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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 almost hundred 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 used in wind turbines 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 and KD 703 for Savonious rotors.

4 The aerodynamic theory for a HAWT is given in report KD 35, KD 97 and KD 697. Questions and answers about each chapter of KD 35 are given in report KD 196. KD 35 gives the aerodynamics of wind turbines and it explains how the rotor geometry can be determined. It also gives a 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 gives information which isn't given in KD 35. One can make a choice in between KD 319, KD 465, KD 484, KD 518, KD 532, KD 576, KD 578, KD 579, KD 614, KD 615, KD 616, KD 617, KD 632, KD 651, KD 652, KD 654, KD 656, KD 658, KD 664, KD 669, KD 670, KD 671, KD 678, KD 679, KD 684, KD 690, KD 693, KD 699, KD 702, KD 709 (in Dutch), KD 710, KD 717, KD 727, KD 732 or KD 733.

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 R-443-D, given at the bottom of the menu KD-reports or certain KD-reports about airfoils. One can choose in between KD 285, KD 333, KD 398, KD 463, KD 501 or KD 698.

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, KD 622 of the VIRYA-5 starting at chapter 9 or KD 654 of the VIRYA-3.6PC starting at chapter 6.

9 Small wind turbines are normally put into the wind by a vane. Characteristics of rectangular vane blades with five 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 503, KD 560, KD 580, KD 624, KD 632, KD 644, KD 645, KD 648, KD 681, KD 683, KD 690, KD 708, KD 730 and the note: 10-pole PM-generator. For generators with no iron in the coils information is given in KD 664, KD 667 and KD 668. I also did some research to axial flux generators. Information about these generators is given in reports KD 522, KD 531, KD 571, KD 596, KD 631, KD 679, KD 705 and KD 707.

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, for delta and for rectification of each phase. Rectification of a 5-phase and a 9-phase generator is explained in KD 712.

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, KD 678 and KD 679.

14 Ideas about a tubular tower for the VIRYA-3.3S are given in report KD 562. Ideas about a tubular tower for the VIRYA-4.2 and the VIRYA-4.6B2 are given in report KD 582. The last 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 build a wind turbine according to drawings which are made by someone else. However, one must be sure that the correct design procedure was followed, that the wind turbine has been tested thoroughly and that it has no hidden mistakes. I no longer supply licences of my bigger VIRYA windmills which have been tested for years but recently I 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 are three folders of totally fourteen small VIRYA-windmills for which no license is required. Read these folders 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.

16 Premium members of Geocache can find two caches around Boskant, Sint-Oedenrode about wind turbines. These are the caches "wind turbine theory" about report KD 35 and "wind turbine practice" about a folder and drawings of small VIRYA wind turbines. The caches are in Dutch and English.