Licence for manufacture and sale of windmill

VIRYA-3.3S

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The VIRYA-3.3S is a new type electricity generating windmill primarily designed for water pumping using a small centrifugal pump with a 3-phase asynchronous motor. However, the windmill can also be used for 24 V battery charging if the generator is provided with a low voltage winding which is rectified in star. The rotor and the head are derived from those of the former VIRYA-3D windmill which was also designed for water pumping but which made use of a special solar pump with a 48 V DC motor. The VIRYA-3D has been tested for about half a year and a photo of the prototype is given below to give an impression. The rotor blades of the VIRYA-3.3S are longer and wider. The tower is different and is a free standing tubular tower with three 3 m sections made of light 3", 4" and 5" pipe. A larger head pin and larger head bearings are used than for the first version of the VIRYA-3D.

The rotor calculations are given in report KD 567. The P-n curves of the rotor for different wind speeds and the lines for different frequencies are given in figure 4 of KD 567. This figure is copied as figure 1. The VIRYA-3.3S has a special direct drive 34-pole PM-generator which generates a frequency of 50 Hz already at a rotational speed of 176.5 rpm. The 34-pole generator is described in the free public report KD 560.

Former VIRYA-3D prototype

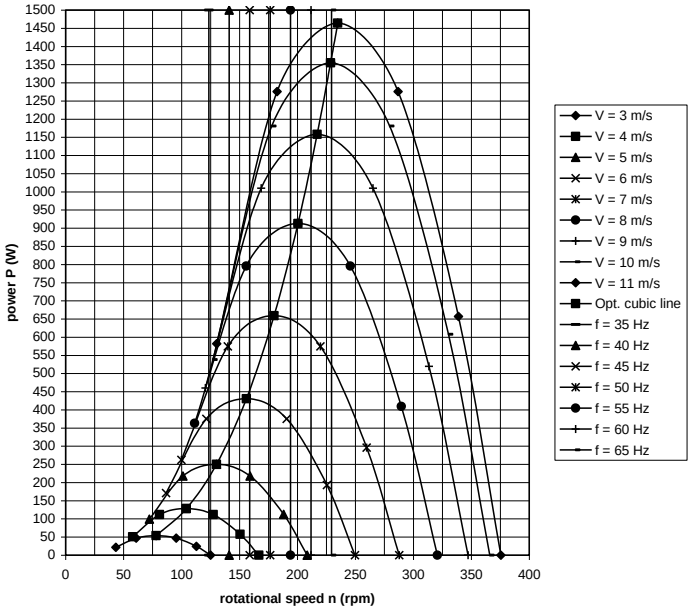

fig. 1 P-n curves of the VIRYA-3.3S rotor and lines of constant f

The optimum cubic line which goes through the tops of the P-n curves is also given in figure 1. The line for f = 50 Hz is intersecting with the optimum cubic line at a mechanical power of 630 W. This point belongs to a design wind speed of about 6.9 m/s. It is assumed that the pump has a 0.55 kW motor and that the pump and the motor can also be used at higher frequencies than 50 Hz. It still has to be investigated what maximum frequency and what maximum voltage is allowed.

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 eighteen windmills with rotor diameters from 1 to 4.6 metre haven been developed and more than 570 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-3.3S windmill

The VIRYA-3.3S windmill is designed especially for manufacture in developing countries. This windmill is designed to be coupled to the 3-phase asynchronous motor of a small centrifugal pump. The pump motor should have a nominal power of 0.55 kW and should be loaded up to maximal a factor 0.8 of the nominal power. The rotor of the VIRYA-3.3S has three curved blades which are made from 2.5 mm galvanised steel sheet. 12 blades can be made from a standard sheet size 1.25 * 2.5 m with almost no material waste. The blades are bolted to a welded spoke assembly which is bolted to the hub. A special blade press is designed for cambering the blades.

This windmill uses a generator which is made of a 6-pole asynchronous motor frame size 112. The motor is modified by a 34-pole permanent magnet armature with 51 neodymium magnets size 40 * 10 * 5 mm. The original motor shaft is used. The windmill rotor is mounted directly to the generator shaft. The generator stator is provided with a special 3-phase winding which has 18 single coils. The generator can probably be used as a brake by short-circuiting the generator winding over a resistance. A frequency controlled 3-phase switch is mounted in between the generator and the pump motor. This switch connects the motor and the generator at a frequency of about 52 Hz and disconnects motor and generator at a frequency of about 35 Hz. This facilitates starting of the rotor and gives a pulsating water flow even at low wind speeds. This switch also allows the use of a positive displacement pump or even an other load which accepts a varying frequency, like a corn mill.

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 5 m/s the rotor starts to turn gradually out of the wind. The rotor is about 35° turned out of the wind at a wind speed of 11 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. Detailed description of this safety system is given in public report KD 223 for a rotor with cambered steel blades

The free standing tubular tower consists of three, 3 metre long sections which are bolted together. The lowest section is clamped in between two heavy foundation strips which are poured into concrete. The tower can hinge at the tower foot by using only two of the eight foundation bolts, an auxiliary tower and a winch.

A prototype of the VIRYA-3.3S has not yet been built and tested but an Indian company is interested to build it and will first test a prototype of the generator. 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, magnets, electronics and pumps. The required workshop skills are sawing, drilling, turning, milling and welding.

Specification VIRYA-3.3S

Rotor diameter	D = 3.3 m
Number of blades	B = 3
Design tip speed ratio	$\lambda_d = 4.5$
Material rotor blades	galvanised steel
Material spoke assembly, head and tower	mild steel
Material vane blade	plywood
Gear ratio	i = 1
Rotor eccentricity	e = 0.27 m
Tower height	H = 8.45
Mass including tower but excluding concrete	m = 190 kg
Starting wind speed	$V_{start} = 2.3$ m/s
Cut in wind speed for water pumping	$V_{cut\ in} = 4.5$ m/s
Cut in wind speed for 24 V battery charging	$V_{cut\ in} = 3$ m/s
Rated wind speed	$V_{rated} = 11$ m/s
Design wind speed for water pumping	$V_d = 6.9$ m/s
Survival wind speed	$V_{surv} = 35$ m/s
Nominal phase voltage for water pumping	U = 230 V AC
Nominal voltage for battery charging	U = 24 V DC
Rectification generator for battery charging	star
Power at rated wind speed for 24 V battery charging	$P_{rated} = 600$ W
Licence fee excluding VAT	€ 2,000

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, generator, head, tower and dump load and detailed drawings of all parts. Drawings of a press to camber the blades 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-3.3S windmill 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 windmill has been designed carefully, no responsibility is accepted for the operation of the windmill neither as a whole, nor for any of its separate parts.