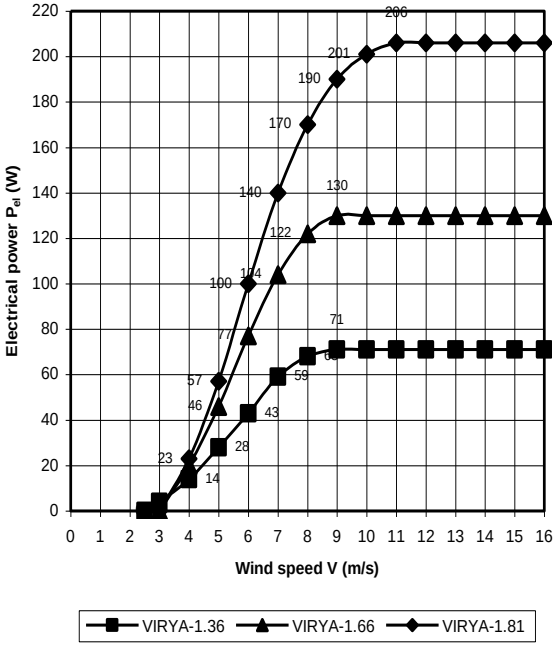
Free licence for manufacture and sale of windmills

VIRYA-0.98, VIRYA-1, VIRYA-1.04, VIRYA-1.36, VIRYA-1.66 and VIRYA-1.81

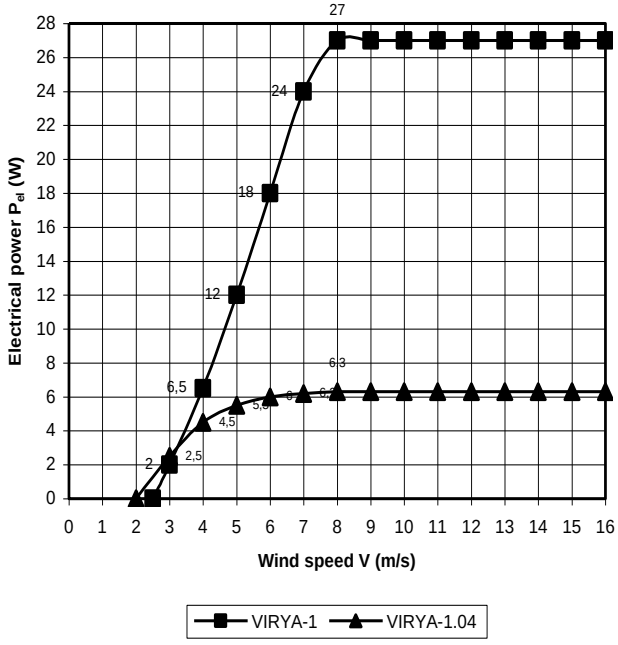
February 2021

VIRYA-1.04

P_{el}-V curves VIRYA-1.36, VIRYA-1.66 and VIRYA-1.81 windmills



P_{el}-V curves VIRYA-1 and VIRYA-1.04 windmills



Rotor VIRYA-0.98 + Nexus hub dynamo

Kragten Design

Kragten Design (KD) is a one man engineering office founded in 1989 and specialises in windmill design but KD is no longer commercial active from 1-1-2018. Up to now 24 windmills with rotor diameters from 1 to 4.6 metre haven been developed and 679 KD-reports haven been written. Adriaan Kragten, B.Sc., worked for fifteen years in the Wind Energy Group, Faculty of Physics of the University of Technology Eindhoven, one of the parties of the former CWD (Consultancy services Wind energy Developing countries). The address of KD is: Kragten Design

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Description of the windmills

The rotor blades of the VIRYA-0.98 and the VIRYA-1.04 are made out of 1.5 mm aluminium sheet. The rotor of the VIRYA-1 is made out of 2 mm aluminium sheet. The rotor blades of the VIRYA-1.36, -1.66 and -1.81 are made out of stainless steel sheet. The VIRYA-1, -1.36 and -1.81 have a 2-bladed rotor. The VIRYA-0.98, -1.04 and -1.66 have a 3-bladed rotor. All rotors have blades with a constant chord which simplifies manufacture. All rotors except the VIRYA-0.98, have 7.14 % cambered blades. The VIRYA-0.98 has blades for which the sides are 15° bent. The generator and rotor calculations of the VIRYA-0.98, -1, -1.04, -1.36, -1.66 and -1.81 are given in respectively free public reports KD 615, 679, 518, 571, 596 and 631.

The VIRYA-0.98 and -1.04 use a Nexus bicycle hub dynamo as generator. The main disadvantage of this generator is that the maximum power is rather low. The VIRYA-1, -1.36, -1.66 and -1.81 have an axial flux generator which must be manufactured completely. The VIRYA-1 generator makes use of the front wheel hub of a mountain bike. It is expected that a battery charge controller with dump load isn't required for the VIRYA-0.98, -1 and -1.04 if the battery has enough capacity. For the bigger types, the maximum charging voltage must be limited. The VIRYA-0.98, -1 and -1.04 make use of the same head and the same tower pipe. The head of the VIRYA-1.66 and the VIRYA-1.81 are derived from the head of the VIRYA-1.8. The tower of the VIRYA-1.81 is derived from the tower of the VIRYA-1.8. Photo's of the VIRYA-1.8 head and tower are given in appendix 2 of the manual of the VIRYA-1.81. The VIRYA-1.66 has an aluminium vane blade size 2 * 375 * 375 mm. The VIRYA-1.81 has a stainless steel vane blade size 1 * 416 * 416 mm and therefore a higher V_{rated}.

The windmills are provided with a "hinged side vane safety system" to limit rotor speed 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 5 m/s, the rotor starts to turn gradually out of the wind. At very high wind speeds the rotor turns out of the wind by about 70° and the vane blade is almost horizontal. The behaviour of this system is very stable and the rotor speed is well controlled.

The towers of the VIRYA-0.98, -1 and -1.04 consist of a 1 metre tubular upper section which can be connected to 3 m long wooden pole which can be connected to a supporting structure such as a wall of a house. The VIRYA-1.36 and -1.66 have a 2 m tubular upper section and a 3 m wooden pole. The VIRYA-1.81 has a 2 m tubular upper section and a 6 m tubular tower. Ten VIRYA-1.04 windmills have been built during a weekend in spring 2013 by a group of students of the University of Technology Twente. The other types have not yet been manufactured and tested by Kragten Design but the safety system has been tested in many bigger windmills. The VIRYA-1.81 generator has a synthetic stator sheet so no eddy currents will be generated. The sticking torque will be low and the starting behaviour will be very good. These six windmills are designed primarily for serial manufacture in developing countries. However, a prerequisite is that the prescribed material is available. Kragten Design cannot supply materials and parts such as bearings, generators, magnets etcetera. The required workshop skills are sawing, drilling, turning and welding.

Specification

	VIRYA-1	**VIRYA-0.98 + -1.04**	**VIRYA-1.36**	**VIRYA-1.66**	**VIRYA-1.81**
Diameter	D = 1 m	D = 0.98,1.04 m	D = 1.36 m	D = 1.66 m	D = 1.81 m
Number of blades	B = 2	B = 3	B = 2	B = 3	B = 2
Design tip speed ratio	$\lambda_d = 4.25$	$\lambda_d = 3, 3.5$	$\lambda_d = 5$	$\lambda_d = 4.5$	$\lambda_d = 5$
Gear ratio	i = 1	i = 1	i = 1	i = 1	i = 1
Rotor eccentricity	e = 0.09 m	e = 0.09 m	e = 0.12 m	e = 0.15 m	e = 0.15 m
Number of poles and phases	8-pole, 3-phase	28-pole, 1-phase	8-pole, 3-phase	12-pole, 3-phase	8-pole, 3-phase
Height tower pipe	H = 1 m	H = 1 m	H = 2 m	H = 2 m	H = 2 m
Total tower height	$H_{tot} = 3.7$ m	$H_{tot} = 3.7$ m	$H_{tot} = 4.7$ m	$H_{tot} = 4.7$ m	$H_{tot} = 7.5$ m
Mass with tower pipe only	m = 4.8 kg	m = 4.85 kg	m = 13.6 kg	m = 22 kg	m = 25 kg
Starting wind speed	$V_{start} = 2$ m/s	$V_{start} = 2.6$ m/s	$V_{start} = 2.4$ m/s	$V_{start} = 2.3$ m/s	$V_{start} = 2.6$ m/s
Cut in wind speed (if started)	$V_{cut\ in} = 2.5$ m/s	$V_{cut\ in} = 2$ m/s	$V_{cut\ in} = 2.5$ m/s	$V_{cut\ in} = 3$ m/s	$V_{cut\ in} = 3$ m/s
Rated wind speed	$V_{rated} = 8$ m/s	$V_{rated} = 8$ m/s	$V_{rated} = 9$ m/s	$V_{rated} = 9$ m/s	$V_{rated} = 11$ m/s
Survival wind speed	$V_{surv} = 30$ m/s	$V_{surv} = 30$ m/s	$V_{surv} = 30$ m/s	$V_{surv} = 30$ m/s	$V_{surv} = 35$ m/s
Nominal battery voltage	U = 12 V DC	U = 12 V DC	U = 12 V DC	U = 12 V DC	U = 12 / 24 V DC
Power at rated wind speed	$P_{rated} = 27$ W	$P_{rated} = 6$ W	$P_{rated} = 71$ W	$P_{rated} = 130$ W	$P_{rated} = 206$ W
Licence fee	Free	Free	Free	Free	Free

Drawings and manuals

All required drawings of the VIRYA-1.04 and the VIRYA-1.36 are given in two separate free manuals given at the menu KD-reports. Drawings for tools to camber and twist the blades of the VIRYA-1.04 are also given in the manual of the VIRYA-1.04. The drawings of the rotor of the VIRYA-0.98 are given in free report KD 615. The blades of the VIRYA-0.98 can be made without a blade press. The drawings of the rotor and the generator of the VIRYA-1 are given in report KD 679. Manufacture of the blades of the VIRYA-1 and -1.36 can be done with similar tools which can be derived from the tools of the VIRYA-1.04 but these tools are not given. For the VIRYA-1.66 and the VIRYA-1.81 the drawings of the rotor and the generator are given in the free manual. Photo's of the drawing of the head and the tower of the VIRYA-1.8 are given in part 2 of the manual of the VIRYA-1.81. All drawings are made on A3 format and then scaled down such that they could be scanned and incorporated in the manual. A set of drawings consists of a main assembly drawing and detailed drawings of all parts. A list with standard parts is given on the assembly drawing. In the manual several aspects are explained in detail including the safety system, manufacture of parts, mounting and installation.

Licence conditions

No licence is required for manufacture and sale of the VIRYA-0.98, -1, -1.25AF, -1.36, -1.66 and -1.81 windmills so anyone is allowed to build and sell these windmills. It is advised to not deviate from the drawings. Although these windmills have been designed carefully, no responsibility is accepted for the operation of a mill neither as a whole, nor for any of its separate parts.