

Dynamic simulation of the Power Shift Drive (PSD)-Axle in the Forklift

Ji Won Yoon¹, Tae Won Park², Kab Jin Jun³, Soo Ho Lee³, Sung Pil Jung³

Summary

Industrial vehicles like forklifts are used in many areas, such as the heavy industries, shipbuilding, and manufacturing industries. Recently, the rise in the oil prices and stricter environmental regulations have created the need for new technologies for industrial vehicles. Presently, the performance of the power train has reached its limit and cannot be further improved without increasing cost, weight and volume. Therefore, a system based on a new paradigm is needed. To achieve this goal, the structure of the power transfer system needs to be revolutionized. First, weight and size need to be reduced. In addition, the number of gears should be increased. Furthermore, various features could be added to meet the needs of customers. A PSD-Axle, which can meet such specification, is a new conceptual automatic transmission system that combines the transmission and the drive axle. With the PSD-Axle, it weighs 30% less than the existing automatic transmission for the forklift. Therefore, it provides many benefits, such as fuel savings and increased fuel economy. Automatic transmission and drive axle that are usually used in cars are composed of a torque converter, a transmission and a drive axle. However, the PSD-Axle is installed in-between the bevel gear and the differential. The systems are different from the existing power train for the forklift. Furthermore, the helpful operations such as automatic parking brake, anti-slip against hill, on-the-spot 360°-rotation is possible. To model the PSD-axle for simulation, good understanding about the automatic transmission and components of the drive axle integration is necessary. There has been much researches done on vehicle automatic transmission, especially for the transient response and gear shift pattern generation of the transmission, as well as the simulation of dynamic system modeling by commercial tools. In this research, a model for the new conceptual power transfer system was developed. Power Shift Drive (PSD)-Axle vehicle modeling and dynamic behavior analysis were performed by numerical simulation. The dynamic model of the PSD-Axle was constructed from the data obtained from the derived equation, considering the specific characteristic of each part. By unifying the mathematical equation of each component into one equation, the mathematical model for the 1st forward gear was derived. Based on the mathematical model, a system dynamic

¹Ajou University, Department of mechanical engineering, San5, Wonchon-Dong, Yongtong-Gu, Suwon, Korea, 443-749, kelvin71yo@hotmail.com

²Ajou University, Department of mechanical engineering, San5, Wonchon-Dong, Yongtong-Gu, Suwon, Korea, 443-749

³Ajou University, Division of mechanical engineering, San5, Wonchon-Dong, Yongtong-Gu, Suwon, Korea, 443-749, park@ajou.ac.kr

model was created using MATLAB/Simulink and ADAMS software. The simulation was carried out to analyze the dynamic behavior of the PSD-Axle. Also, the reliability of the model was verified by the dynamo test result.