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Electromagnetic actuator to reduce vibration sources

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In order to improve passenger comfort, a reduction of vibration sources in vehicles is being considered by the manufacturers. The vibrations can be compensated mainly by 4 ways : mechanical damping (passive system), hydraulic or pneumatic actuators, electromagnetic actuators [1], piezoelectric actuators.

As part of a study with Airbus, these solutions were compared: there is no universal solution, each should be used to compensate specific frequencies, amplitudes and forces, for a closed loop regulation.

In particular, Airbus wanted to compensate a vibration on an aircraft engine for which an electromagnetic actuator was recommended. (The specifications are : maximal force 6kN, frequency approximately 100Hz, movement amplitude $3\mu\text{m}$, volume 10cm (length) x 10cm (width) x 20cm (height), temperature between -50 and $+150^\circ\text{C}$).

Different topologies of electromagnetic actuators were compared and the chosen one was an electromagnet whose geometry has been optimized.

In regard of the 3D shape of the magnetic circuit, the choice of soft magnetic composite was quite natural because of its electromagnetic field isotropy.

In order to simulate the global system and estimate losses, we need an accurate model. [2], able to modelize dynamic hysteresis.

The aim of this study consists in finding a global behaviour model of the actuator that can give the temporal evolution of physical quantities and the different losses.

A first prototype that meets the main specifications has been built in the laboratory. The electromagnetic force, so as magnetic and electrical signals (voltage U , current I , magnetic flux ϕ , magnetizing field H , magnetic induction B) generated by the actuator, and finally the actual losses, confirms that the soft magnetic composite is a good material candidate for this kind of actuators.

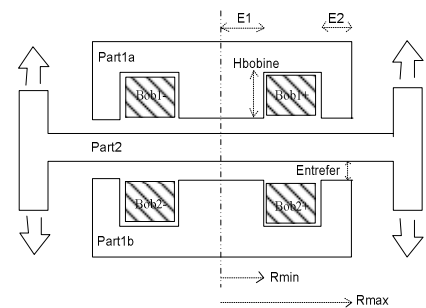


Figure 1: General aspect of the actuator

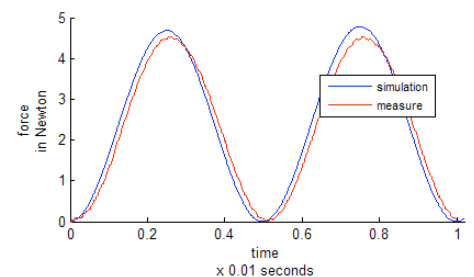


Figure 2: Simulation and measure of the force at 100Hz and 25°C

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- [1] Zupan et al./Actuator Classification and selection- The Development, Advanced Engineering Materials, Vol. 4, N°12 2002
- [2] Dynamical Models for Eddy Current in Ferromagnetic Cores Introduced in an FE-Tuned Magnetic Equivalent Circuit of an Electromagnetic Relay, Sixdenier F., Raulet M.-A., Marion R., Goyet R., Clerc G., Allab F., IEEE Transactions on Magnetics 44, 6 (2008) 866-869