Licence for manufacture and sale of windmill

VIRYA-3.5 + VIRYA-3.18

June 2015 (provisional)

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-3.5 and the VIRYA-3.18 it is therefore decided to use an axial flux PM-generator of Chinese manufacture. The choice of the generator is explained in the design report of the rotor KD 589 for the VIRYA-3.5 and KD 590 for the VIRYA-3.18. It is chosen to use an axial flux generator which can supply a rated electrical power of 1 kW at a rated rotational speed of 350 rpm and a DC voltage of 56 V (after rectification). This generator is supplied by different Chinese suppliers. Provisionally the supplier Hefei Top Grand is chosen. The generator type number of this supplier is TGET320-1KW.350R. The characteristics of the generator are only given in the Chinese folder for a resistance load. The characteristics for a 48 V battery load are derived in KD 589 and in KD 590 and are given in figure 4 of these reports. With these characteristics it was possible to derive the P_{el}-V curve for 48 V battery charging. The P_{el}-V curves of both windmills are given figure 1.

The VIRYA-3.5 has a 2-bladed rotor with wooden blades connected to each other by a twisted steel strip like it is also done for the VIRYA-4.2 rotor. The VIRYA-3.18 has a rotor with two stainless steel blades. The tower has a lower section made of angle iron and strip and an upper section made of a single pipe. It looks about the same as the tower of the former VIRYA-3D windmill given in the photo below.

Former VIRYA-3D prototype

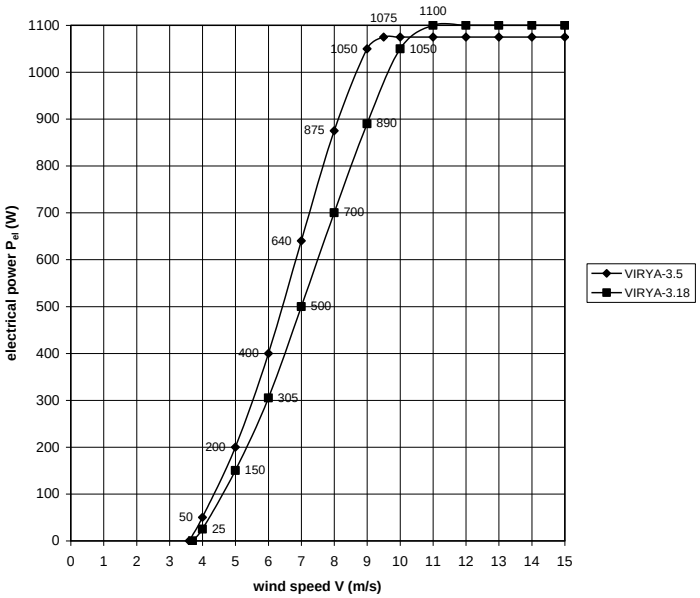

fig. 1 Estimated P_{el}-V curves of the VIRYA-3.5 and VIRYA-3.18

More accurate P_{el}-V curves can only be made if a generator is bought and measured on an accurate test rig for a battery load, 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 and wind energy consultancy (see separate folder). Up to now nineteen windmills with rotor diameters from 1 to 4.6 metre haven been developed and 590 KD-reports haven 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:

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Description of the VIRYA-3.5 and the VIRYA-3.18 windmills

The VIRYA-3.5 and the VIRYA-3.18 windmills are designed especially for manufacture in developing countries. The VIRYA-3.5 has a simple 2-bladed rotor with wooden blades connected to each other by a twisted steel strip. The blades have a constant chord with a Gö 711 airfoil and no twist and manufacture is therefore rather easy. The VIRYA-3.18 has a 2-blades rotor with 7.14 % cambered stainless steel blades with no twist which are connected to each other by a twisted stainless steel strip. The VIRYA-3.18 is designed for countries where good quality wood isn't available or when machining and protection of wood is a problem. Both windmills make use of the same generator, head and tower. The PM-generator has a 45 mm shaft and a housing with a diameter of 320 mm. The generator is mounted to the head frame by four blocks which clamp around the shaft. The central strip of the rotor is mounted to the front side of the generator housing by eight M10 bolts.

The VIRYA-3.5 and the VIRYA-3.18 are meant for 48 V battery charging. They have two 28 V battery charge controllers in parallel, so the windmills can be used for 24 V DC equipment. However, it is also possible to create a 230 V, 50 Hz stand alone grid by using an inverter. It might be possible to connect these windmills directly to the grid (so without batteries) using a 3-phase grid connected inverter but this use is not the main goal. It might be possible to use the generator as a brake by short-circuiting the generator winding. 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 the free public report KD 485. A detailed description is given in reports KD 213 and KD 223.

The δ-V characteristic of the VIRYA-3.18 differs somewhat from that of the VIRYA-3.5 because a rotor with 7.14 % cambered blades has a larger self orientating moment than a rotor with a Gö 711 airfoil. This is the reason that the VIRYA-3.18 has a higher rated wind speed of 11 m/s in stead of 9.5 m/s for the VIRYA-3.5.

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-3.5 and VIRYA-3.18

	VIRYA-3.5	VIRYA-3.18
Rotor diameter	D = 3.5 m	D = 3.18 m
Number of blades	B = 2	B = 2
Design tip speed ratio	$\lambda_d = 8$	$\lambda_d = 7$
Material rotor blades	hard wood	stainless steel
Material, head and tower	mild steel	mild steel
Material vane blade	plywood	plywood
Gear ratio	i = 1	i = 1
Rotor eccentricity	e = 0.3 m	e = 0.3 m
Tower height	H = 9.5	H = 9.5
Mass including tower but excluding concrete	m = 186.8 kg	m = 189.4 kg
Starting wind speed	V_{start} = 2.1 m/s	V_{start} = 2.8 m/s
Cut in wind speed	$V_{cut\ in}$ = 3.6 m/s	$V_{cut\ in}$ = 3.7 m/s
Rated wind speed	V_{rated} = 9.5 m/s	V_{rated} = 11 m/s
Survival wind speed	V_{surv} = 35 m/s	V_{surv} = 35 m/s
Nominal battery voltage	U = 48 V DC	U = 48 V DC
Rectification generator	star	star
Power at rated wind speed	P_{rated} = 1075 W	P_{rated} = 1100 W
Licence fee excluding VAT	€ 2,000	€ 2,000
Licence fee VIRYA-3.5 + VIRYA-3.18		€ 2,250

Drawings and manuals and licence conditions

A set of drawings consists of a main assembly drawing of the whole mill, sub-assembly drawings of rotor, head, tower and dump load 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. In the manual several aspects are explained in detail including the safety system, manufacture of parts, mounting and installation. The charge controller for battery charging is described in a separate manual.

A licence for manufacture of the VIRYA-3.5 or VIRYA-3.18 windmills is available only for professional manufacturers. A licence is valid for the whole world, for an infinitive number of windmills and for infinitive time. For details about the licence ask Kragten Design. The licensee will be informed about important modifications and can ask Kragten Design for support (at the normal hourly fee). Although the windmills have been designed carefully, no responsibility is accepted for the operation of the windmill neither as a whole, nor for any of its separate parts.