HYBRID STEERING FOR REDUCING FUEL CONSUMPTION OF COMMERCIAL VEHICLES

During the course of a development project undertaken by the Truck Product Engineering department at Daimler AG in close collaboration with Karlsruhe Institute of Technology (KIT), a methodology was developed for modelling and validating a reduced fuel consumption hybrid steering system for trucks. To establish an optimum system design and to evaluate a variety of technologies for the hybrid steering system, a development methodology approach was put forward. This will allow the developer to make a detailed analysis of the complexity of this mechatronic system, to quantify the optimisation potential and to draw up a requirement profile for the simulation and experiment-based development environment, taking particular account of modelling quality and development efficiency.
1 INTRODUCTION

According to the BGL (Federal German Association for Road Haulage, Logistics and Disposal), fuel costs, at 26% of total costs, represent the greatest cost factor after labour costs [1]. This means that optimizing the energy-efficiency aspects of auxiliary assemblies and sub-systems is acquiring ever increasing importance in the commercial vehicle sector. There is a great potential to increase energy efficiency in the hydraulic open centre steering system (HPS-OC) used today in commercial vehicles.

In order to evaluate the energy flows in the hydraulic open centre steering system in current use, the degree of mechanical power assistance was measured on test runs by a 40 t semitrailer truck equipped with pressure sensors. The power steering pump’s mechanical input, which, together with the power steering assistance, is strongly influenced by the individual flow losses in the steering system, was determined by precise measurement of the individual steering components on a purpose-built hardware in the loop (HIL) test stand in the research department at Daimler AG.

Using the recorded test run data, illustrates the distribution of the parameters for servo torque and steering wheel velocity, parameters, which are decisive factors for the hydraulic servo power. The distribution of the parameters for power steering pump pressure and delivered volume, parameters that characterise the power steering energy input, are also shown. A theoretically-calculated comparison shows that the degree of mechanical power assistance used represents just approximately 1% of the power input.

The high losses are attributable to the fact that the traditional power steering pump generates a delivered volume dependent on the engine speed and feeds it against the system pressure, irrespective of the actual steering requirement. Since the steering system is designed to meet the criterion for maximum steering speed when turning the steering wheel while the vehicle is stationary, this results – even at engine idling speeds – in the requirement for a relatively high pump displacement volume [2]. At higher engine speeds, the system volume flow is limited, when the residual delivered volume being ducted into a return run inside the pump [3]. The effect of this, particularly for long-haul commercial vehicles, is a constant hydraulic power loss due to the long distance element in their overall mileage.