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Measurement and Torque Calculation of Magnetic Spur Gear Based on Quasi 3-D Analytical Method

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A mechanical spur gears inherently suffer from the drawbacks of high transmission loss, bulky size, high noise, wear-and-tear. In order to alleviate these problems, magnetic spur gears are designed which use the magnetic force. They offer the advantages of reduced silent operation, overload protection and maintenance fee. As the magnetic spur gear diverges in all directions according to the divergence theorem of magnetic flux, a leakage flux in the z-axis direction develops. Therefore, it is necessary to consider the magnetic flux in the z-axis direction for the accurate analysis of the characteristics and for the calculation of torque. Thus, in order to design a magnetic gear through the three dimensional (3D) finite element method (FEM), however it is time consuming and the results are not intuitive. It is difficult to design a magnetic gear that has variable design point. However, by using analytical methods, the analysis time is shorter than 3D FEM and is intuitively understood according to the change of parameters. This paper deals with design and analysis of the magnetic spur gears using analytical method. Based on the governing equation and boundary condition, analytical solutions are obtained for magnetic fields produced by source magnets. Based on these solutions, the magnetic field are determined analytically. Next, the drive magnet is reduced to equivalent current densities, and the torque is computed on these current densities in the external magnetic field, which is obtained from simpson's method. Finally, in order to consider the z-axis direction magnetic flux, by employing the curve-fitting. We proposed a quasi- 3D analytical method using curve-fitting and verified it with 3D FEM and experimental results. The detailed analysis results, discussions, and measurements of the magnetic spur gear will be presented in the final paper.

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