TECHNISCHE UNIVERSITÄT WIEN
Vienna | Austria

Institute of Energy Systems
and Electrical Drives
Gußhausstr. 25-25a
1040 Vienna, Austria
www.ieam.tuwien.ac.at

Electric Planetary Generator

Smaller volume and integrated gears

New, lighter and energy-efficient electric machines with smaller volume are required – at lower costs – for energy-efficient electricity generation from renewable energy sources, such as wind and water, as well as for the widespread, efficient recovery of energy for use in electromobility and railways, as well as in industrial applications such as conveyors and construction machinery.

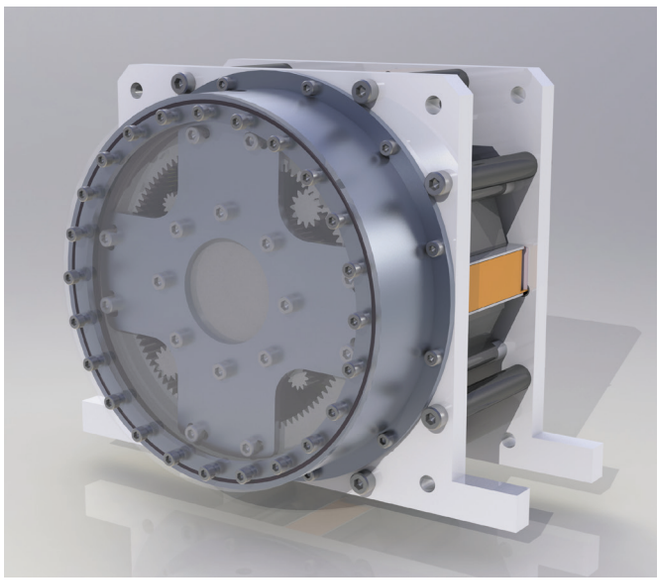
The machines currently on the market mostly require spur gears or planetary gears in order to connect the mechanical drive to the electric motor and achieve the desired speed adjustment. The gears and motor are two functionally and spatially separate components. The rotor's rotational speed is limited by the mechanical strength of the rotor material. Typically, peripheral velocities of 100-200 m/s can be achieved cost-effectively.

Objective

Prof. Manfred Schrödl and his Electric Machines and Drives research group at TU Wien aimed to develop a simplified, particularly powerful motor-gear system. They wanted to find a way to raise the performance limits of machines by increasing the rotor speeds without changing the peripheral velocity. The objective was also to ensure the gear could be integrated into the electric machine as far as possible, while saving on mechanical components.

Solution

The basic idea for the newly developed machine type is to divide the conventional single rotor design into a multi-rotor system. Compared to single-rotor machines, the rotors share a common stator with a simple winding system. This saves on copper and iron. The magnetisation in the rotors, which rotate synchronously, but in opposite directions in pairs, is preferably realised through permanent magnets.



However, other variants, such as reluctance machines for example, are possible.

The rotors are mechanically coupled by a gear that is similar to a planetary gear. Half of the rotors are driven by an internally-toothed ring gear, whereas the other, in opposite direction rotating half is driven by an externally-toothed sun gear. The rotors resemble the planets of a planetary gear, hence the name of this machine.

The ring gear and sun gear rotate in the same direction and, if dimensioned accordingly, with the same angular velocity. Therefore, they can be mechanically linked in order to evenly distribute the power from the main shaft to all rotors.

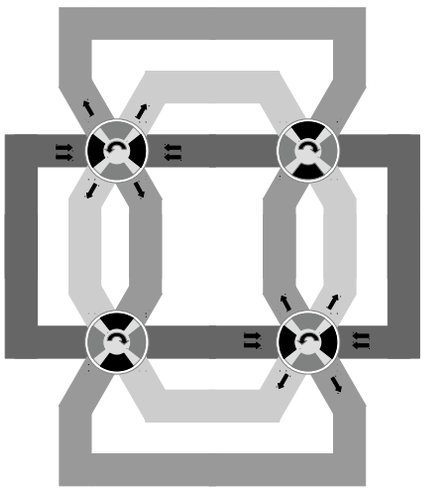
To obtain an even more cost-effective system, the planetary generator can be controlled without sensors using the combined control technology of the INFORM and EMF methods, which has been used successfully for years in thousands of drives. This allows fault-prone sensors to be eliminated and the installation space to be reduced even further. A highly dynamic, robust, cost-effective drive is achieved in this way.

Results

The gears become an integrated component of the machine.

The power electronics can be housed easily on the front, on the opposite side to the gears. This, together with the winding configuration, will bring significant advantages for automated production.

The measurement results from a prototype with an integrated 10:1 gear reduction show that the electrical behaviour at the terminals of the planetary generator corresponds to a classic three-phase machine, controlled by a conventional inverter.



Planetary motor with 4-pole rotors (the straight arrows signify the magnetic flux density in the phases U, V, W of the stator)

The benefits for you

- Compact motor system thanks to the integration of machine and gears
- Higher power density resulting in a weight reduction with the same performance
- Reliability due to the elimination of sensors
- Lower production costs
- Less magnet material at the same rated power

Applications

- Aerospace
- Wind power plants
- Hydropower plants
- Alternator
- Emergency generators

Notes

Contact

Prof. Dr. Manfred Schrödl
TU Wien
Institute of Energy Systems
and Electrical Drives
www.ieam.tuwien.ac.at
T: +43 1 58801 370 212
manfred.schroedl@tuwien.ac.at