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HYDROSTATIC SYSTEMS OF WIND MILLS

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Abstract: *Renewable energy sources - theirs using and ratio; wind mills – using in Europe, used hydrostatic systems and gears; wind mills with adjustable planetary gears ratio + conclusion.*

Keywords: ***Alternative sources, hydrostatic systems, wind mills, planetary gears.***

1. Renewable Energy Sources

The requirement of maximum use of alternative sources is one of the key points of the world economy. According to the surveys´ results, the most developed countries of the world see the increasing share of using the alternative sources of energy as one of the priorities. The current tendency in the energy commodity balance promotes a balanced "energy mix" of respective types of the sources. Their role is directly depending on the assessment from the point of view of the sustainable development and from the point of view of the economic indicators. Apart from the primary sources (fossil fuels, i.e. classical power plants, uranium), this holds true also for the so-called **alternative sources**, more often called the renewable sources. Using the existence of the mankind and its needs as a scale, the inexhaustible forms of energy come from the Sun and the Earth. The Fig. 1 shows share of world energy consumption in relations to alternative sources.

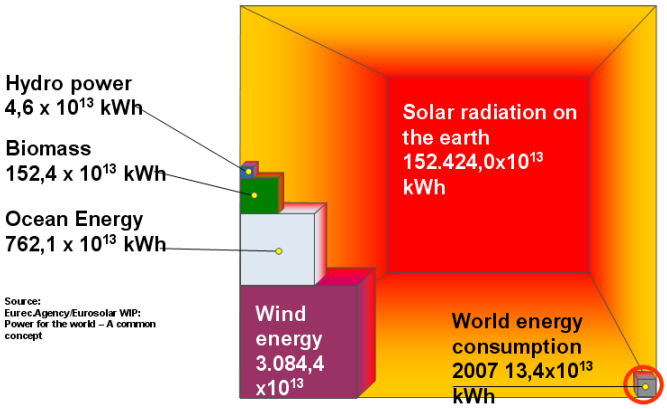

Fig. 1: Share of world energy consumption and the size of alternative energy sources.

2. Wind Mills

The industry of wind power generation has been witnessing a fast development in Europe and has been gaining a strong position on the global market. Number of wind mills in Europe 2008 is shown in figure 2. For instance, this industry employs more than 45,000 people in Germany. Significant is technological progress towards larger and larger wind generators and reduction of investment costs. While in 1992, 200kW units with the rotor diameter of 35 m were used, in 2000, 900kW units (rotor – 80m) were used. Currently, wind mills of 5 MW output and rotor of up to 129 m in diameter are being tested. The rotors are optimized in order to minimize sound emissions. Adjustable rotor blades are used to regulate the rotation speed. Nacelle of the wind mills are designed with a gear and asynchronous generators mounted by the majority of manufacturers (current share of approximately 59% of applications), or multi-pole generators right behind the rotor and efficient electronic rectifiers.

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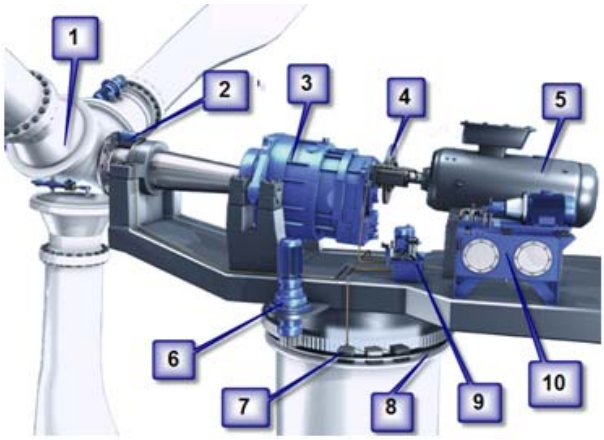
Fig. 2: Capacity of wind mills in Europe by the end of 2008.

Company Bosch Rexroth has been manufacturing drives and related technology for approximately 100 years. Since the beginning of the 90s, company REXROTH has been delivering gears for 3.2 MW equipment. Thus, the company was at the development of the wind mills right from the beginning. The cooperation with leading universities and dialogue with the global manufacturers of bearings help to increase the state-of-the-art level of these drives. Company Bosch Rexroth focuses its know-how and technical expertise on a wide spectre of products for applications of renewable sources´ use. The specialized development centre is able to address both the issues of hydraulic/electric drives and hydraulic/control circuits and also specific features of these technologies. Thus, company Bosch Rexroth enhances its role on the market as a partner of choice for global manufacturers of wind mills. Description of wind mill is in the Fig. 3.



1 - rotor with the rotor head
2 - rotor brake
3 - planetary gear
4 - generator shaft´s clutch and brake
5 - generator
6 - drive for the nacelle turning
7 - brake of the swivel base for the nacelle
8 - bearings of the swivel base for the nacelle
9 - hydraulic power unit of the rotor brake
10 - hydraulic power unit for geometry adjustment of the power blades

Fig. 3: Description of a wind mill.

3. Hydrostatic Systems of Wind Mills

The drive for hydraulic setting of the blades´ geometry (Fig. 4) complies with all the requirements: accurate regulation for the position, compact design, high dynamics, long service life and excellent reliability. All these drives are tested on the test stand and, simultaneously, all the electrical quantities are mutually harmonized. This mutual approval of signals and harmonization of electrical characteristics allows a very fast setting up of the drives for operation right after their assembly on the site. Security against failure is provided by the logical interconnection of the respective components. Their functions are based on solely mechanical principle and thus secure high reliability. Should a failure state occur, blades of the turbine are adjusted for the safe end position with accumulator without any need of an external device.

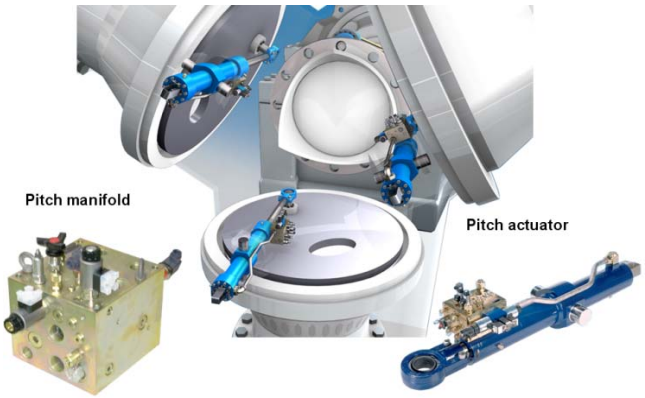


Fig. 4: Systems for the adjustment of rotor blades geometry.

4. Planetary Gears of Wind Mills

Most wind mills use gears with a constant gear ratio which changes the rotation speed and torque between the rotor and the generator. The speed of the rotor is very slow and moves between 6 – 20 rev/min with high torque. The speed of the generator is between 900 – 2000 rev/min with low torque to achieve high efficiency and adjustment of the network frequency to 50 or 60 Hz.

Bosch Rexroth manufactures and delivers two-stage planetary gears for wind mills with the constant gear ratio from 70 to 150. Gears for the wind mills are a combination of planetary and spur gearings. The special technology of grinding of the teeth´s surface secures a smooth running. The gears are also equipped with sensors for the oil pressure of the internal lubricating system and sensors for the oil heat. The gears may be custom-delivered including the sensors for monitoring the bearings vibrations with remote indication. The gear designed for generators of up to 2000 kW, with 50 – 120 gear ratio is showed on the figure 5. The gear is a combination of a planetary stage with two spur gear stages. The gears for generators of up to 5000 kW (see Fig. 6) are manufactured with 70 – 150 gear ratios. These gears are a combination of two planetary gear stages, one differential and two spur gear stages.

Fig. 5: Design of gears for generators up to 2000 kW.

Fig. 6: Design of gears for generators up to 5000 kW.

5. Systems of wind mills with adjustable gear ratio of planetary gears and a synchronous generator

The principle of regulation of a wind mill using the gear with adjustable gear ratio and a synchronous generator with constant rotation speed was successfully verified in a wind mill with output of 3 MW in 1987, for the first time.

A hydrostatic transmission on the second stage of the planetary gear allows smooth regulation of the gear ratio depending on the wind strength and speed of the wind mill rotor. The hydrostatic closed

loop consists of two axial piston units with adjustable geometric volume and option to reverse the rotation. The adjustable geometric volume of both the hydrostatic converters is adjustable by integrated proportional valves and electronic control cards. Schematic kinematic chart of the gear with adjustable transmission is in the Fig. 7.

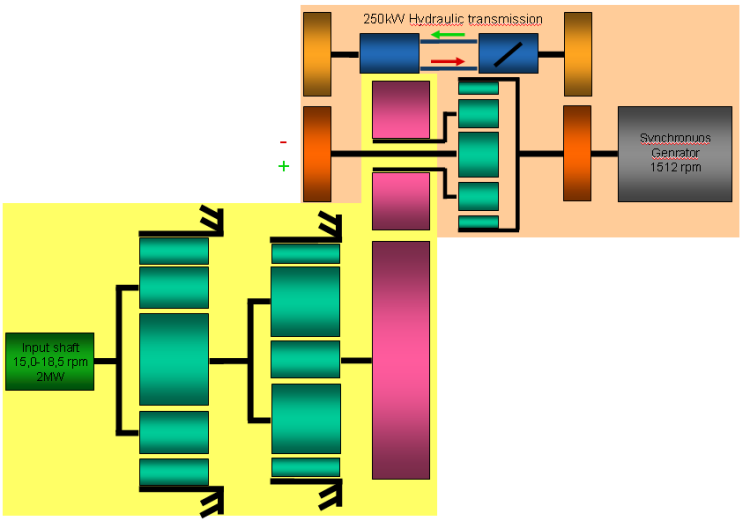


Fig. 7: Super position gear (SPG) variable ratio.

6. Conclusion

One of the advantages of this system is the fast and easy connection of the wind mill into the high-voltage network. Therefore, there is no need to install the costly frequency converters and heavy-current electronics. This solution offers and allows maximal efficient use of kinetic energy of the wind for the generation of electric power. An example of installation of a gear with adjustable ratio for the transmission of 2000 kW is in the Fig. 8.

Fig. 8: Super position gear variable ratio photo for transmission of 2 MW.

Resources

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