Licence for manufacture of windmill

VIRYA-3.5B3

June 2026

Most VIRYA windmills have PM-generators made from asynchronous motors. However, in some developing countries it appears to be too difficult or too expensive to make such generators. For the VIRYA-3.5B3 it is therefore decided to use an axial flux PM-generator of Chinese manufacture. The choice of the generator is explained in the public design report KD 805 of the VIRYA-3.5B3 rotor. It is chosen to use an axial flux generator which can supply a rated electrical power of about 1 kW at a rated rotational speed of 350 rpm. This generator is supplied by different Chinese suppliers. The supplier Hefei Top Grand is chosen. The generator model number of this supplier is TGET320-1KW-350R. The characteristics of the generator are only given in the Chinese specification for a resistance load. The windmill will be used for 24 V battery charging and it is assumed that the average charging voltage is 27 VDC. The characteristics for 27 VDC are derived in chapter 6 of KD 805. With these characteristics it was possible to derive the P_{el}-V curve for 27 VDC. The estimated P_{el}-V curve is given figure 1.

The VIRYA-3.5B3 has a 3-bladed rotor with wooden blades connected to each other by a welded stainless steel hub assembly. The windmill is provided with the so called hinged side vane safety system. The tower has two lower sections made of angle iron and strip and an upper section made of a single pipe. The tower and the head look about the same as those of the former VIRYA-3D windmill given in the photo below.



Former VIRYA-3D prototype

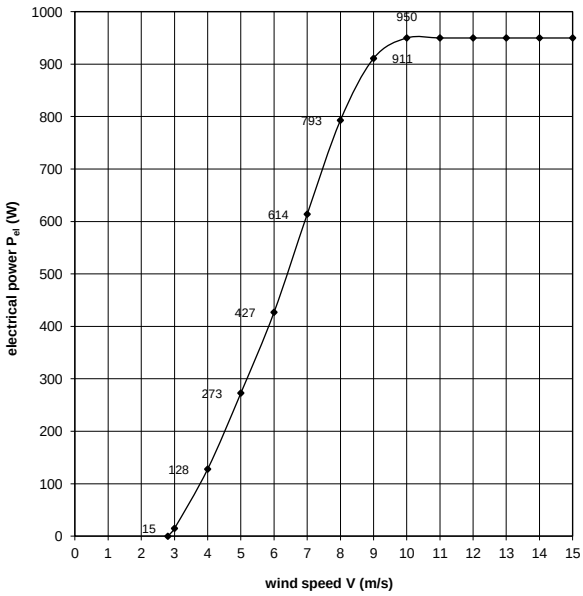

fig. 1 Estimated P_{el}-V curves of the VIRYA-3.5B3 for 27 VDC

The cut-in wind speed is about 2.8 m/s. The maximum power is about 950 W at a wind speed of 10 m/s and higher. A more accurate P_{el}-V curve can only be made if a generator is bought and measured on an accurate test rig for a 24 V battery load or for a load with a constant voltage of 27 VDC, like this was done for other VIRYA generators.

Kragten Design

Kragten Design (KD) is a one man engineering office founded in 1989 and specialises in designing windmills. From 1-1-2018, I am no longer commercially active. Many windmills with rotor diameters from 1 to 14 metre haven been designed and more than 800 KD-reports have been written. Adriaan Kragten, B.Sc., worked for fifteen years in the Wind Energy Group, Faculty Physics of the University of Technology Eindhoven, one of the parties in the former CWD (Consultancy services Wind energy Developing countries). The address of KD is:

Kragten Design, ing. A. Kragten
Populierenlaan 51, 5492 SG Sint-Oedenrode, The Netherlands
Telephone: +31 413 475770
e-mail: info@kdwindturbines.nl

More information about Kragten Design and the VIRYA windmills is given on: www.kdwindturbines.nl

Description of the VIRYA-3.5B3 windmill

The 3-bladed VIRYA-3.5B3 is derived from the 2-bladed VIRYA-3.5, already designed in 2015. Both windmills have the same blades and make use of the same generator. Almost all drawings are the same but it isn't advised to build the VIRYA-3.5 as the noise production will be rather high and a 2-bladed rotor will be sensible for vibrations due to the gyroscopic moment. The VIRYA-3.5 with $\lambda_d = 8$ was meant for 48 V battery charging. The VIRYA-3.5B3 has a lower design tip speed ratio $\lambda_d = 6$ and therefore runs at lower rotational speeds. Therefore it can be used for 24 V battery charging which is a more common battery voltage. A voltage controller with dump load is needed to limit the maximum charging voltage up to about 27.6 VDC. However, it might be possible to create a 230 V, 50 Hz stand alone grid by using an inverter. It might also be possible to connect this windmill directly to the grid (so without batteries) using a 3-phase grid connected inverter but this use is not the main goal. It is expected that the generator can be used as a brake by short-circuiting the generator winding for wind speeds below 8 m/s. However, to be sure if the breaking torque is large enough, a generator has to be bought and measured.

The windmill is provided with the so called "hinged side vane safety system" to limit rotor rpm and thrust at high wind speeds. The rotor axis is offset from the tower axis. The vane juts out along the rotor and the vane blade is connected to the vane arm using hinges. At low wind speeds, the vane blade hangs in almost vertical position and the rotor is perpendicular to the wind. At wind speeds higher than about 6 m/s, the rotor starts to turn gradually out of the wind with a yaw angle δ. The rotor is about 30° turned out of the wind at a wind speed of about 10 m/s. At very high wind speeds the rotor turns out of the wind by about 75° and the vane blade is in almost horizontal position. The behaviour of this system is very stable and the rotor speed is well controlled. A rough description of this safety system is given in public report KD 485. A detailed description is given in public report KD 213.

A prerequisite for manufacture of this windmill in developing countries is that one is able to import some of the materials and standard parts. Kragten Design cannot supply materials and parts such as bearings, generators, electronics and batteries. The required workshop skills are sawing, drilling, turning, milling and welding.

Specification VIRYA-3.5B3

Rotor diameter	D = 3.5 m
Number of blades	B = 3
Design tip speed ratio	$\lambda_d = 6$
Material rotor blades	hard wood
Material hub assembly	stainless steel AISI 304
Material, head and tower	mild steel
Material vane blade	9 mm water proof plywood
Gear ratio	i = 1 so direct drive
Rotor eccentricity	e = 0.3 m
Tower height	H = 9.5
Mass including tower but excluding concrete	m = 192 kg
Starting wind speed	$V_{start} = 2.7$ m/s
Cut in wind speed	$V_{cut\ in} = 2.8$ m/s
Rated wind speed	$V_{rated} = 10$ m/s
Survival wind speed (expected)	$V_{surv} = 35$ m/s
Nominal battery voltage	U = 24 V DC
Rectification generator	star
Power at rated wind speed	$P_{rated} = 950$ W
Licence fee	free

Drawings and manuals

A set of drawings consists of a main assembly drawing of the whole windmill, sub-assembly drawings of rotor, head and tower and detailed drawings of all parts. Drawings of tools for manufacture an erection of the tower are also included. Lists of parts to be manufactured and of standard parts are included too. These drawings and parts lists are specified in chapter 7 of KD 805. A manual of the VIRYA-3.5B3 was made which can be found at my website at the bottom of the menu KD-reports. The charge controller for battery charging is described in a separate public manual.

All four windmill drawings are hand written on film size A1. The tools are given at film size A2. So the drawings aren't digital. I have made photos of the drawings and these photos are added as figure 11 up to 15 in KD 805. I could not make better photos but it is what it is. If a photo is printed at paper size A4, it becomes too small to read the measures. The measures can be read on the computer screen if the picture is blown up but this is very impractical in a workshop. Making real paper copies is expensive as I have to drive to Eindhoven because no large size printing is possible in Sint-Oedenrode. If someone is interested in building the VIRYA-3.5B3, I can make paper copies but one has to pay the printing costs, the transport and mailing costs and a certain fee for my time. This will cost € 150. The part lists are given after the photos.