Cfd Analysis Of Dawt Diffuser Using Different Flange Angles To Improve Wind Velocity

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Abstract- *The Diffuser augmented wind turbine is used to enhance the velocity of the natural wind into improved high velocity wind therefore the flanges play a significant role in this process in the current project the flange angle will be considered as 45 degree and 60 degree the symmetrical model is considered to be designed using geometry design modeler in ansys and the remaining discretization and fluid modelling is done in fluent 16 in the end the velocity magnitude is compared with the model of no flange flange with 45 degree Flange with 60 degree.*

The successfully analysed DAWT is more efficient when the anle is set at 45 degrees angle the maximum velocity is reched when compared to the previous studies 15 % significant velocity is observed

Keywords- • Diffuser augmented wind turbine,
• Flange angle of 45 and 60 degree to taken in this project
• The successfully analyzed DAWT is more efficient when the angle is set at 45 degrees angle the maximum velocity is reached when compared to the previous studies 15 % significant velocity is observed

I. INTRODUCTION

A. MECHANICS

Wind control measures how much vitality is accessible in the wind, and it can be spoken to by the accompanying condition {\displaystyle w=(1/2)rAv^{3}} where r is air thickness, An is rotor region, and V is wind speed. This implies the measure of vitality accessible in the wind is specifically corresponding to the wind speed cubed. For instance, accepting that every single other variable are held steady, multiplying the wind speed would expand the accessible vitality in the wind by 8 times.A slight increment in wind speed brings about emotional increments in wind control. Shockingly, this implies if the wind speeds were to back off even somewhat, it would definitely decrease wind control.

B. WIND FOCAL POINT

An outline by Yuji Ohya, an educator at Kyusu University, additionally changed the diffuser by including an expansive ring around the leave gap and a gulf cover at the passage—a "wind focal point". This plan intensifies the beneficial outcomes of an ordinary diffuser cover to bring about a more effective diffuser. The overflowed leave gap makes more grounded vortices than a customary diffuser, which implies that the weight contrast is more prominent than it would be with a typical diffuser. Accordingly, wind can achieve higher rates. What's more, the bay cover at the passage makes it less demanding for air to enter, so air won't be backed off as much going in.

C. MULTI-ROTOR PLAN

Different outlines are fundamentally the same as a diffuser however comprise of numerous rotors inside it to catch as much electrical vitality frame the wind. One approach to create more vitality is increment the rotor zone, which should be possible in two ways. One path is to build the distance across of a solitary rotor, in any case, this causes horrible picks up in mass. Another route is to expand the quantity of rotors per turbine, which does not cause unfortunate increments in weight. Frameworks with up to 45 rotors in a single turbine have been tried, and no negative obstruction has been found between the rotors.

Turbines furnished with a diffuser-formed cover and a wide leave ring produce 2– 5 times more power than exposed wind turbines for any given wind speed or turbine diameterFurther examination infers that as far as possible can be surpass if the wind turbine were to be outfitted with a diffuser. For multi-rotor turbines furnished with a diffuser, the power enlargement is littler, yet at the same time great at around 5%– 9% expansion.

E. CONFINEMENTS OF CUSTOMARY TURBINES

Uncovered wind turbines have a few confinements that abatement their proficiency in producing power. These restrictions assume a major part with regards to large scale manufacturing of vitality.

II. LITERATURE REVIEW

KoganAndSeginer (1963): inferred that the outline is one of the principle elements to acquire a power increase. All things considered, they proposed that the span of the pipe turn into an economically uncompetitive plan. Besides, some genuine stream partition inside the diffuser were portrayed.

Exploratory examinations performed by **Gilbertand Foreman (1983, 1979) and Igra (1981),** demonstrated that power extraction past Betz confine is conceivable. Moreover, DAWT innovation have been considered not productive moderately to regular wind turbines. In this manner, these examinations were not proceeded.

On account of **Igra (1981)** work, the power upgraded of a covered wind turbine is depicted as been as an immediate outcome of the sub-environmental weight made around the rotor and at the exist plane of the diffuser. These sub-environmental weights create one impact of suction that delivers a higher mass stream.

A few most extreme power coefficient esteems were accounted for and diverse systems that representing DAWT enlargement wonders were proposed. The work from de Vries (1979) expressed that DAWT control growth is decided by the power that straightforward diffuser applies on the stream. Besides, one explanatory approach was made, in view of work created by Igra (1981), checking in a greatest power coefficient of 0.7698.

In respect to restored enthusiasm for DAWTs, an expanding number of productions have been discharged and a few endeavors has been made to popularize the thought.

The DAWT outline and execution was improved by **Phillips (2003),** applying CFD techniques, in which the wind turbine was demonstrated as an actuator circle. Likewise a few little scale tests were produced. **Phillips (2003)** inferred that the information of the fullscale DAWT demonstrated just an increase of 2.4 rather than the normal 9, portrayed in different productions.

As of late, agreeing a few creators, a formed diffuser structure including the wind turbine was connected. Besides, the structure incorporates a spine connected at the leave plane of the diffuser.

Wager &Grassmann (2003) built up a covered wind turbine with a wing-profile ring structure. An expansion in control yield by the wing arrangement of 2.0 was acquired. Furthermore, Grassmann et al. (2003) proceed with the work playing out some trial estimations utilizing a non-improved wind turbine. The expansion of energy yield in a factor of 55 % for high wind velocities and 100 % at low wind speed was depicted.

Wang (2008) researched joined disparate scoop impact on the power yield applying on little wind turbine. Results demonstrated that the scoop expands the wind stream speed and improve the power yield 2.2 times in respect to traditional wind turbines. These outcomes likewise demonstrate that power yield can be enhanced at bring down wind speeds.

On Ohya&Karasudani (2010) an astounding increment, in the yield energy of roughly 4-5 times in respect to traditional wind turbine is depicted. This, noteworthy augmentation, is instigated by the low-weight district, that creates a zone of solid vortex arrangement behind the wide overflow that attracts more wind current to the wind turbine inside the diffuser.

Kosasih&Tondelli (2012) performed exploratory investigations of covered miniaturized scale wind turbines. Test estimations of coefficient execution demonstrated an expansion of 60 % what's more of a straightforward funnel shaped diffuser, and 63 % with the expansion of spout - tapered diffuser cover contrasted with the execution standard little wind turbines. Moreover, it's depicted how the diffuser length and overflow stature can influence the execution growth of small scale wind turbines.

As portrayed in **Jafari&Kosasih (2014)** diffuser produces a sub-barometrical district at downwind, which appears to pull in more wind through the rotor in respect to a regular wind turbine. The work from **Van Bussel (2007)** demonstrated that power growth is identified with mass stream enlargement which is performed by increment of the leave territory proportion and decline of back weight.

With present day registering power, more CFD ponders have been performed on DAWT including sharp edge and cover plan.

Applying numerical reproductions and Particle-Image-Velocimetry in wind burrow tests **Kardous (2013)** reasoned that the use of a diffuser with a rib is capable of a wind speed increment rate ran from 64 % to 81 % while diffuser without rib is capable just an expansion rate of 68 %.

Toshimitsu (2008) performed stream speed estimations with flanged diffuser by Particle-Image-Velocimetry. Results demonstrated that turbine edges pivoting impacts stifle the turbulence and the stream division close to the inward diffuser surface. At diffuser downstream some vortices, was reliably discovered, for example, one behind the rib demonstrations suction impact on wind to the diffuser, thus raise the gulf stream speed. Henceforth, diffuser gadget upgrade the wind control in 2.6 times in respect to standard wind turbine.

Aranake (2013, 2014) played out some computational investigation of covered wind turbine setups, and a low proportion between cover sweep to cover harmony length of the diffuser is attractive, this demonstrate the advantage of acquainting cover with a wind turbine is all the more effectively to acknowledge in little wind turbines, where this proportion is practical. Likely checked in past works, the cover can be utilized adequately at low profile in velocities and offers enhance the vitality catch. Expansion proportion of up to 1.9 with the presentation of a cover was acquired.

Agreeing with Mansour &Meskinkhoda (2014), CFD count was performed, applying two diverse turbulence models for stream field around flanged diffuser. To put it plainly, an exceptional increment in wind speed of 1.6-2.1 times higher contrasted with little wind turbine was depicted. Besides, the turbulence models exhibit the ability of giving sensible forecasts to complex turbulent streams.

As beforehand specified the utilization of a diffuser initiates stream partition, by and by as observed in past work process detachment can be smothered. Broad work from Gilbert and Foreman (1979) were made. The whirling stream delivered by the rotor defers stream division inside the diffuser was finished up because of an energy exchange to the limit layer.

Abe &Ohya (2004), Ohya&Karasudani (2010) have played out a broad test and numerical work that prompt the advancement of one elite flanged diffuser connected on little wind turbines. The weight in the wake downstream of the diffuser including a rib around the trailing edge of the diffuser, making the stream independent and make a vast low weight locale downstream of the diffuser making a suction impact through the diffuser was created.

Concurring with **Shives and Crawford (2010)** the stream division of the limit layer in diffuser areas prompts huge loses in execution of DAWT. In any case, the base weight impact gives an impressive improvement.

Takahashi (2012) took a shot at advancement of Wind-Lens turbine. The prompted vortex framed, most likely by sharp edge tip vortex inside the limit layer of the inward surface of the diffuser, stifles the stream detachment from the internal diffuser surface. As result gathering and speeding up of the wind is increased.

Jafari&Kosasih (2014) detailed that stream partition in diffuser may prompt decreases on general power coefficient. This wonder can be moderated by adjusting the length of the diffuser.

Another adaptation of the great Betz constrain has been proposed by Jamieson (2008), which depict that the most extreme power extricated from a wind turbine with expansion is 0.89 of the accessible power.

As of late, a few techniques to investigate the DAWT have been proposed**. Vaz et al. (2014)** proposed inventive 1D numerical model way to deal with the investigation of DAWT utilizing Blade Element Momentum show. Carroll (2014) makes one comparable technique to the way sharp edge component force hypothesis for a speedy examination device for DAWT utilizing an axisymmetric surface vorticity strategy. Plainly these preparatory examinations require approval thinks about.

III. METHODOLOGY

A. INTRODUCTION OF CFD

Computational Fluid Dynamics (CFD) has developed from a scientific interest to end up plainly a fundamental device in practically every branch of liquid flow, from aviation impetus to climate expectation. CFD is normally acknowledged as alluding to the wide point incorporating the numerical arrangement, by computational techniques. These representing conditions, which depict liquid stream, are the arrangement of Navier-Stokes condition, congruity condition and any extra source terms, for instance, permeable medium or electric body drive.

Since the approach of the computerized PC, CFD, as a creating science, has gotten broad consideration all through the universal group. The fascination of the subject is twofold. Right off the bat, there is the want to have the capacity to demonstrate physical liquid wonders that can't be effortlessly reenacted or measured with a physical analysis, for instance, climate frameworks. Besides, there is want to have the capacity to research physical liquid frameworks more cost viably and more quickly than with trial strategies.

Conventional confinements in stream examination and configuration restrict the exactness in fathoming and representation of the liquid stream issues. This applies to both single and multi-stage streams, and is especially valid for issues that are three dimensional in nature and include turbulence, extra source terms, or potentially warmth and mass exchange. All these can be viewed as together in the use of CFD, a capable procedure that can beat numerous limitations intrinsic in customary examination.

CFD is a strategy for understanding complex liquid stream and warmth exchange issues on a PC. CFD permits the investigation of issues that are excessively troublesome, making it impossible to tackle utilizing established strategies. The stream inside the ESP is mind boggling and this can be broke down utilizing CFD apparatus, which gives a knowledge into the perplexing stream conduct.

The CFD analysis setup goes by the following process

1) To design the geometry of the project u need to be solved the designing can be done using an external source or using the ansys design modeler.
2) The unique way of solving a computational; problem is to extract and design the fluid volume with the inlet outlet and the wall of the diffuser.
3) Secondly the meshing part is very important in the fluid modelling mesh is the concept were we discretize the single fluid volume in to finite set of control volumes to ensure that the flow is as realistic as possible.
4) Thirdly the setup will come here we have to define type of flow type of solver boundalry conditions and calculation entities in theis case k_epsilon and the steady state solver as boundary conditions given below.

B. **BOUNDARY CONDITIONS**

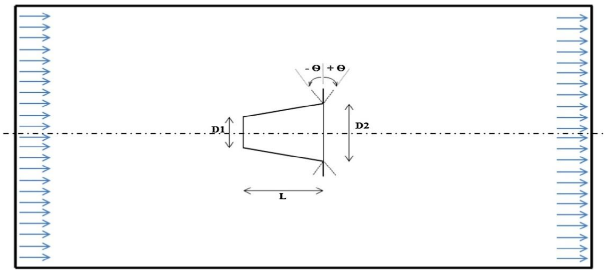


FIG 1: THE DIFFUSER MODEL TO BE DESIGNED IN ANSYS

The above fig represents the project schematic of the problem statement when the inlet velocity is considered to be 5 m/s

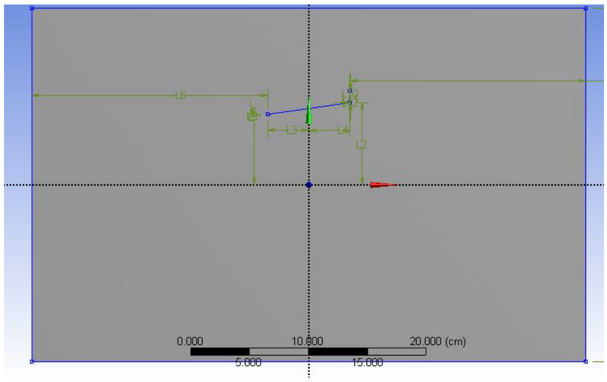
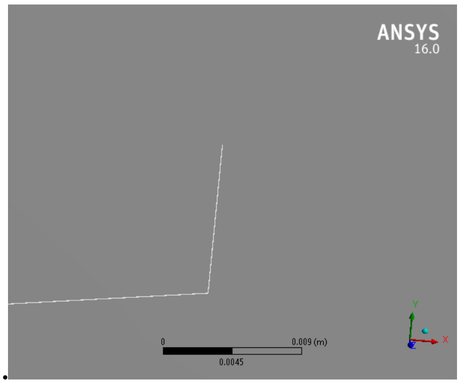


FIG 2: THE ABOVE FIG REPRESENTS THE GEOMETRY MODELED IN THE DESIGN MODELER



IV. RESULT AND DISCUSSION

A. INTRODUCTION

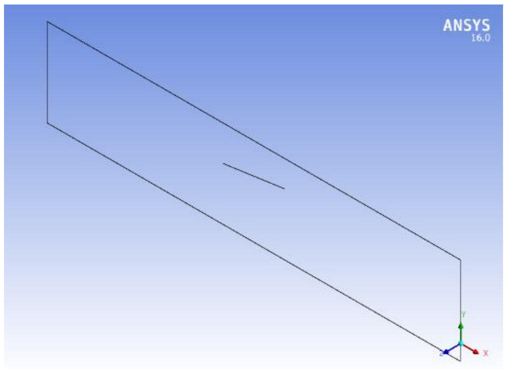


FIGURE 3 : ISO VIEW OF WIREFRAME

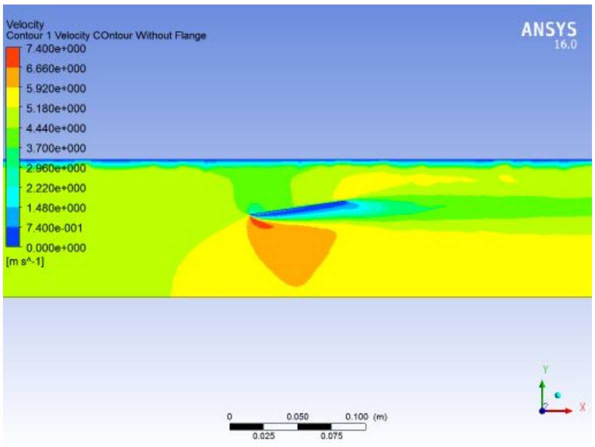


Fig 4 Contour 1 velocity contour without flange

The above Figure represents the Velocity variable contour a contour is a bandwidth and intensity of Colours represented and understand in a minimum to maximum way left side of the figure is the bar known as legend which represents the colors from blue to red where blue colored area represents the minim Velocity region and red colour represents the maximum Velocity area and the colurs between them are intermediate Velocity regions

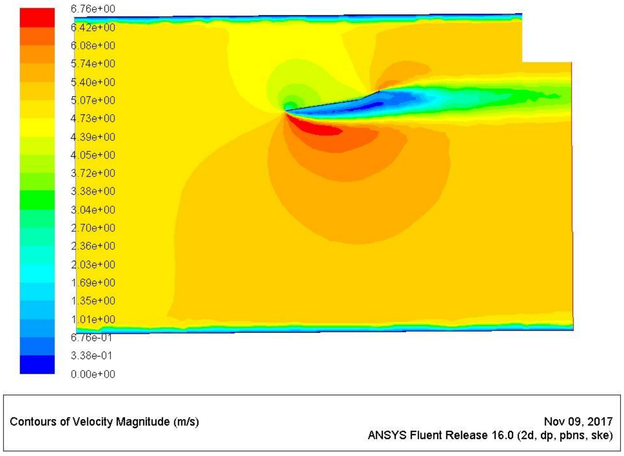
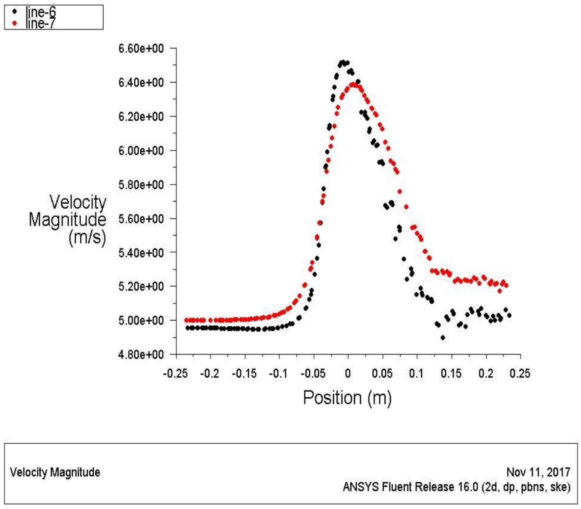


Fig 5 Contour 1 velocity contour with 15 degree flange

The above Figure represents the Velocity variable contour a contour is a bandwidth and intensity of Colours represented and understand in a minimum to maximum way left side of the figure is the bar known as legend which represents the colors from blue to red where blue colored area represents the minim Velocity region and red colour represents the maximum Velocity area and the colurs between them are intermediate Velocity regions

__**Validation of Base paper results**__



The above graph represents the Base paper result with15 degree flange and the current analysis results with 15 degree flanges

- The exit velocity of air in the case of 15 degree with inlet velocity 5 m/s as in vbase paper is 6.40m/s as shown in graph (red line)
- The exit velocity of air in case 15 deree with the inlet velocity 4.95 m/s is 6.45 m/s as shown in graph (black line)

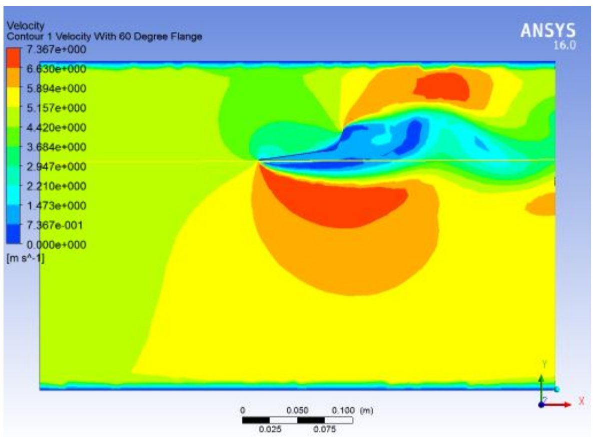


Fig 7 Velocity contour with 60 degree flange

The above Figure represents the Velocity variable contour a contour is a bandwidth and intensity of Colours represented and understand in a minimum to maximum way left side of the figure is the bar known as legend which represents the colors from blue to red where blue colored area represents the minim Velocity region and red colour represents the maximum Velocity area and the colurs between them are intermediate Velocity regions

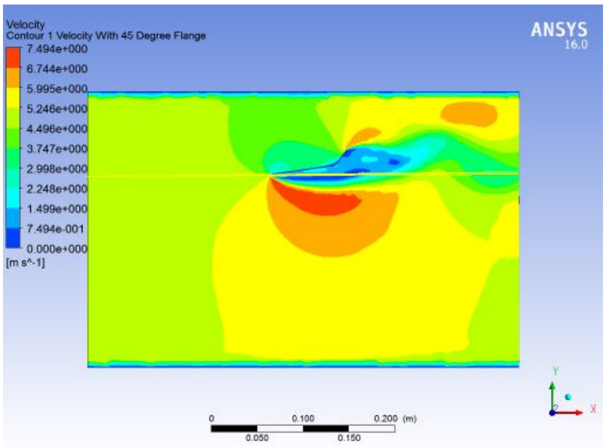


Fig 6 Velocity contour with 45 degree flange

The above Figure represents the Velocity variable contour a contour is a bandwidth and intensity of Colours represented and understand in a minimum to maximum way left side of the figure is the bar known as legend which represents the colors from blue to red where blue colored area represents the minim Velocity region and red colour represents the maximum Velocity area and the colurs between them are intermediate Velocity regions

V. CONCLUSION

The present numerical study using FLUENT package shows the flow characteristics inside diffuser model and around it for different flange angles, where the flowing conclusions are obtained:

1. The angle of the flange is considered to be 45 and 60 where as the substantial increase of the Velocity may see in the 45 degree angle .
2. The comparisions have been made

CASE 1:-<u>SHROUD DIFFUSER WITHOUT FLANGE ANGLE</u>

In this case the behaviour of the graph wavy due to wind velocity and diffuser structured the end velocity at the time of diffuser exit is 5.85 m/s when we consider in velocity is as 5m/s.(green line)

CASE 2:-<u>SHROUD DIFFUSER WITH 15 DEGREE FLANGE ANGLE</u>

In this case the behaviour of the graph is wavy due to wind velocity and diffuser structureand the end velocity at the time of diffuser at 15 degree flange exit is 6.40 m/s 9(blue line) when we considered in velocity as 5 m/s

CASE 3:- <u>SHROUD DIFFUSER WITH 45 DEGREE FLANGE ANGLE</u>

In this case case the behaviour of the graph is wavy due to wind velocity and diffuser structureand the end velocity at the time of diffuser at 15 degree flange exit is 7.20 m/s(black line) when we considered in velocity as 5 m/s

CASE 4:- <u>SHROUD DIFFUSER WITH 60 DEGREE FLANGE ANGLE</u>

In this case case the behaviour of the graph is wavy due to wind velocity and diffuser structureand the end velocity at the time of diffuser at 15 degree flange exit is 7 m/s(red line) when we considered in velocity as 5 m/s

REFERENCES

[1] Ackermann, T.; and Soder, L. (2002) A diagram of wind vitality status, Renewable and Sustainable Energy Reviews, 6(1-2), 67– 127.
[2] Frankovoc, B.; and Vrsalovic, I. (2001) New high gainful wind turbines, Renewable Energy, 24(3-4), 491-499.
[3] Ueno, H.; and Serada, T. (2002) Wind turbine age framework and photovoltaic power age framework. NTT Power Build Facil J, 39(231), 42-45.
[4] Van Bussel, G.J.W. (2007). The Science of making more torque from wind: diffuser examinations and hypothesis returned to. Diary of Physics: ConferenceSeries,75,1-12.
[5] Bet, F.; and Grassmann, H. (2003). Redesigning regular wind turbines. Sustainable power source, 28(1), 71-78.
[6] Abe, K.- I.; and Ohya, Y. (2004) An examination of stream fields around flanged diffusers utilizing CFD. Diary of Wind Engineering and IndustrialAerodynamics, 92(3-4), 315-330.
[7] Chen, T.Y.; Liao, Y.T.; and Cheng, C.C. (2012) Development of little wind turbines for moving vehicles: Effects of flanged diffusers on rotor execution. Test Thermal and Fluid Science, 42, 136-142.
[8] Abe, K.; Nishida, M.; Sakurai, An.; Ohya, Y.; Kihara, H.; Wada, E.; and Sato, K. (2005) Experimental and numerical examinations of stream fields behind a little wind turbine with a flanged diffuser. Diary of Wind Engineering andIndustrial Aerodynamics, 93(12), 951–970.
[9] Ohya, Y.; Karasudani, T.; Sakurai, An.; Abe, K.- I.; and Inoue, M. (2008). Advancement of a covered wind turbine with a flanged diffuser. Diary ofWind Engineering and Industrial Aerodynamics, 96(5), 524-539.

[10] Wang, F.; Bai, L.; Fletcher, J.; Whiteford, J; and Cullen, D. (2008). The strategy for streamlined investigation on a little local wind turbine with scoop. Diary of Wind Engineering and Industrial Aerodynamics, 96(1),1-24.
[11] Gardan, D.L.F.; and Bibeah, E.L. (2010). A numerical examination concerning the impact of diffusers on the execution of hydro motor turbines utilizing an approved force source turbine show. Sustainable power source, 35(6),1152-1158.