



INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH & REVIEWS

journal homepage: www.ijmrr.online/index.php/home



More Efficient and Modified Ways of Generation of Renewable Energy System through Wind Energy using Convergent Nozzle

AMARDEEP

MSC PHYSICS, CSIR NET /JRF, Country: INDIA

How to Cite the Article: Ashutosh. (2023). More Efficient and Modified Ways of Generation of Renewable Energy System through Wind Energy using Convergent Nozzle. *International Journal of Multidisciplinary Research & Reviews*, 2(3), 4-8.

Keyword

Wind, power, Nozzle, Plant and energy

Abstract

Wind energy is the renewable source of energy through which we continue found energy. But the general method of power conversion is given efficient amount of energy. So here we try to modify the plant using convergent nozzle to increase the wind concentration on the blade. That maximizes the rotation of the blade and ultimately which increase the power generation capacity of the plant as compare of normal plants.

Introduction:

The renewable energy source is wind energy. Because wind energy has no negative environmental effects, wind energy power systems are non-polluting. A very promising energy source is wind energy. According to estimates, the atmosphere absorbs 2% of the solar radiation that hits its surface as kinetic energy, with the lowest 1000 metres of the atmosphere receiving approximately 30% of this energy. If we can use this energy, a nation's energy needs can be more than satiated. Therefore, a modified plant must use this wind. We are aware that when wind is routed via the little mountain gaps, its speed increases. Therefore, in this case, the convergent nozzle is used to boost the wind speed beneath the nozzle section. After the portion, a wind fan that rotates more frequently than a typical wind fan is set up. The wind energy plant's power output is maximised by the rotation of the fan and its shaft.

Lift and drag are two crucial aerodynamic principles that are applied in turbine operations. Wind can turn a wind turbine's rotor by either lifting the blades (lift) or passing against the blades (passing against) (drag). Turbines can be divided into lift types and drag types based on how the wind interacts with the blades. The drag forces exerted on the rotor are the primary source of power for high speed turbines. Since slower turbines need a larger blade area, their blades are constructed from curved plates. For these turbines, the rotor shaft torque is fairly considerable. Lift forces are used by high speed turbines to move the blades. In order to provide a high lift relative to drag, it works similarly to what happens to the wings of an aerofoil type with a high thickness to chord ratio.

Therefore, increasing the wind speed is important to maximise the lift and drag forces on the blades. The fact that wind energy conversion facilities do not require rotational winds is another important aspect in maximising wind speed.

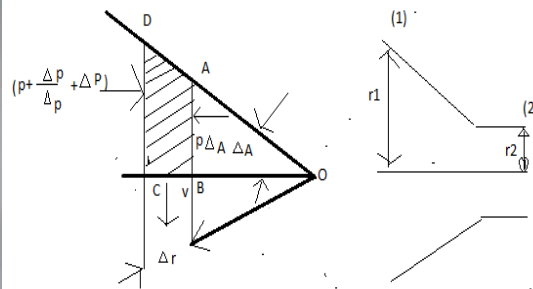


Wind Nozzle Design: A nozzle is a tool used to change the characteristics of a fluid flow, especially to enhance its velocity as it leaves a pipe or chamber. A nozzle is frequently a pipe or tube with a variable cross sectional area that is used to control or direct the flow of air. Nozzles are widely used to control the stream that emerges from them in terms of flow rate, speed, direction, mass, form, and pressure. The fluid's velocity rises in the nozzle at the expense of its pressure energy. Increasing the kinetic energy of the flowing medium often comes at the expense of its pressure and internal energy. Subsonic fluids are accelerated by convergent nozzles. The flow will achieve sonic velocity at the narrowest point if the nozzle pressure ratio is sufficient.

The nozzle is considered to be clogged in this instance. The throat Mach number cannot rise above one even after increasing the nozzle pressure ratio further. Although the flow is allowed to grow to supersonic speeds downstream (i.e. away from the nozzle), Mach 1 can be a very high speed for a hot gas because sound varies as the square root of absolute temperature. This knowledge is often applied in the rocketry industry, where hypersonic flows are necessary and specific propellant combinations are utilised to further boost sonic speed. Fluids that have clogged in the convergent portion can therefore be accelerated to supersonic speeds using convergent nozzles. In comparison to enabling a convergent nozzle to grow supersonically externally, the CD method is more effective. Because any sideways component would not contribute to thrust, the form of the diverging section also assures that the path of the departing gases is directly backwards.



Wind plant model



Nozzle Model

Calculation of Nozzle Velocity: By setting the value of external torque to zero or the time rate of change of angular momentum is moment of momentum must be zero, the relationship between velocity and radius in a free vortex is produced. Consider air particles with mass "m" and tangential velocity V that are located radially away from the axis of rotation.

$$\text{Time rate of change of angular momentum} = \frac{\partial(mVr)}{\partial t}$$

Integrating we get

$$mVr = \text{Constant} \text{ or } Vr = \frac{\text{constant}}{m} = \text{constant} \dots (1)$$

Equation of motion for vortex flow

Consider a wind element ABCD rotating at a uniform velocity in a horizontal plane about an axis perpendicular to the plane of paper and passing through o.

Let r = Radius of the element from O

$\Delta\theta$ = Angle subtended by the element at O

Δr = Radius of the element

ΔA = Area of the cross section of element.

The forces acting on the element are

(a) Presser force, $P \Delta A$, on the face CD .

(b) Presser force, $(P + \partial P / \partial r \Delta r) \Delta A$ on the face CD

(c) Centrifugal forces, $\frac{mV^2}{r}$ acting in the direction away from centre O .

Now, The mass of element = mass density $\times$ Volume = $\rho \times \Delta A \times \Delta r$

Centrifugal forces = $\rho \Delta A \Delta r \frac{V^2}{r}$

Equating the forces in the radial direction, we get

$$(P + \partial P / \partial r \Delta r) \Delta A - P \Delta A = \rho \Delta A \Delta r V^2 / r$$

Cancelling $\Delta r \times \Delta A$ from both side, we get

$$\frac{\partial P}{\partial r} = \rho \frac{V^2}{r} \dots\dots(2)$$

Equating (1) gives the presser variation along the radial direction for a forced or free vortex flow in a horizontal plane. The expression $\frac{\partial P}{\partial r}$ is called presser gradient in the direction. As $\frac{\partial P}{\partial r}$ is positive, hence presser increase with the increase of radius ' r '. The presser ' P ' varies with respect to r .

$$\partial P = \rho \frac{V^2}{r} \partial r \dots\dots\dots(3)$$

Consider two point 1 and 2 in the air having radius r_1 and r_2 from the central axial respectively .

Integrating the above equation from point 1 to 2, we get.

$$\int_1^2 \partial P = \int_1^2 \frac{\rho V^2}{r} dr$$

$$\frac{P_2}{\rho g} + \frac{P_1}{\rho g} = \frac{V_1^2}{2g} + \frac{V_2^2}{2g} \dots\dots\dots(4)$$

Equation (4) is Bernoulli's equation. Hence in case of vortex flow Bernoulli's equation is applicable in the nozzle velocity is increase in the pressure decrease.

Design analysis of Nozzle: The nozzle is crucial in concentrating the wind on the blade. Through it, the tapering angle is a crucial factor in determining the nozzle's output velocity. We looked at different tapering

angles to determine which has the highest constant output velocity. When applied to a nozzle wind turbine with a 38-degree taper angle, the input wind velocity of 5 m/s results in a constant wind speed of 27 m/s. Since the output velocity range is fixed in this case, oscillations are evident. The cone's front end has a 2 m diameter. The diameter of the hollow cylinder's front and rear ends is 0.4 metres, and the length of the cone turbine's tapering section, with a 38-degree tapering angle, is 1.4 metres. A model of duct wind turbine was created and produced using the entire wind turbine arrangement, the frame construction, and the improved nozzle shape of the duct design. The practicality of this entire installation has been examined.

Testing of wind fan with nozzle: The wind fan with nozzle that we created and tested is used in our computation to analyse the relationship between speed (rpm) and wind velocity (m/S). Two tables are given below, the first of which displays the characteristics of the nozzle-augmented wind turbine, where velocity is inversely proportional to rotor speed. The rotor's speed is directly impacted by changes in wind velocity. A set reading is obtained to compare the wind turbine's output velocity and rotor speed.

The table below shows the voltage produced by the wind turbine with nozzles at various rotor speeds. The output power of nozzle-type wind turbines is compared to wind power from open-model turbines. There is a 40% increase in output power in nozzle type relative to open type, which clearly demonstrates the rise in wind power output.

S. No.	Wind velocity in m/s	Speed of rotor in rpm
1	6	223
2	7.3	265
3	8.7	296
4	10.7	350
5	11.2	402
6	12.3	418
7	12.9	342
8	13.3	347
9	14.4	463
10	14.6	466
11	15.7	496
12	17..1	527
13	18.4	563
14	21.4	633
15	24	651
Sl. No.	Rotor speed in rpm	Output voltage
1	223	10
2	265	18

3	296	23
4	350	28
5	402	31
6	418	32
7	342	33
8	347	34
9	463	35
10	466	36
11	496	37
12	527	40
13	563	43
14	633	50
15	651	52

Conclusion: Greater efficiency is provided by the wind turbine with nozzle configuration than by the standard or traditional wind energy producing system. The performance of the nozzle-augmented wind power producing facility demonstrates the improved and enhanced methods of producing a renewable energy system using wind energy.

References

- Er. Narendra Singh (2012) Renewable energy system.
- Domkundwar (2013) Non-Conventional energy resources.
- G. Balaji (2014) Wind power generator using horizontal axis turbine with convergent nozzle.
- Hua (2008) conducted an experimental on duct wind turbine using single convergent nozzle system.