slows the tubine down to something less than the wind speed, TSR < 1.

So make the savonius half the diameter of the main turbine, then its blades will spin at approx 2x the wind speed. Maybe. How much power will it take to overcome the drag of the savonius itself plus the drag of our main turbine (bearings, aerodynamic,...)? So how tall does the savonius need to be? We can't really put it inside the main turbine because it will choke out much needed air flow through the turbine and may not even be high enough. Put it on top and as the central shaft traces a circular path due to forces on the blades of the main turbine (the central shaft tends to wander during operation), the savonius starts a rockin' in a major way. It still could be done however. Perhaps some sort of clutching mechanism would be needed so that

the savonius could drive the main turbine, but the turbine wouldn't drive the savonius. And cables to keep the shaft from wandering.

Another option might be to redesign the struts using spring-loaded airfoils that are open at low wind speeds and close once the turbine begins to lift on its own, essentially operating as drag turbine at low speeds and lift at higher speeds. Thats what I'd like to see, but then there are some issues with mechanical complexity, weather proofing the components, and like any mechanical devices would be succeptible to failure, especially under the cyclic operating conditions of a VAWT.

Large scale commercial HAWT's (and VAWT's) are very much computer controlled, direction, speed, pitch, pretty much everything. Why can't it be done for a small VAWT? Start 'er up when its windy and start harvesting power. That depends how much power the monitoring and control equipment consume, as well as the cost of the monitoring equipment, the turbine itself, plus installation and accessories. At what point does the turbine (any turbine for that matter) stop costing money and start saving it? Maybe never.

Before I get comments on cost not being the deciding factor, I do realize that personal accomplishment, interest, fun, etc., all play a role. The cost is only referring to making this venture economically feasible as a prouction version. I build things for fun just because I can and enjoy it, one reason I like reading the posts from like-minded individuals on this site.

Shawn

« Last Edit: September 18, 2006, 06:44:10 PM by MechEngShawn » Logged

Countryboy
Sr. Member
Posts: 269

Re: 'My' VAWT (Vertical Axis)
« **Reply #5 on:** September 18, 2006, 07:07:53 PM »

You mentioned the turbine has 3 meter tall blades. What is the diameter, and what TSR is it designed for?

Blades are two fibreglass shells joined at seams along the leading and trailing edges. NACA0012's, but the trailing edge is rounded off, not sharp, which changes the airfoil characteristics a bit. *

It doesn't change airfoil characteristics 'a bit'. It changes airfoil characteristics A LOT. Ideally, you want the trailing edge ot be a 20 degree angle, and you want it razor sharp.

***The motor is only used for starting (since, as you know, VAWT's don't self start),**

No, I didn't know. Since when do VAWT's NOT self-start? VAWT's have been used for centuries, and up until now, they have self-started. A Savonious VAWT is known for self starting in virtually no wind. A Darrius VAWT has more trouble self-starting, but you can still get a Darrius to self-start. Ed Lenz of www.windstuffnow.com has had great success with self-starting Darriuses.

I'm not sure how far you've gone into their operation,

Even then, the blades are only lifting during parts of their cycle, and are either stalled or dragging the rest of the time.

I'm not sure how far you have gone into their operation either.

A lift-type VAWT generates lift the full 360 degree rotation, as long as you have a TSR >1. It generates more lift for the 180 degrees the blade is coming into the wind, and less lift when the blade is moving the same direction as the wind - but it still produces lift the entire 360 degrees, because the blades are moving faster than the wind is moving.

A drag type VAWT has a TSR <1, and the blades capture energy for 180 degrees, and the blades fight the wind the other 180 degrees.

Thats why we put the airfoils on the struts, try and reduce their drag.

You put airfoils on the struts to generate LIFT - not to reduce drag.

Wait a minute. Is this VAWT a Savonious or a Darrius? Your pictures show a Darrius, but your posts suggest this is a Savonious.

Does this turbine work by generating lift from the wind, or does it work off drag, by catching the wind?

« *Last Edit: September 18, 2006, 07:07:53 PM by Countryboy* » Logged

MechEngShawn

Newbie

Posts: 8

Re: 'My' VAWT (Vertical Axis)
« **Reply #6 on:** September 18, 2006, 07:49:25 PM »

Allow me to clarify, out turbine is a Darrieus, as in the pictures.

I do realize that a non-sharp trailing edge changes the lift-drag curves sufficently, and if you want to get down to the fluid flow around the profile, that will be different also. However, they still act similarly and under the same principles as other airfoils. Even a flat piece of carboard acts like an airfoil if you hold it at an angle to oncoming wind. It generates lift perpendicular to the airflow and drag parallel to it. The intent was only to comment that they perform differently than an exact NACA0012.

The non-starting comment may have been misleading, so I should have said Darrieus turbines have trouble self starting, not VAWT's in general. The 'you' in my reply was for vawtman, since I assumed by the name he had an interest in them and had probably spent some time reading up on them. I actually like Ed's vawt's, although I believe the particular models I've seen belong to a category called cyclo-turbines where the blade pitch is mechanically varied throughout the rotation, whereas a Darrieus uses fixed blade pitch? Correct me if I'm off on this one.

I strongly suggest you look more into the 'generates lift the full 360 rotation' principle. Depending on the operating speed and wind speed, the blades will actually be in stall for differing segments of the rotation, and hence not produce any lift, or at least a minimal amount compared to the drag. This occurs when the angle of attack, for a static blade, is about 16-18 deg. The dynamic stall characteristics are significantly different though, and since the angle of attack for a Darrieus airfoil is constantly changing, dynamic stall is much more important but we can't really define a narrow range where this occurs, yet.

Please look more carefully at our struts. Blades connected to the struts connected to the central vertical shaft, so we're not confused what I'm calling the struts. We put airfoils, approx NACA0024's, on the struts to reduce their drag at high speeds, not to produce lift. In their original form, they cut up the air pretty well at high speeds and drained a fair bit of useful energy from the turbine.

Hope that clarifies.

« *Last Edit: September 18, 2006, 07:49:25 PM by MechEngShawn* » Logged

elvin1949
Hero Member
Posts: 645

Re: 'My' VAWT (Vertical Axis)
« **Reply #7 on:** September 18, 2006, 08:39:44 PM »

Shawn

Read this,and LOOK at the video.

http://www.fieldlines.com/story/2005/8/31/234656/297

later

elvin

« *Last Edit: September 18, 2006, 08:39:44 PM by elvin1949* » Logged

windstuffnow
Hero Member
Posts: 1065

Re: 'My' VAWT (Vertical Axis)
« **Reply #8 on:** September 18, 2006, 08:40:17 PM »

Very nice work Shawn ! Is it going to be put to work? or is this simply a project for your engineering.

I've always had a soft spot for the darrieus even with their drawbacks. I had built a couple of them before I realized they simply don't like to start. I wrapped a rope around the shaft and started it like a briggs, damn thing scared the heck out of me when it took off. I guess that's my biggest problem with them is the speed they run and the stressing of parts.

The cycloturbine version I built worked very well and was self starting but the mechanism needed to have a feathering device added once it was up and running. It wouldn't reach the speed of the fixed blade. Also, didn't make quite as much power.

I guess I became fixated on the VAWT's, passion or obsession which ever you wish. I simply like the way they look. I really liked the slow moving VAWT's the best overall although they have their own set of problems. Quite fun to say the least. It's probably not really the machine it's the challenge.

Great work again Shawn ! Definately made one beautiful machine !

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« *Last Edit: September 18, 2006, 08:40:17 PM by windstuffnow* » Logged

Windstuff Ed
www.windstuffnow.com

Ungrounded Lightning Rod

SuperHero Member

Posts: 2727

Re: 'My' VAWT (Vertical Axis)

« **Reply #9 on:** September 18, 2006, 09:22:45 PM »

So make the savonius half the diameter of the main turbine, then its blades will spin at approx 2x the wind speed. Maybe.

A savonius (say, the Sandia design rather than the classic offset split-cylinder) runs at a tsr of about .8 Darrieus runs at a TSR of, what, maybe 6?

So make your Savonius about 1/7.5 or 1/8 the diameter of your darrieus and you won't need a clutch. (Or adjust that number if your Darrieus runs at some other TSR.) It will still be driving when the darrieus is up to speed. No clutch required: It won't be producing a net drag until its TSR is near 1. So even if the darrieus pushes it beyond its optimal power-collection speed it will never act as a brake.

As a drag-type turbine, the savonius provides MORE torque at lower TSR, so when the rotor is stopped it will be providing max start torque.

How much power will it take to overcome the drag of the savonius itself plus the drag of our main turbine (bearings, aerodynamic,...)? So how tall does the savonius need to be?

I think that will depend almost entirely on your bearing friction and genny's cogging, and from drag asymmetries if you have an odd number of blades. As I recall an N-blade Darrieus starts having some forward drive as soon as it's moving enough to go through 1/Nth of a rotation. (That's why 3-bladers will self-start if the friction is low enough: The asymmetric drag due to two blades on one side of the mast gets 'em moving enough to start getting drive, if I have this right.) So if the Savonius gets it going at all it should spin it up to speed.

A darrieus has pretty low drag even with one extra blade on the downwind side being driven backward, due to the thinness of the blades and their orientation at right angles to the radius. So it shouldn't take much of a Savonius to do the startup. I'd try making one that ought to break cogging and bearing friction in 80% of the cutin windspeed if it were the only thing on

the shaft and give that a try. If it doesn't do the job at cutin windspeed, make it taller until it does. B-)

We can't really put it inside the main turbine because it will choke out much needed air flow through the turbine and may not even be high enough.

For sure. It would also increase the flexing stresses on the blades by magnifying the windshadow of the central shaft.

But if it needs to be even a fifth the height of the darrieus I'd be shocked, and wonder what you're doing for bearings and what happened to the design of the genny.

(By the way: I'd modify that housing in the bottom-middle of the rotors, especially the blue one - bringing in the corners and replacing the rectangular casing with a cylindrical one, as narrow as possible.)

Put it on top and as the central shaft traces a circular path due to forces on the blades of the main turbine (the central shaft tends to wander during operation), the savonius starts a rockin' in a major way.

"rockin'" won't bother a savonius. It will get a litte more power when moving toward the wind, a little less when moving away. Side-to-side will do nearly zilch - averaging to a slight boost across the various orientations. It's not like a lift-type, where angle-of-attack errors cause stalling, so you can "shake the wind out of" the rotor.

Another option might be to redesign the struts using spring-loaded airfoils that are open at low wind speeds and close once the turbine begins to lift on its own, essentially operating as drag turbine at low speeds and lift at higher speeds.

I wouldn't attempt that. Moving parts and joints are a disaster. (It's bad enough that we have to have the rotor in the first place, and that the blades flex.) Same argument applies to the clutch: Design with the right diameter ratio so you don't need it, making the rotor one solid structure that does its job just by being the right shape.

Large scale commercial HAWT's (and VAWT's) are very much computer controlled, direction, speed, pitch, pretty much everything. Why can't it be done for a small VAWT?

It can be done. But it's a far larger percentage boost in the cost. With a large turbine you have a lot more machinery to build and a lot more power being collected, so the cost of the control is a smaller fraction of the resources. Also, a large one may NEED serious process control to work properly and safely. And a small percentage improvement in efficiency can pay for a LOT of control hardware and programming on a big machine, while on a small machine it's a drop in the bucket. (Just like with fossil fuel plants vs. automobile engines...)

Now perhaps your mill will need the computer and motor control to furl properly, or otherwise to control and/or monitor it. If so, it might not be that much extra expense and effort to make it also funciton as an electric starter. In that case it there's little to be gained by making the rotor self-starting and it makes more sense to use the whole cross-section for the darrieus and K.I.S.S.

Also: Computers are dirt cheap these days, and servo control is getting there, too. Perhaps the cost will not be an issue.

And I'm sure there are other factors I'm not taking into account.

Anyhoo, it's your design and your call. Good luck.

« *Last Edit: September 18, 2006, 09:22:45 PM by Ungrounded Lightning Rod* » Logged

Ungrounded Lightning Rod

SuperHero Member

Posts: 2727

Re: 'My' VAWT (Vertical Axis)

« **Reply #10 on:** September 18, 2006, 09:41:37 PM »

You put airfoils on the struts to generate LIFT - not to reduce drag.

Naw. On the struts (the horizontal supports) the airfoils are just to reduce drag. It's on the blades (the vertical ones on the H-rotor-like darrieus) that the airfoils are providing lift.

« *Last Edit: September 18, 2006, 09:41:37 PM by Ungrounded Lightning Rod* » Logged

Stonebrain

Sr. Member

Posts: 342

Re: 'My' VAWT (Vertical Axis)

« **Reply #11 on:** September 19, 2006, 04:24:45 AM »

Hi,shawn,

Most of what I would say/ask has been mentioned allready.

Just one thing.

I think the bearings at the base of your model have to support great stress

because the length of the shaft.

Wouldn't it be more effectif

- to have a bearing right underneath the rotor,at the top of a pyramidshape tower.

this would also allow to bring the alternator down underneath the path of the

airstream through the rotor.

- to approach the two struts in the center to reduce the length of the shaft.

Just a thought.

Great work.

cheers,

stonebrain

« *Last Edit: September 19, 2006, 04:24:45 AM by Stonebrain* » Logged

MechEngShawn

Newbie

Posts: 8

Re: 'My' VAWT (Vertical Axis)
« **Reply #12 on:** September 19, 2006, 05:42:05 AM »

Hi Ed,

I'd like to start off by saying that I've visited your site several times and I'm always impressed with your work. How do the deep groove bearings offered in your kits perform in comparison to tapered rollers? I know companies like Southwest Wind use them in their AirX 400 and Whisper models.

There are 30 more of these being built for Cleanfield to go up at different locations in and around Hamilton. I should clarify that we didn't actually build the turbine. It pretty much got dropped of for us and they said 'Tell us how it performs, characterize it, and make it work better.' We have added some parts of our own, but the bulk of it was actually manufactured in Romania, but we have no idea by who. On a production model, all the instrumentation and accessories near the base would be gone, leaving only the generator. That will allow better air flow through the bottom quarter of the turbine.

Shawn

« *Last Edit: September 19, 2006, 05:42:05 AM by MechEngShawn* » Logged

MechEngShawn

Newbie

Posts: 8

Re: 'My' VAWT (Vertical Axis)
« **Reply #13 on:** September 19, 2006, 05:54:12 AM »

Hi again Lightning Rod,

We're definitely considering a savonius style rotor on top. Who knows, the extra mass on top may even prevent the shaft from swaying as much as it does now. Interesting you mention cogging. The generator is actually very, very smooth, but there is a moderate amount of bearing friction to overcome. A production model would likely need some sort of computer control anyway too keep the turbine on the stable side of its power curve. Once it jumps over to the unstable side, overspeeding becomes an issue.

As for the big rectangular box at the bottom, its only there to house some electrical instrumentation that isn't waterproof. When the panels aren't on, it doesn't cut out too much wind, but a production version would only have the generator at the bottom, no external motor, no brake disc & servo.

Thanks again!

Shawn

« *Last Edit: September 19, 2006, 05:54:12 AM by MechEngShawn* » Logged

ffoegw
Full Member
Posts: 104

Re: 'My' VAWT (Vertical Axis)
« **Reply #14 on:** September 19, 2006, 07:53:06 AM »

"There needs to be a sufficient wind to get the velocity triangles oriented correctly so that the blades actually lift in the right direction and with enough force to drive the turbine. Even then, the blades are only lifting during parts of their cycle, and are either stalled or dragging the rest of the time. Most of the force is acually generated radially and does no useful work, but does cyclically load the blades and struts (compression, tension, compression,...) and fatigues the materials."

"Even then, the blades are only lifting during parts of their cycle"

1/ To get a better low wind start move the blades further away from the axis.

(It's like the lever principle. The longer the lever the less force but more distance.)

"and are either stalled or dragging the rest of the time."

2/ To help the blades perform more lift throughout the cycle, suspend them.

That way you can get drag working for you in low winds.

(Same as a sail. I have been using bungee cord.)

"Most of the force is acually generated radially and does no useful work, but does cyclically load the blades and struts (compression, tension, compression,...) and fatigues the materials."

3/ With the blades suspended the force although still not in the prefered direction is still always moving the vawt in the required direction. (like a sail boat)

There is less compression and tension because the wind pushes or sucks the blade into a more favorable alignment with the wind than if the blade was fixed.

The fatigue is transfered to the bungee cords being used to suspend the blade

and not the joints. Instead of the energy fatiguing the materials it is turned into kinetic enery in the bungee cord (stored instead of wasted) and more slowly transferred into a pull in the desired direction.

When the vawt starts to speed up the blades will begin to take on a less favorable alignment with the wind due to centrifugal forces throwing them outward on their suspension. This is a good thing in very high winds as it will slow down the vawt.

The blade on my last prototype uses both drag and lift.

Go here:

http://www.fieldlines.com/user/ffoegw/files

run this file:

Ffoeg2fixed.avi

4/ I live in Georgetown, Ontario about 1 hour away from McMaster.

good to see some local interest in vawts.

Geoff

« Last Edit: September 19, 2006, 07:53:06 AM by ffoegw » Logged

vawtman

Hero Member

Posts: 1425

Re: 'My' VAWT (Vertical Axis)
« **Reply #15 on:** September 19, 2006, 12:59:27 PM »

Hello again Shawn

Vawts dont self start Hmmm mine not only self started in the slightest breeze but spun at 3o rpm in 5mph wind.It was 8x8 2blade pics in my files.

Im in the process of adding 2 more blades to help stabilize it and furl it in high winds.2 blades caused vibration at high rpms.

I never had any luck with thin blades the test i did they acted like weathervanes until i got this crazy idea to curve a thicker airfoil.

Im also working on a axial stator 36 slots 12pl. The stator is plastic will post pics just a wave winding so far and need to make rotors yet.Plan on gearing it slightly.

There comes a point where theres no wind to lift and the blades tsr drops good thing.

I wouldnt put airfoils on the rotor.

« *Last Edit: September 19, 2006, 12:59:27 PM by vawtman* » Logged

windstuffnow

Hero Member

Posts: 1065

Re: 'My' VAWT (Vertical Axis)
« **Reply #16 on:** September 19, 2006, 03:10:26 PM »

I think there are pro's and cons to either bearing, I've had good luck with the deep groove bearings... so far. I guess it depends on the application and load.

Out of curiosity, if you happen to know, what is the weight of the main rotor?
I assume your using a tapered roller system on that one, what is the size of the main shaft?

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« *Last Edit: September 19, 2006, 03:10:26 PM by windstuffnow* » Logged

Windstuff Ed
www.windstuffnow.com

makenzie71

Jr. Member

Posts: 59

Re: 'My' VAWT (Vertical Axis)
« **Reply #17 on:** September 19, 2006, 05:08:24 PM »

Floating rotor setups aren't too keen with a horizontal setup. They're intended to be vertical, where gravety pulls them away from their axis, not along it. It's very good for reducing friction as the disc and/or caliper will naturally center and follow "the path of least resistance", and the lack of solid connection between the calipers/rotors and their supporting structures allow for lighter materials. Turn it on it's side, however, and gravity will pull the disc downward constantly, which will inscrease wear on the brake pads (mostly the lower pad) and will increase the braking temperatures during and after operation. The most noticeable effects will be front the disc and caliper binding...which will cause noise, uneven pad wear, and even more heat...and hydrolic "lag" (the rotor will eventually clear it's self from the pads as the hydrolic system bleeds off, but this increases the piston travel, which slows response time).

Giving the application this stuff is likely not a concern...but I believe a solid rotor and fixed caliper would be better.

Spiffy contraption, all the same.

« *Last Edit: September 19, 2006, 05:08:24 PM by makenzie71* » Logged

thefinis

Sr. Member

Posts: 335

Re: 'My' VAWT (Vertical Axis)
« **Reply #18 on:** September 20, 2006, 05:47:12 AM »

Very nice work great way to spend the summer. You should be proud. I am sure you are finding it takes several models/revisions to refine the design

because usually it does not work in real life as well as it does on paper.

How much vibration are you seeing and does the mounting have anyway to dampen it from being transfered to the building? Do you have figures on what it will do in regular winds say 10 to 15 mph? What kind of tsr are you getting out of this?

I have found that round pipe seems to be almost as good an aerodynamic design as most foils for use on wing support arms. If you want to place foils on the support arms why not hinge them with stops and if needed lightly springload/bungee them so that facing the wind they ride up/horizonal but as they start to go with the wind they hang down/vertical. When your turbine is up to speed the foils will always see a facing wind and stay in the up position. It takes very little to start a well designed turbine in winds that are near cutin speed.

"We were able to get that hole aligned due to the clearance on the assembly holes, but it did take a little convincing." That is what they make cutting torches and big hammers for.

"There are 30 more of these being built for Cleanfield to go up at different locations in and around Hamilton. I should clarify that we didn't actually build the turbine. It pretty much got dropped of for us and they said 'Tell us how it performs, characterize it, and make it work better.' "

Hey you play with the toys you can get.

A comment on the power cycle of a vawt. A well designed lift based vawt produces lift on all 360 degrees of the circle if it is traveling above >1 tsr(the more above 1 the better) it is the l/d ratio that changes as it goes around the circle. This normally produces a power curve for each blade that has two peaks and two valleys per rev with at least one of the valleys being in the negative power range.

Finis

« *Last Edit: September 20, 2006, 05:47:12 AM by thefinis* » Logged

ffoegw
Full Member
Posts: 104

Re: 'My' VAWT (Vertical Axis)
« **Reply #19 on:** September 20, 2006, 06:14:02 AM »

Try these videos if the link to my files on this forum doesn't work:

http://s114.photobucket.com/albums/n278/VerticalAxis/VAWT/?action=view&current=Ffoeg2fixed.flv&a
mp;refPage=&imgAnch=imgAnch2

and

http://s114.photobucket.com/albums/n278/VerticalAxis/VAWT/?action=view&current=VAWT.flv

I am building a vawt with fully suspended and adjustable airfoils.

Will post on this forum when complete.

Love your vawts.

Geoff

« *Last Edit: September 20, 2006, 06:14:02 AM by ffoegw* » Logged

vawtman

Hero Member

Posts: 1425

Re: 'My' VAWT (Vertical Axis)
« **Reply #20 on:** September 20, 2006, 04:30:35 PM »

One way to test how good a fixed blade darrius will self start would be to block off one side and see if it holds or backs up.

Just a thought for you Shawn

« *Last Edit: September 20, 2006, 04:30:35 PM by vawtman* » Logged

windstuffnow

Hero Member

Posts: 1065

Re: 'My' VAWT (Vertical Axis)
« **Reply #21 on:** September 20, 2006, 07:15:07 PM »

Vawtman, mine runs with either side blocked... does that count? Although at a much lower output of course.

You know, I'll bet Shawn has access to much better testing equipment than we do on a normal basisis. When I took my 2x2 to WMU for testing in the aeronautical engineering lab, I was simply in awe of the equipment available. I could have spent hours even days there... give me a key to the place and I would be like a pit bull defending his bone. You mount the machine and wire it up, dial it in and watch the performance at different wind speeds. I spent a couple weeks measuring for mounts and wiring for connections before I actually had the opportunity to see everything in action. Unfortunately I could only afford a couple hours of testing. But the experience in itself was worth every penny...

If you get the chance to do it... go for it... you'll never regret it ! If I were younger I would have enrolled just to have another chance at the lab !

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« *Last Edit: September 20, 2006, 07:15:07 PM by windstuffnow* » Logged

Windstuff Ed

www.windstuffnow.com

ffoegw
Full Member
Posts: 104

Re: 'My' VAWT (Vertical Axis)
« **Reply #22 on:** September 21, 2006, 05:09:55 AM »

Mine will also start and run with only one blade however, the performance is not as good.

With one blade it makes it easier to see how it picks up more during certain parts of the cycle. Testing with one blade brings out the faults and or advantages of different designs and setups more readily.

Makes me wonder if I should try for three or maybe four blades?

Has anyone found what the optimum number of blades is?

I suspect it might depend on the distance they are from the center.

Also could having a set of blade at different distances from center be advantageous.

These are all answers that can more easily be had in the lab.

If anyone already knows it could save a lot of time.

Geoff

« Last Edit: September 21, 2006, 05:09:55 AM by ffoegw » Logged

vawtman
Hero Member
Posts: 1425

Re: 'My' VAWT (Vertical Axis)
« **Reply #23 on:** September 21, 2006, 01:13:19 PM »

Hello Ed

What i meant by blocked was that the rotor could not turn.This was meant more for an hbar configuration i guess.If only one side is blocked the machine could backup.

If the machine holds against the brace no matter what the wind its a good starter if it backs up not good.

What did you think i meant?

Your turbine would hold and not backup good thing.

They should let us use all them gizmos for free since we pay for them dont we.

Ill call my buddy George and ask.

« *Last Edit: September 21, 2006, 01:13:19 PM by vawtman* » Logged

wdyasq

Hero Member

Posts: 1324

Prevoius Art

« **Reply #24 on:** September 22, 2006, 03:46:57 AM »

Previous art is a term used in patent work meaning somebody else has done it. Before one tries to invent something new and possibly waste a lot of money, they should at least look at what others might have done.

In a vertical axis wind turbine that means from this:

To looking through the reams of data published by Sandia Labs. Many of the questions asked here were answered with US citizens tax dollars. Many problems were solved, many more still haunt the builders of VAWTs.

Good luck in your adventures,

Ron

« *Last Edit: September 22, 2006, 03:46:57 AM by wdyasq* » Logged

"I like the Honey, but kill the bees"

jmk
Hero Member
Posts: 603

Re: 'My' VAWT (Vertical Axis)
« **Reply #25 on:** September 22, 2006, 05:45:10 PM »

I have seen this picture posted before. I wonder how old it was. Is it still standing today? Did they use it to mill grain, or what? It looks really old. Looks like it worked. I would think it would have worked good. It's a little bit boggling because it looks like its in a dessert.

« *Last Edit: September 22, 2006, 05:45:10 PM by jmk* » Logged

MechEngShawn
Newbie
Posts: 8

Re: 'My' VAWT (Vertical Axis)
« **Reply #26 on:** September 24, 2006, 12:13:01 PM »

Hi Geoff,

From what we've seen so far, and from experiences of others, 3 blades seems to be more favorable over 2 (or 1), and possibly 5 over 4. It has more to do with ballance and vibrations than anything else. 2 or 4 blade models will tend to vibrate more because of the cyclic loading, the power peaks and vibrations peaks are synchronized, kind of like an unballanced washing machine that starts walking across the floor on the spin cycle. The blades on a 3 or 5 blade turbine will contribute vibrations peaks & power peaks out of phase, making for smoother operation.

You probably don't see too many 5 bladers because more blades makes the turbine solidity higher (ratio of solid space to empty space in the swept area, for anyone who may not know what solidity is). That being said, check out this link for a 5-blade water-based Darrieus:

http://www.althydrosolutions.com/

You can get a lower soliditiy turbine with 2 blades, but more vibration.

Less vibration with 3 blades, but higher solidity, but the blades could also be made smaller.

Or turbine has a solidity of 0.3, which is pretty high. We`ve actually made a 2-blade adapter, but haven`t used it for any testing yet. See some of the competing models, quietRevolution and Turby:

http://www.quietrevolution.co.uk/

http://www.turby.nl/ (hit the English link)

Cheers,

Shawn

« *Last Edit: September 24, 2006, 12:13:01 PM by MechEngShawn* »

Logged

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