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Assessment wind field in the region of Annaba East Algeria with an aerodynamic analysis for installation a small wind turbines

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1. Introduction

Renewable energy is abundant and its technologies are well-established to provide complete security of energy supply. To get a clear assessment of the wind power potential in Algeria, it is necessary to make long meteorological observations in the area. However, wind as a source of energy is not sufficient to provide continuous electricity because even in the best location wind is variable. If there is no wind blowing no energy can be generated. So, the amount of power that can be harvested from the wind will depend on wind frequency and wind direction (since wind turbines are most efficient when facing into the wind). In recent years the Weibull distribution has been one of the most widely used and recommended tool to determine the potential of wind energy. Moreover, it is used as a benchmark to estimate the wind energy commercially viable. In this study, the methodology that we implement for the calculation of wind power parameters was based on the study of meteorology over 10 years with a daily rate. At first glance weather given by power and direction of wind “Algeria airport” has a good coverage of observations over the territory, the regions concerned in this study named: Annaba is situated in east coast of Algeria. In order to find a suitable location it is necessary to know spatial distribution of wind, for this reason and for improved allocation data, frequencies of wind direction are presented in this work by a rose compass.

2. Wind speed modeling

The main objective of the analysis of wind data is a clearer knowledge of the temporal and spatial variation.

Temporal variation includes:

- low frequency (annual variations, seasonal, monthly);
- medium frequency (changes daily, hourly);
- high frequency (changes to the second or higher frequency above 1 Hz);
- typical of wind turbulence.

2.1. Temporal variability and Numerical methods for estimating Weibull parameters

- The Weibull distribution “Graphical method”

The results obtained by a several authors [1, 2-3] has shown that the wind speed is a random variable and to determine the wind potential of a region it is necessary to use statistical analysis.

In paper [4] has shown they require the existence of time series records of wind speed. Such records are the wind data. Based on the wind speed data collected, the Weibull distribution can be described as a probability density function and a cumulative distribution function, determined by the following equation:

$$f(V)=\frac{k}{c}\left(\frac{V}{c}\right)^{k-1} exp\left[-\left(\frac{V}{c}\right)^{k}\right], \tag{1}$$

$$F(V)=\int_{0}^{+\infty} f(V)dV=1-exp\left[-\left(\frac{V}{c}\right)^{k}\right], \tag{2}$$

where V is the observing wind speed parameter, m/s; k is the dimensionless Weibull shape parameter and c is the Weibull scale parameter, m/s. The k values range from 1.5 to 3.0 for most wind conditions. The Rayleigh distribution is a special case of the Weibull distribution in which the shape parameter is 2.0.

The graphical method is achieved through the cumulative distribution function. In this distribution method, the wind speed data are interpolated by a straight line, using the concept of least squares. The equation for this method can be represented by a double logarithmic transformation as follows:

$$ln\{-ln[1-F(V)]\}=k\,ln(V)-k\,ln(c). \tag{3}$$

The two significant parameters k and c are closely related to the mean value of the wind speed:

$$\overline{V}=c\Gamma\left(1+\frac{1}{k}\right), \tag{4}$$

where Γ is the gamma function.

- Maximum likelihood method

The maximum likelihood estimation method is difficult to solve, since numerical iterations are needed to deter-mine the parameters of the Weibull distribution. A many researchers have used this way [5]. In this method, the parameters k and c are determined according to the equations below:

$$k = n\left[\frac{\sum_{i=1}^{n} V_i^k \, ln(V_i)}{\sum_{i=1}^{n} V_i^k}\right], \tag{5}$$

$$c = \left[\frac{1}{n}\sum_{i=1}^{n} V_i^k\right]^{\frac{1}{k}}, \tag{6}$$

where n is the number of observations performed and V_i is the wind speed measured at the interval i.

- Moment method

The moment method can be used as an alternative to the maximum likelihood method is used by [6]; in this case, the parameters k and c are determined by the following equations:

$$c = \frac{\overline{V}}{\Gamma\left(1+\frac{1}{k}\right)}, \tag{7}$$

$$\delta = c\left[\Gamma\left(1+\frac{2}{k}\right) - \Gamma^2\left(1+\frac{1}{k}\right)\right]^{1/2}, \tag{8}$$

where $\overline{V}$ and δ are the mean wind speed and the standard deviation of the observed data of the wind speed, respectively.

- Empirical method

The empirical method is considered a special case of the moment method, where the Weibull parameters k and c are given by the equations shown below:

$$k = \left(\frac{\sigma}{V}\right)^{-1.086}. \tag{9}$$

The scale parameter c is given by Eq. (7).

3. Special variability

3.1. Vertical wind speed variation

The topographic study over the years "1995-2005" has given practical information on meteorological conditions and specific wind condition of various cities of Algeria; we are interested only in this work on Algerian regions such as "Annaba, east Algeria. There are several systems for measuring and recording the speed and direction of wind. According to international standards, the wind measurements at a height of 10 meters above the ground and its average speed every 10 minutes were recorded. In addition to the average speed and wind direction. Fig. 1 shows the curve of the average speed detected in the area Annaba wind; it appears almost constant over the 11 years and varied between 3.5 and 4 m/s. Very often, measures wind speeds are taken at a different height at which wind turbines are installed.

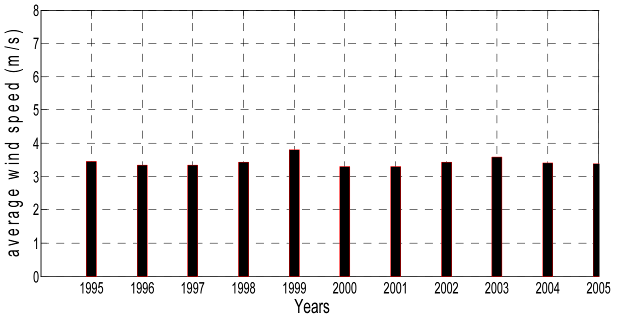


Fig. 1 The average speed detected in the area Annaba East Algeria wind

It is therefore necessary to determine a relationship between wind speeds varying heights, the formula expressing the speed gradient is logarithmic but normally approached by a potential form:

$$V_2 = V_1\left(\frac{z_2}{z_1}\right)^{\alpha}. \tag{10}$$

The wind profile indicates the average wind speed based on the height z_2 above the ground. V_1 is the reference speed at the height z_1, and α is the empirical parameter of the law potential. This parameter varies on the same site 1/7 during days and 1/2 during the night, it takes the value of 0.2 according IEC 2005 61400 [6-7].

3.2. Wind direction

Wind roses are circular, graphical displays of wind speed, direction, and frequency based on a simple compass rose. Wind direction is shown by the length of a line representing a number of wind collection events. The length of the line from the outer circle to the center of the rose shows the percentage of total wind measurements where the wind blows from that compass direction – incorporating both frequency and direction data. Wind speeds are shown using a number of different techniques. Indeed, during the wind turbines installation on a site, it is necessary to know where the principal directions of the wind in order to limit the negative interaction between several wind and obstacles. Therefore, the wind roses give more information.

4. Results and discussion

4.1. Parameters Weibull results

Fig. 1 show the Weilbull distribution, described by its probability function, versus the mean wind speed, for data collected on an annual basis from 1995 to 2005, for the city of Annaba - Algeria, based on parameters calculated using the Weibull methods presented in previous section. The annual parameters Weibull k and c as well as the standard deviation data observed in the city over 10 years are shown in the Table 1.

Furthermore, it is possible to verify how the curves representing the yearly Weibull probability density function, city Annaba .The probability density distribution shape develops the real data set around the average speed for small values of k distribution is wide, however, the data distribution is very narrow for large values of k. Fig. 2 shows the shape of the probability distribution function regions during the 10 years (1995-2005), the shape factor in this case varies between 1 and 2; this is why there is a little wide distribution data around the average wind speed, which is between 1 and 3.5 m/s.

Table 1

Values of the coefficients *k* and *c*

	Years	*k*	*c*
Annaba station	1995	1.63	3.91
	1996	1.82	3.78
	1997	1.82	3.79
	1998	1.84	3.87
	1999	1.94	4.31
	2000	1.81	3.73
	2001	1.59	3.72
	2002	1.63	3.87
	2003	1.66	4.04
	2004	1.84	3.86
	2005	1.85	3.82
	11 years	1.63	3.89

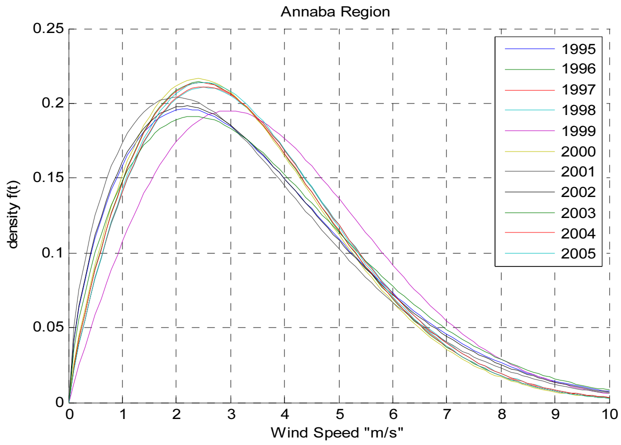


Fig. 2 Weibull probability density of Annaba Region

4.2. Compasses rose results

To improved knowledge idea of the wind speed distribution and directions, rose compasses were studied from meteorological data to the region mentioned previously. Compass rose of Annaba region (Fig. 3) shows that wind directions are distributed on an almost similar in all regions and with equal percentages (Fig. 4), however the wind almost neglected in the direction north-west and south-east, with a calm wind 20.3% in south – south. The winds are the most frequent wind speeds between 1 and 6 m/s (55.4% Occurrences), these winds are 30% of the south side.

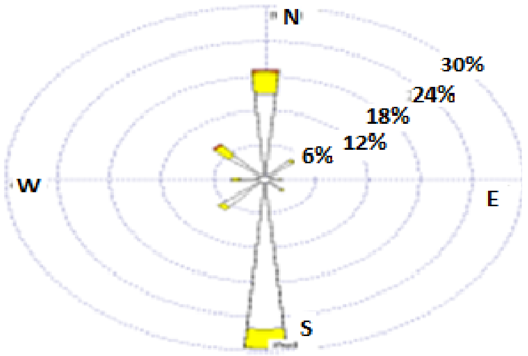


Fig. 3 Compass rose (Annaba-Algeria)

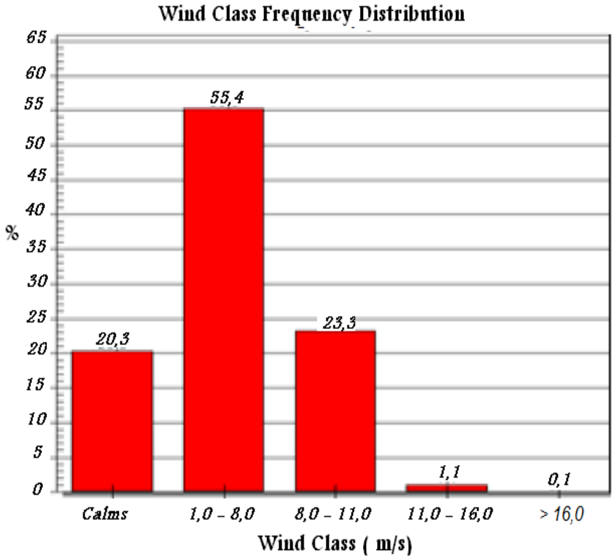


Fig. 4 Wind class frequency distribution (Annaba-Algeria)

5. Wind turbine aerodynamics

5.1. Introduction

After to improved knowledge idea of the wind speed distribution and directions, you can estimate the nominal wind speed and rotor diameter that our turbine must have to produce the desired amount of energy. The blade aerodynamic modelling study is used to improve the performance taking into account the majority of parameters (length chord distribution, the twist angle, the estimation of forces and the power generated by the blades....) that influence on the operating characteristics of the designed wind turbine. The aerodynamic of the wind blade has been studied by [8, 9-10] and many others authors.

5.2. Material and methods

- Blade element momentum theory

In reference [11-12] their study based on the analysis. The combination of axial flow theory and blade element theory allow for writing a set of equations all necessary information can be determined. To make the modelling of the rotor possible, several simplifications are considered. Fraud Frankine work and Betz and the preliminary work of Euler (Euler's theorem) assume that the flow through a rotor is axisymmetric with a perfect and incompressible fluid. The one-dimensional model used does not accurately describe the rotational flow of air, so the second theory, called theory of blade element "blade element theory is therefore called, which takes into account the rotation component of the air due to the rotation of the blades. Indeed, the combination of these two theories can have all the information for a wind rotor performance.

The blade element theory is to divide the blade into a sufficient number of elements and calculate the forces acting on these elements. Consider a blade divided into *N* elements, every element is independent; a variation in one element will not affect other elements. In Fig. 5, each element of the blade undergoes a slightly different flow because they have a different rotational speed, a different chord length C and a different twist angle for a blade twisted β is schematic of blade elements; dr is radial length of element; r is rotor radius; Ω is angular velocity of rotor [13]. The tip speed ratio is the ratio of the blade tip speed over wind speed.

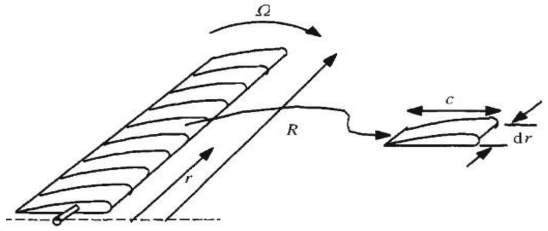


Fig. 5 Blade element model

It is a significant parameter for wind turbine design and its definition is shown in Eq. (11):

$$\lambda_r = \frac{\Omega\, r}{V}. \tag{11}$$

In general, there are two forces that act upon an aerofoil; these being lift.

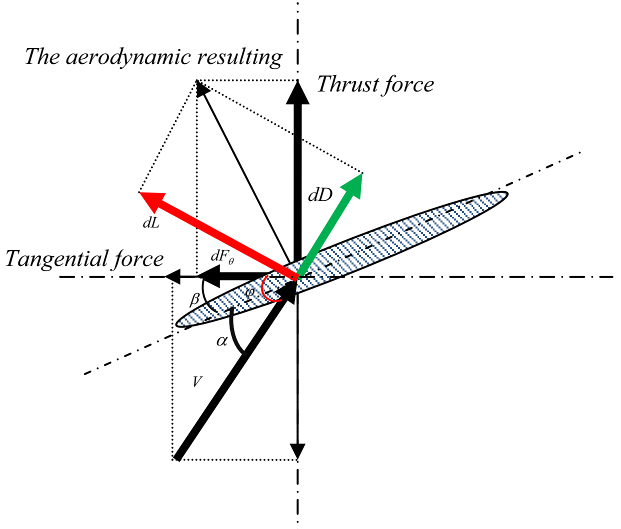


Fig. 6 Forces on the blade element

The force from the blades is determined individually by the lift and drag of the airfoil shape of the blades .The different forces acting on the blade element are shown in Figure 6. It should be noted that by definition the lift and drag forces are perpendicular and parallel to the incoming flow. For each blade element one can see:

$$dF_\theta = dL \cos\varphi - dD \sin\varphi\,, \tag{12}$$

$$dF_x = dL \sin\varphi + dD \cos\varphi\,, \tag{13}$$

where dL and dD are the lift and drag forces on the blade element respectively. dL and dD can be found from the definition of the lift and drag coefficients as follows:

$$dL = C_L \frac{1}{2} \rho\, W_{rel}^2 C\; dr\,, \tag{14}$$

$$dD = C_D \frac{1}{2} \rho\, W_{rel}^2 C\; dr\,, \tag{15}$$

where σ is called the local solidity and is defined as follows:

$$\sigma = \frac{C\; B}{2\pi R}. \tag{16}$$

The determination of expressions a and a' given in [14]:

$$a = \frac{1}{\dfrac{4 \sin^2\varphi}{\sigma\, C_L\, \cos\varphi} + 1}\,, \tag{17}$$

$$a' = \frac{1}{\dfrac{4 \cos\varphi}{\sigma\, C_L\, \cos\varphi} - 1}\,, \tag{18}$$

where C_L is the optimum value of lift coefficient.

- Force, torque and power

Expressing the axial forces and torque in terms of flow parameters:

$$dF_x = Q\, \rho V^2 \left[4a\left(1-a\right)\right] \pi\, r\, dr\,, \tag{19}$$

$$dT = Q\, \rho\, 4a'\left(1-a\right) V\, \Omega\, \pi\, r^3 dr\,, \tag{20}$$

$$dP = \Omega\; dT\,. \tag{21}$$

We now define two coefficients, one of the power production and one of the axial forces as:

$$CT = 4a\left(1-a\right), \tag{22}$$

$$CP = 4a\left(1-a\right)^2. \tag{23}$$

- Calculation of aerodynamic loads on the rotor

The following parameters define the blade geometry:

- the radius of blade;
- the number of blade;
- the distribution of the length chord;
- the distribution twist angle;
- the type of airfoil used along the blade (coefficient of lift and drag as a function of incidence angle $C_L(\alpha)$ and $C_D(\alpha)$ you can find in the paper of [13];
- the desired number of discretization N (typically 10 to 25 elements);
- assumptions specifying operating conditions of the wind (wind speed, air properties, angular velocity).

- Calculation of the optimal shape of the blade

- the distribution of the length chord $C(r)$;
- the distribution of the twist angle $\beta(r)$.

$$tan\phi = \frac{\Omega\, r\left(1+a'\right)}{V\left(1-a\right)} . \tag{24}$$

The optimum twist angle is given by [5]:

$$\beta_{optim}\left(r\right) = \varphi\left(r\right) - \alpha_{optim}\left(r\right) \tag{25}$$

where α_{optim} is the optimal incidence angle corresponding to a maximum fine:

$$\alpha_{optim} = \frac{C_L\left(\alpha\right)}{C_D\left(\alpha\right)} = max .$$

In the ref. [14] gives the optimal expression of the length chord along the blade:

$$C\left(r\right) = \frac{8\pi r}{B\, C_L}\left(1 - cos\,\varphi\right) . \tag{26}$$

With $V\left(r\right)$ velocity relative:

$$V\left(r\right) = \sqrt{v^2\left(1-a\right)^2 + \Omega^2 . r^2\left(1-a'\right)^2} . \tag{27}$$

The following example of turbine has been taken:

A tip radius of 3 m will operate in a wind speed of 3.49 m/s, three blades, $\Omega = 24$ rad/s is the angular velocity of the wind turbine rotor, Assume that the tip loss and the drag coefficient are zero. The turbine uses a NACA0012 aerofoil. The drag coefficients C_D is zeros the correction factor of loss peak Q equal to unity. The solution for a given blade cannot be found directly from the equations but an iterative solution is required. There is more than one way to carry this out. In this method a solution based on guesses for a and a' with a subsequent iteration (Fig. 7) [14].

The first step in this method used to calculate the optimal distribution of the length chord and the twist angle is summarized in the following steps:

1. Guess a and a' ($a = 0$, $a' = 0$), are constants.
2. Divide the blade into N elements. Typically 9 to 25 elements would be used (m): $r(1)$, $r(2)$... $r(n)$.
3. Calculate $\varphi\left(r\right)$ by Eq. (24).
4. Determine the optimum angle of incidence (it is an optimal maximum fine (NACA 0012 [15]).
5. Calculate the optimum twist angle $\beta_{optim}\left(r\right)$ by Eq. (25).
6. Calculate the optimal distribution of the length chord $C_{optim}\left(r\right)$ along the blade radius by the Eq. (26), with the coefficient of lift optimal $C_{Ldesign}$ corresponding to α_{optim}.

Once the optimal shape of the proposed blade (twisted blade with a variable chord) is determined, comes the second step by an algorithm for an iterative solution is as follows:

1. Divide the blade into N elements (Typically 9 to 25 elements would be use): $r(1)$, r (2)..., r (n).
2. Guess a and a' ($a = 0$, $a' = 0$).

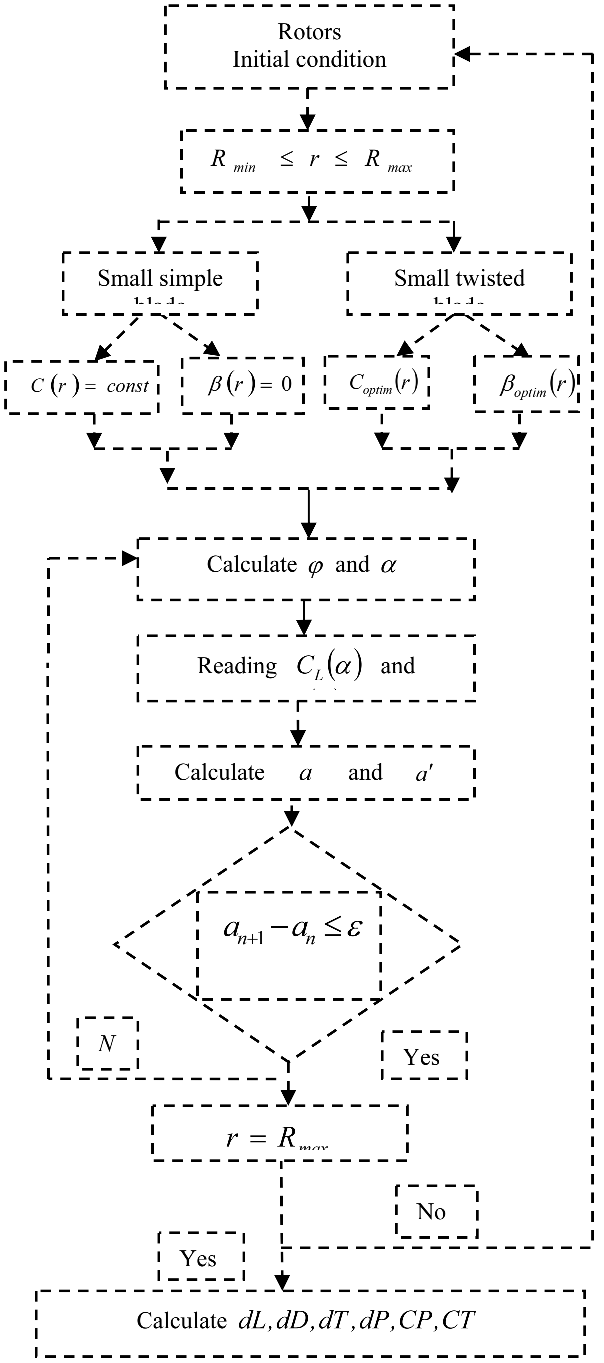


Fig. 7 Flowchart approach for calculating the basic forces

3. Calculate $\varphi\left(r\right)$ from Eq. (24).
4. Calculate $\alpha\left(r\right)$ from Eq. (25).
5. Look up $C_L\left(\alpha\right)$ and $C_D\left(\alpha\right)$ for the appropriate incidence angle [15].
6. Calculate a and a' again from Eq. (17) and Eq. (18).
7. Compare the values of a and a' with the preceding values, repeating steps 3 and 6 until convergence to a desired precision.
8. Calculate dL, dD, dT, dP, CP, CT (note: in the case of a simple blade her case a single section we injected $\beta\left(r\right) = 0$ and $C\left(r\right) = const$.

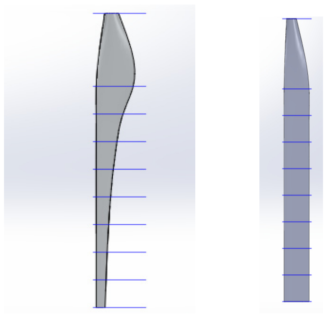


Fig. 8 Modeling of both types of blades in Solid Works

7. Results

Fig. 9 shows the distribution of the twist angle along the radius of the both types of blades, in small twisted blade β decreases from root to tip of blade. In the simple blade the twist angle is zero along the radius. Fig. 10 illustrates the distribution of the length chord along to the radius of tow types. The length Chord is maximum at root section and is minimum at tip-section in the case of blade of variable chord. It can be noticed that the decreasing of chord length is not linear with the increasing of the radius.

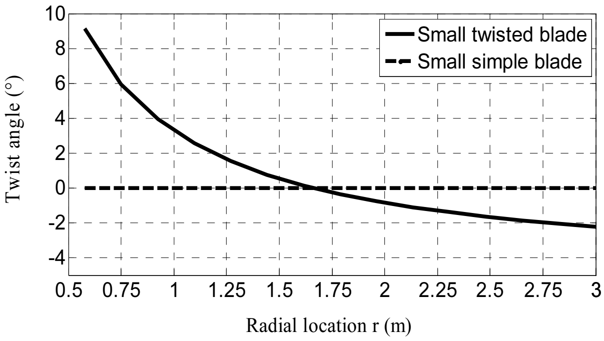


Fig. 9 Optimal twist angle distribution

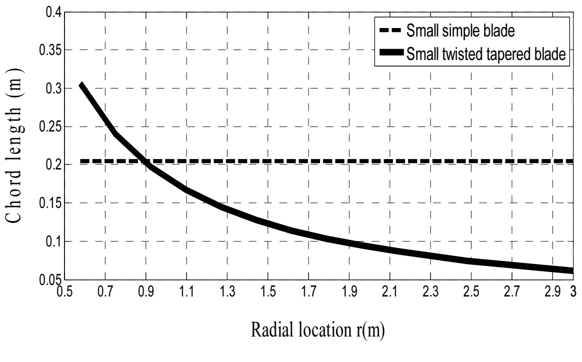
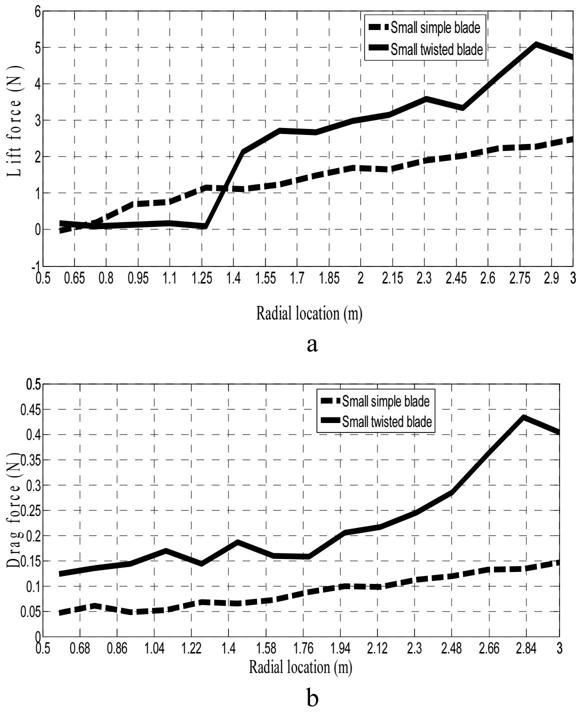


Fig. 10 Optimal chord length distribution



a

b

Fig. 11 The lift forces distribution (a); the drag forces distribution (b)

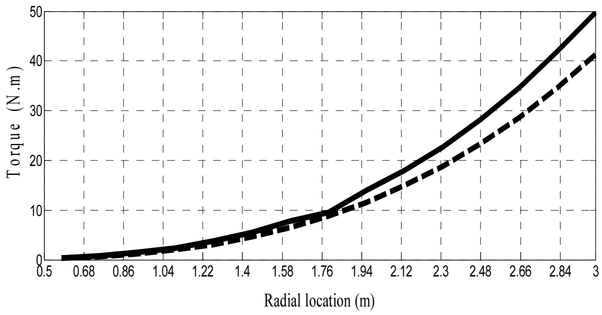


Fig. 12 The torque

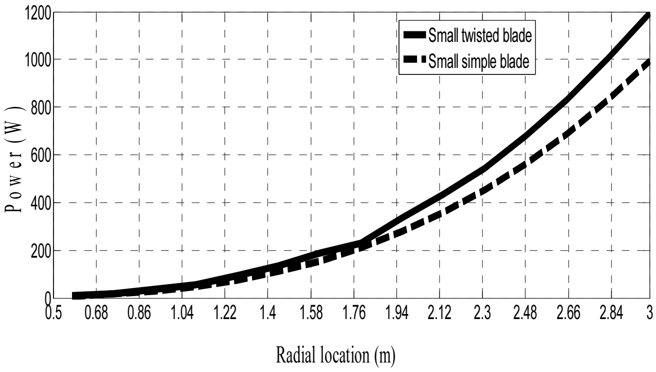


Fig. 13 The distribution of the power

From Fig. 11, a, b it can be noted that the lift and drag forces generated by twisted blade are important than that of tapered and simple blade with a large gap. Fig. 12 shows a gradual evolution of the torque along the blade radius in the both types of small blades. The torque generated by a twisted blade is more important with a low torque generated by the simple design.

Fig. 13 shows the effects of varying of the length chord and twist angle on the power generated, the first observation that can be drawn is: Power increases with the radius, it is maximum at the foot to the blade in the three types.

In Figs. 14 and 15, curves for *CP* and *CT* are shown the big effect to the presence or absence to the twist angle and chord length in the *CP* and *CT* distribution.

Note, that there is a difference between the power generated by a small twisted blade and small simple blade. Whenever we have increased the length of Wind blade get more energy and this is shown by the Fig. 16.

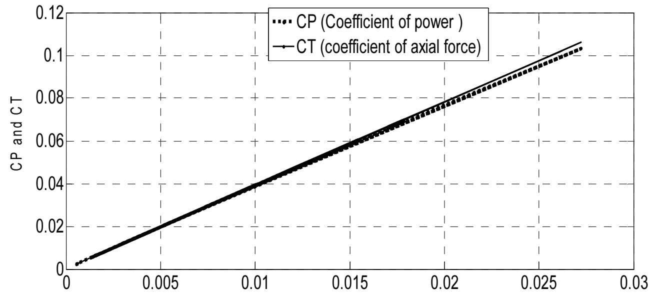


Fig. 14 *CP* and *CT* coefficient to the small simple blade according to axial int.`factor

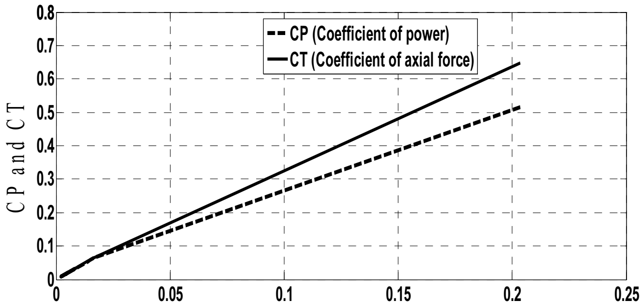


Fig. 15 *CP* and *CT* coefficient to the small wisted blade according to axial int. facto*r*

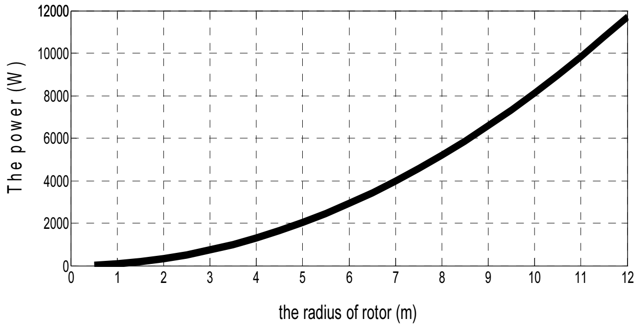


Fig. 16 The evolution of the power as a function of the radius of the wind turbine blade

7. Conclusion

This work focused on the estimation of wind power in the region of Annaba East Algiers, must drive the development of wind power. The research consists of the study of a phase prior to provide effective assistance to all those who have to make decisions about the planning and implementation of projects Wind Power. In this perspective, we began by determining various parameters related to the wind, such as the mathematical modelling of the frequency distribution of wind Weibull distribution and treatment simulation and real data collected on the wind over 10 years to size a wind turbine on a city. It has been estimated wind power potential, while relying on the automatic determination of the direction of the wind sites in study subjects. Parameter values measured using the rose compass is very close approximation of the values obtained by mathematical modelling of Weibull distribution, which validates our study. Consequently a result of all valid data during the study period, the compass shows that there is no dominant direction marked. However, we could identify preferred directions of the wind. We finished by an aerodynamic analysis of a small wind turbine using the information found in the first step in this work. This part presents the investigation of small blade horizontal axis wind turbine. It's based on blade element momentum theory and the axial flow theory. The aerodynamic forces found in this study are used to estimate the energy performance for wind turbine to be specially installed specially at that location. The most difficult issues for this theory are mathematical representation of the correct lift and drag coefficient values and correct evaluation of the axial and tangential induction factor. From the results of numerical analysis we can conclude that twisting and variation in the length chord have an influence on the power captured by the wind .In this study the length chord and twit angle are modified for improving the aerodynamic property of blade, this is reflected its impact on the resulting power. In fact there are other factors having an impact on the behaviour of the small wind turbine, but we can't ignore the great effect of two factors we studied .Intended effect does not appear well in the case of small wind blade. After studying the nature and impact of wind on the blade of wind turbine and energy that can be deduced from a small wind blade in our region.

References

1. **Bensaid, H**. 1985. The Algerian programme on wind energy, Procceding of weac, Oxford, 21-27.
2. **Celik, A.N.** 2003. A statistical analysis of wind power density based on the weibull and Rayleigh models at the southern region of Turkey, Renew energy 29: 593-604. http://dx.doi.org/10.1016/j.renene.2003.07.002.
3. **Akpinar, E.K.; Akpinar, S.** 2004 .Determination of the wind energy potential for Maden-Elazig, Energy Convers Manage 45: 2901-2914. http://dx.doi.org/10.1016/j.enconman.2003.12.016.
4. **Ohunakin, O.S.; Adaramola, M.S.; Oyewola, O.M.** 2011. Wind energy evaluation for electricity generation using WECS in seven selected locations in Nigeria, Appl Energy 88: 3197-3206. http://dx.doi.org/10.1016/j.apenergy.2011.03.022.
5. **Costa, R.P.A.; Sousa, R.C.; Andrade, C.F.; Silva, M.E.V.** 2012.Comparison of seven numerical methods for determining Weibull parameters for wind energy generation in the northeast region of Brazil, Elsevier Applied Energy 89: 395-400. http://dx.doi.org/10.1016/j.apenergy.2011.08.003.
6. **Stevens, M.J.; Smulders, P.T.** 1979. The estimation of the parameters of the Weibull wind speed distribution for wind energy utilization purposes, Wind Eng 3: 132-145.
7. **Nichita, C.; Luca, D.; Dakyo, B.; Geanga, E.** 2002. Large bande simulation of wind speed for real time wind simulators, IEEE Transactions on Energy Conversion 17(4): 523-529. http://dx.doi.org/10.1109/TEC.2002.805216.
8. **Larson, J.** 2008. The Effect of Cord Length and Taper on Wind Turbine Blade Design, Turbinator Technologies AME.
9. **Mendez, J.; Greiner, D.** 2010. Wind blade chord and twist angle optimization by using genetic algorithms, Institute of Intelligent Systems and Numerical Applica-

tions in Engineering, Univ. Las Palmas de Gran Canaria.

10. **Wallenius, T.; Matthew, C.H.; Nicklasson, J.; Makkonen, L.** 2010. The relationship between chord length and rime icing on wind turbines, VTT Technical Research Centre of Finland.
11. **Ameur, K.; Guerri, O.; Harhad, M.** 1999. Aerodynamic Performance Evaluation of Horizontal axis wind rotors, Centre for Development of Renewable Energy, PO Box 62, Bouzaréah, Algiers, DZ .
12. **Masson, C**. 2011. Wind Technology, Department of Mechanical Engineering École de technologie supérieure SYS84.
13. **Chlyah, B.; Benchagra, M.** 2011. Wind Technology and Aerodynamics. Ecole de Technologie Supérieure Université du Québec, SYS 847.
14. **Ingram, G.** 2005. Wind Turbine Blade Analysis using the Blade Element Momentum Method, School of Engineering, Durham University.
15. **Sheldah, l; Robert, E.; Paul, C.** 1981. Aerodynamic Characteristics of Seven Symmetrical Airfoil Sections Through 180-Degree Angle of Attack for Use in Aerodynamic Analysis of Vertical Axis Wind Turbines , Sandia National Laboratories, Albuquerque. USA.

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VĖJO RYTŲ ALŽYRO ANABOS REGIONE AERODINAMINIS VERTINIMAS MAŽŲ VĖJO JĖGAINIŲ ĮRENGIMUI

Reziumė

Mažų vėjo jėgainių statymas izoliuotose vietovėse įgalina gaminti elektros energiją nesudėtingais įrenginiais. Siekiant optimizuoti vėjo jėgainės darbą, prieš ją įrengiant labai svarbu žinoti toje zonoje dominuojančių vėjų pokyčius: vėjo intensyvumą, jo greitį, dažnį ir kryptį. Prieš statant mažas vėjo jėgaines Rytų Alžyro Anabos regione atlikti jo vėjo resursų tyrimai. Vėjo energijos pajėgumui ir ekstremalaus vėjo prognozavimui šiame regione tinka Veibulo metodas. Pirmojoje šio straipsnio dalyje vertinami du vėjo greičio Veibulo funkcijos pasiskirstymo parametrai: formos parametras *k* ir mastelio parametras *c*. Veibulo funkcijos pasiskirstymo formos ir mastelio parametrų reikšmės parinktos įvertinant vėjo kryptį ir tai pasirodo yra tik pirminis svarbus žingsnis parenkant vėjo jėgainės statymo vietą. Buvo apskaičiuoti vėjo greičio vidurkiai remiantis duomenimis išmatuotais kas valandą dešimties metų laikotarpyje 12-oje meteorologinių stočių esančių šalia Alžyro aerouosto Anabos regione. Išanalizavus vėjo elgseną šiame regione, radus vėjo greičio vidurkius, tuo pačiu žinant energijos poreikį, atlikti aerodinaminiai tyrimai siekiant įvertinti ir patobulinti vėjo jėgainės sparno formą. Tyrime naudojant momentų ir srautų teoriją įvertinamos darbo ir pasipriešinimo jėgos veikiančios dviejų formų sparnus, nustatomi jų sukurti sukimo momentai ir generuojama energiją. Įvertinta sparno ilgio pokyčio ir jo susukimo kampo įtaka nedidelei vėjo jėgainei. Tyrimų rezultatai pritaikyti Anabos regionui. Tai leido parinkti tinkamą vėjo jėgainės sparno formą nors vėjo greitis regione yra nedidelis.

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ASSESSMENT WIND FIELD IN THE REGION OF ANNABA EAST ALGIERS WITH AN AERODYNAMIC ANALYSIS FOR INSTALLATION A SMALL WIND TURBINES

Summary

The basic principle of a small wind turbine in the isolated location is to produce electricity with a simple design. Before installing a wind turbine The knowledge of the wind climate is very important for the reason to optimize the performance of wind turbines, it is necessary to study the intensity, speed, frequency and direction of the wind. In this context that we will evaluate the wind resource of Annaba - Algeria of the region in order to establish small wind turbine. Hence a Weibull method fit to determine wind energy potential and predict extreme wind in our region. The first part in this paper is to study the estimation of the two Weibull parameters of the wind speed distribution function namely, shape parameter *k* and the scale parameter *c*. The suitable values for both shape and scale parameters of weibull distribution of weibull are without forgetting to study the direction, from which the wind comes, appears as very primordial steps important for selecting location of installing wind turbine generator. For 10 years were computed from the wind speed averages data measured hourly at 12 meteorological stations located at “Algiers Airport”. The region concerned in this study named: Annaba. After analysing the behaviour of the wind in this region and find out the average speed in order to study the possibility of installing small wind turbine in the region, as well as knowledge of energy that can output we must hold aerodynamic study to learn and to improve the wind blade shape. The study uses Element Momentum and the axial flow theory, the lift and drag forces acting on the two blade types the torque and the power generated can be determined for our both blade, we concluded the real effect of variation of the length chord and the absence or presence of the twist angle on the performance of a small wind blade. Finally, therefore, this paper treat the techniques applicable to data sets in a defined area for implanted a small wind turbine with best yield, we concluded that a small wind turbine. We put attention on the region of Annaba. Can installer in this region despite the low wind speed through good wind blade shape.

Keywords: Wind energy, Weibull parameters, Compass Rose, Small wind turbine, aerodynamic behaviour.

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