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Analysis of Magnetorheological Brake System with a Fuzzy Logic Controller

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ABSTRACT

The conventional contact type brake system which uses a hydraulic system has many problems such as time delay response due to pressure build-up, brake pad wear due to contact movement, bulky size, and low braking performance in a high speed region. As vehicle speed increases, a more powerful brake system is required to ensure vehicle safety and its reliability. In this work, a contact less brake system using a magnetorheological is proposed to overcome the problems. The magnetorheological fluid found applications first of all in brakes and dampers. A coil supplied with power is placed on the moving component of the converter or inside the casing, depending magnetorheological fluid enable to change the parameters of a mechanic system (rigidity, braking force) as a result of electric voltage and current control.

1. INTRODUCTION

Conventional brakes and clutches require complex mechanical parts to transmit the energy. Large size and therefore high weight make the problem more serious. In addition, the control of such devices is usually passive. Fortunately, this sort of problem may be solved by introducing magnetorheological (MR) fluids as a medium to transmit the required energy. MR fluids, as well as their counterparts electrorheological (ER) fluids have the characteristics that their rheological properties can be continuously and reversibly changed within milliseconds solely by applying or removing a magnetic field. This feature has inspired the design of a large variety of power transmission devices based on the use of MR and ER fluids, such as brakes and clutches [1–3]. Choi et al. [1] compared performance characteristics of ER and MR clutches, and derived a non-dimensional model to determine the principal design parameters. Lee et al. [2] produced a simplified mathematical model to describe MR clutch performance by the analysis of the magnetic field using the FEM method and the computation of fluid flow by CFD (computational fluid dynamics). Bolter and Janocha [3] proposed an MR fluid disc clutch based on the shear mode and analysed the magnetic field configuration in the clutch to determine the principal design parameters. Taking into account several design considerations, including maximum torque, ratio of maximum on-state to offstate torque, and maximum speed, Carlson and Duclos presented design equations for ER brakes and clutches [4]. Considering the difference between static yield stress and dynamic yield stress, Lampe et al. [5] derived torque-transmitted equation to evaluate "bell"- and "disc"-shaped clutches, and a new friction and wear less permanent magnet seal for MRF was described. Papadopoulos [6] proposed a multi-disc ER clutch and analyzed the field-dependent torque through experimental realization at various temperatures. A force display device in virtual reality with ER brakes was investigated by Furusho and Sakaguchi [7]. A clinical walker with ER-activated brakes was commercialized in Japan [8], with highly favorable evaluations by patients, doctors and clinical workers.

The objective of this work was to implement high-efficiency MR brake with high transmittable torque, good long-term stability and simple construction. The mechanical performance of the MR brake was experimentally evaluated.