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Wind Power Harvest Machine MoWEC

Wind power can be utilised at many locations. Disadvantageous are low energy density and irregular availability. For this reason multivalent energy systems, which primarily use renewable sources, should be designed in the future. Experiences gained from MoWEC1 [1] made it possible to construct the bivalent MoWEC2 wind power plant. Natural wind energy lows can be offset with a diesel engine. The MoWEC concept will be put into practice shortly. The goal is to give rural areas a wind powered harvest machine. Floating versions are available, which incorporate the same design principles. MoWEC is not a permanent facility according to the German Federal Building Code and hence does not need a building permit.

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Keywords

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Literatur

Literaturhinweise sind unter LT 045xx über Internet http://www.landwirtschaftsverlag.com/ landtech/local/fliteratur.htm abrufbar.

The newly founded work area „Renewable Energies“ in the Institute for Production Engineering and Building Research developed the concept of an agricultural machine MoWEC. MoWEC is an acronym for Mobile Wind Energy Converter and presents a further development of available wind power facilities.

Significant MoWEC Characteristics

As a downwind runner the MoWEC makes the installation of one or more rotors possible. Due to the high efficiency level, each of the horizontal axle rotors is fastened on the upwind position on the rotor tower. Thus the downwind rotor areas can be located side by side. The performance characteristics are freely chosen at this time and are currently in the performance range of five to thirty Kilowatts in order to maintain street capable measurements. Floating models on suitable bodies of water enable significantly higher installed performance levels. A further characteristic of MoWEC is the installation of a permanent-magnet synchronous generator not at the height of the hub, but rather on the platform near to the ground. This results in bivalent constructions to provide usable energy at times when there is less wind energy. With the MoWEC, a low cost „wind power harvest machine“ shall be made available which can be used at various locations as needed.

MoWEC 1: Yaw drive frame on the platform, travel path diameter 2.65 m

First experiences with the MoWEC 1 could be collected in 2002. In this variation the frame for the yaw drive is installed on a platform which is supported on the ground with supports [1]. The platform has a shaft and wheels so that the wind power facility MoWEC 1 can be transported if needed. MoWEC 1 is driven with two three blade rotors running in opposite directions (d = 7.10 m).

Construction for the yaw drive until cut-in wind speed and reduction of the rotor areas [2]

The two towers of the rotors are fastened on the yaw drive framework. Due to the heavy weight of this construction, a driving system is required until the cut-in wind speed. Thus a driving system was sought for the MoWEC which is also usable in stand-alone functioning without external energy storage. The choice was made to use the familiar drive of the tower cap from historic windmills, which

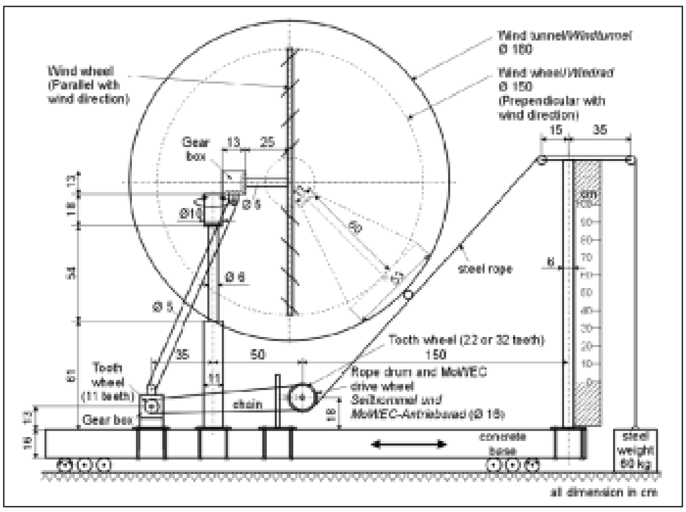

Bild 1: Abmessungen von Windkanal und Windrosette

Fig. 1: Measurement of the wind channel and of wind fantail

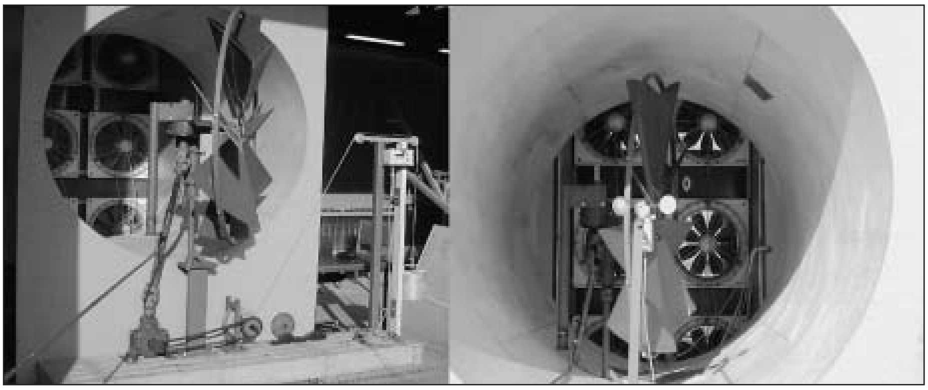

Fig. 2: Photo of the opened wind channel

is also know as a „wind rosette“ in German or as a „fantail“ in English.

Contradictory literature citations regarding the correct angle of the fantail areas and the required speed reduction ratio required for the MoWEC to achieve the required torque on the driving wheel of the yaw drive framework required own testing in a wind channel (*Fig. 1 and Fig. 2*). Theoretically the fantail diameter was then set at 1.5 m.

For the MoWEC 1 yaw drive at low wind velocities, the following construction characteristics resulted and were corroborated in tests: Diameter of the fantail with d ≥ 1.5 m; the speed reduction ratio of the fantails to the driving wheel for yaw drive with rw = 82:1; angle of the even wind areas to fantail level with f = 22.5°; number of wind areas with n = 8; MoWEC 1 total speed reduction ratio to the yaw drive with rg = 1371:1.

To protect the wind power equipment from storms, a safety system must be implemented. For cost reasons pitch controlled rotor wings are as a rule not used. Although the stall- regulation of rigid fastened wings causes a reduction of performance at very high wind speeds it is not enough to protect the equipment itself. Thus two independent braking systems are required here. For this reason, at this time one disk brake per rotor is used and a driving system to drive away the rotor areas from the wind direction through the mentioned fantail. *Fig 3* shows the changes of the effective rotor areas in dependence of the wind flow angle. In order, for example to reduce the performance limit of the rotor areas by 50 percent, the yaw drive frame must be driven 60° away from the wind. Fig. 3 also shows that minimal grade shifts to the wind direction are almost insignificant in the reduction of areas, which speaks for the implementation of this yaw drive system with fantails.

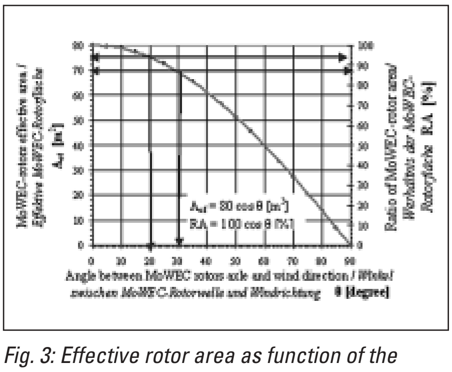

Fig. 3: Effective rotor area as function of the wind direction angle.

MoWEC 2: Yaw drive frame works on a paved ground, travel path diameter 6 m

n contrast to MoWEC 1, the yaw drive framework of the MoWEC 2 was equipped with road wheels, the travel path was paved, and the travel path diameter increased to 6 m. The rigid axle was linked to the 50 cm wide and 16 cm high armed concrete ring and equipped as a turn axle for the mounting of MoWEC 2. In this way the MoWEC 2 is supported on a large area of ground, which has a positive constructive effect.

Bivalent MoWEC 2 Version [3]: Diesel motor and wind rotor

The prototype MoWEC 2 was constructed bivalently. Both the diesel engine and the wind rotor are decoupled from each other with overrunning clutches (*Fig. 4*). The diesel motor cannot drive the wind rotor, but energy losses on the rotor bearings can be compensated due to the backwards resistance of the overrunning clutches to the resting rotors, here one rotor. The following implements requiring electricity are installed at this time: an asynchronous motor to drive a centrifugal water pump (to provide and remove water); heating elements to create heat (water or air warming); electrical energy storage in block batteries with energy removal via an inverter. The bivalent MoWEC 2 prototype can be understood as a machine with a wind power generator and a saddled diesel engine, or as a diesel motor generator with saddled wind rotor. Through the use of the renewable wind power the use of stored energy (diesel, bio-diesel, bio-fuel) can be reduced.

Floating MoWEC Constructions

The downwind direction of one or more wind power areas favours the floating construction on bodies of water, even with higher given rated power values. Both, the adaptation according to MoWEC 1 as well as MoWEC 2 are possible.

Outlook

The combined experiences with both prototypes can be evaluated as positive and now make possible the construction of a bivalent practical version, probably first on the basis of MoWEC 2 and with two four blade rotors running in opposite directions. Agricultural engineering can now be asked to co-operate to help open the market for the new „Wind Power Harvest Machine MoWEC“.

Fig. 4: Bivalent MoWEC2-prototype

Literature

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