Innoverse Expo 2025

Evaluation of the effect of using magnetic gear in improving the performance of process systems based on mechanical gear

1) Alebouyeh,Ava, Valeh Educational and Cultural Institute , 12 th grade, Tehran, Iran (pajohesh.dept@valeh.ir)
2) Bahman,Baran, Valeh Educational and Cultural Institute , 12 th grade, Tehran, Iran (pajohesh.dept@valeh.ir)
3) Ezzati,MohammadHossein, Valeh Educational and Cultural Institute , 12 th grade, Tehran, Iran (pajohesh.dept@valeh.ir)
4) Ferdosizadeh,Elyar, Valeh Educational and Cultural Institute, 11 th grade, Tehran, Iran (pajohesh.dept@valeh.ir)
5) Radmatin,Artin , Valeh Educational and Cultural Institute, 10 h grade, Tehran, Iran(pajohesh.dept@valeh.ir)

Supervisor: Arjmand, Mohammad (pajohesh.dept@valeh.ir)

Valeh Educational and Cultural Institute

Iranian Youth Science and Technology Center

2025

Abstract

Mechanical gear trains have used for industrial power transmission for decades, but their application due to their direct tooth contact presents inherent drawbacks: sliding friction that leads to energy dissipation and the production of heat; cumulative wear that requires lubrication and maintenance; high noise levels not suitable for sensitive environments; and reduced motion accuracy due to backlash, which creates positioning errors in rotary systems. For high-precision operations—such as robotics, semiconductor manufacturing, and automatic inspection—these shortcomings result in instability, reduced control accuracy, and increased operational cost in these systems.

The NEW MAGNETIC GEAR SYSTEM, the central innovation of this project, offers a contact-free solution that minimizes these deficiencies. Instead of meshing steel teeth, it utilizes concentric rotors with permanent magnets integral within, interacting with a ferromagnetic stator. Torque is transferred through guided magnetic forces, which significantly reduce friction, wear, and backlash. Smooth rotational motion, improved positional accuracy, and compatibility with existing mechanical systems are supported by this design, with performance being maintained under long-term operating conditions.

To explore the idea's feasibility, magnetic gear simulations were performed to forecast torque output, rotational behavior, and energy loss through magnetic drag and eddy currents. **Parametric analysis** of magnet geometry, rotor gap, and pole pattern allowed for the location of an optimum compromise between torque density and minimal resistance. Simulation offered a working basis for building prototypes and guiding experimental confirmation.

Experimental testing was also performed on two similar configurations powered by the identical electric motor, one with the NEW MAGNETIC GEAR SYSTEM and the other with an ordinary mechanical gear. Dynamic response, efficiency of transmission, sound pressure, and temperature difference were analyzed using motion analysis equipment for a wide range of operating conditions. Measurements showed excellent conformity with simulated predictions, confirming the design's feasibility.

Performance testing revealed the NEW MAGNETIC GEAR SYSTEM performing much more effectively, with considerably less acoustic emissions, and backlash reduced to near-zero levels. Thermal testing indicated greatly diminished heat buildup on extended operation, and endurance tests demonstrated uniform torque output over extended usage cycles—translating into longer maintenance cycles and greater reliability.

Practical usability was demonstrated in a simulated model of conveyor belt and mixer. In both cases, the NEW MAGNETIC GEAR SYSTEM offered silky-smooth start-stop transition, more precise speed control, and clean operation with no need for major drivetrain modification. The demonstrations confirm that the system is now available for using into different industrial environments.

By enabling silent, precise, and low-maintenance torque transfer with reduced mechanical contact, the NEW MAGNETIC GEAR SYSTEM aids United Nations Sustainable Development Goals —7.fostering affordable energy, 9.resilient infrastructure, and 12.sustainable manufacturing. **Future development** will focus on achieving maximum torque capacity using next-generation magnetic materials and optimizing the system for broader use in heavy equipment, precision robotics, and automated manufacturing platforms.

Keywords: ***Magnetic Gear- Non-Contact Power Transmission-Functional Efficiency-Industrial Automation***