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Specialized in designing small electricity generating windmills and PM-generators

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Sequence of KD-reports for self-study

On my website: www.kdwindturbines.nl at the menu KD-reports, one can find more than sixty KD-reports about different technical aspects of small wind turbines which can be copied for free. The list of KD-reports starts with a folder in which all free KD-reports are specified. As every report has a rather long title, the title gives a good impression of the content. But even with these titles, it might be difficult to determine in which sequence the reports should be read for self-study. It is assumed that one wants to design an electricity generating wind turbine (for water pumping with a windmill, read report KD 490) and hereby I give the reading sequence of the reports which I think is most logic.

1 One should start with the one page note "Development procedure of a range of wind turbines" which can be found at the bottom of the list of KD-reports. Designing of a good wind turbine isn't simple and requires many different steps which should be followed consequently.
2 For all KD-reports it is assumed that one has some basic knowledge of mathematics and energy. The basic knowledge of energy is given in report KD 378.
3 One has to make a choice in between a vertical axis wind turbine (VAWT) or a horizontal axis wind turbine (HAWT). I strongly advise not to go for a VAWT. The reasons why are explained in KD 215 and KD 601 for Darrieus rotors, in KD 416 for drag machines, in KD 417 for the rotating blade turbine and in KD 599 for Savonius rotors.
4 The aerodynamic theory for a HAWT is given in report KD 35. Questions and answers about each chapter of KD 35 are given in report KD 196. KD 35 gives the fundamental aerodynamics of wind turbines and it explains how the rotor geometry can be determined. It also gives a simple theory to determine the rotor characteristics and the output.
5 After studying report KD 35, one should study at least one KD-report in which the rotor calculations of a certain rotor are given because a specific design report may give information which isn't given in KD 35. One can make a choice in between KD 319, KD 437, KD 518, KD 532, KD 578, KD 614, KD 615 or KD 634.
6 A certain airfoil is used for a rotor blade. Characteristics of the Gö 623 airfoil are given in KD 35. However, sometimes another airfoil is preferred. It is advised to study at least one of the KD-reports about airfoils. One can make a choice in between KD 285, KD 333, KD 398 or KD 463.
7 Every wind turbine should have a safety system which limits the rotational speed and the rotor thrust at high wind speeds. This can be realised by turning the rotor out of the wind or by variation of the blade angle (also called pitch control). General information about systems which turn the rotor out of the wind is given in report KD 485. It is assumed that one has made a choice for a certain system after reading report KD 485. For every system which is described in KD 485 in general, there is a KD-report in which the system is described in detail including the moment equations. Detailed information is given in reports KD 213, KD 223, KD 377, KD 409, KD 431 and KD 439. One should at least study the report of the system which one has chosen after reading KD 485. The system which is easiest to describe, is the pendulum safety system which given in KD 377. It was possible to find a mathematical expression for the δ-V curve and so the characteristics could be predicted. So I advice to study this report, even if this system wasn't chosen.

8 If one wants to design a safety system with pitch control, one can study report KD 437 of the VIRYA-15, starting at chapter 6 or KD 622 of the VIRYA-5 starting at chapter 9.

9 Small wind turbines are normally put into the wind by a vane. Characteristics of rectangular vane blades with different aspect ratios (the ratio in between the vane height and the vane width) are given in report KD 551.

10 Every wind turbine needs a generator. For small wind turbines, a permanent magnet (PM) generator is the best option because no energy is lost in the creation of an electro magnetic field. The about 40 year's long history of the development of the PM-generators of the VIRYA-windmills is given in report KD 341. The older VIRYA windmills all have a radial flux generator which is derived from an asynchronous motor. Detailed information of radial flux generators is given in reports KD 480, KD 503, KD 560, KD 580, KD 624, KD 632 and the note: 10-pole PM-generator. Recently I did also some research to axial flux generators. Information about these generators is given in reports KD 522, KD 531, KD 571, KD 596, KD 607, KD 608 and KD 631.

11 For battery charging, the alternating 3-phase current coming out of the generator has to be rectified. Rectification is explained in report KD 340 for star and for delta.

12 For battery charging, one needs a voltage controller and dump load which limits the maximum charging voltage of a lead acid battery up to about 2.3 V per cell. If a full battery is charged at a too high voltage it will be damaged very soon because it will become too hot and because of the electrolyses of the water. A 27.6 V, 200 W battery charge controller is described in a manual which is given at the bottom of the list with KD-reports.

13 For the determination of the matching in between rotor and generator, one needs measured characteristics of the generator for the correct load. Most VIRYA-generators have been measured on a test rig of the University of Technology Eindhoven. These measurements are given in reports KD 78, KD 82 and KD 200. I also have measuring reports of smaller VIRYA-generators but these report are written in Dutch and aren't public. Recently I have developed a test rig to measure a small axial flux generator of Chinese origin. The test rig and the measurements are described in report KD 595. This test rig was also used to perform some basic tests on small axial flux generators which I have designed and built recently.

14 Ideas about a simple tubular tower for the VIRYA-4.2 and the VIRYA-4.6B2 are given in report KD 582. This report gives calculations of the strength and the natural frequency.

15 Even if one has studied all the reports which are mentioned up to now, it might be difficult to start the design procedure. It is easier to buy a licence of one of my VIRYA windmills for which the whole design procedure has already been followed. However, most work shops in developing countries are unable to pay the required license fee. To Western standards, the license fee is rather low but for them it might be too high, especially if one wants to build only one windmill. Another problem is that all my designs are based on materials and machines which are available in The Netherlands and that manufacture in other countries might be difficult, especially if the available materials have inch and foot measures. To solve the problem of a license fee and to give an impression of what kind of wind turbine is created if the whole design procedure is followed, I recently have designed some small wind turbines and made the manuals including the drawings available for free. The manuals can be found at the bottom of the list with KD-reports. At the menu VIRYA-folders, there is a separate folder of the small VIRYA-windmills for which no license is required. Read this folder first and then make a choice what to build. If a small wind turbine according to one of the free designs has been built successfully, it is easier to design a bigger one according to ones own specification. But never start serial production of a new design if this new design is not tested long enough in a strong wind regime.