

Energy Generating Suspension System for Commercial Vehicles

Shaiju M. B. and Mukul Mitra

Ashok Leyland Limited

Copyright © 2008 SAE International

ABSTRACT

Fuel consumption has been a core consideration since the beginning of the transportation era. These are reasons related to our environment, and to economics. In the competitive truck industry fuel consumption is an important sales argument, since customers on an average drive their trucks for distances of 150 000 km per year, which means that fuel becomes a large part of the lifetime cost for a vehicle.

Existing braking system design in commercial vehicles are basically air assisted, which utilizes the compressed air from reservoir, which is being replenished based on requirement by a positive displacement compressor, generally driven directly by vehicle power pack.

In this paper, an effort has been made to partially use the energy stored in the springs (induced due to road undulations) for compressed air generation through a single acting positive displacement pump. The system design and its interface are done considering the actual measured data on a 16T Goods Vehicle at various road and road traffic conditions, namely, the in-city cycle, highway cycle and off-road cycle for both laden and unladen applications.

The preliminary analysis of the data shows a positive indication of availability of simple harmonic displacements after re-sampling of data. The re-sampling has been done using macros developed in Microsoft Excel® and the system response is developed based on the order of re-sampling. It can be strongly inferred from the acquired data that this novel design has a potential to extract road energy and support conventional braking system of commercial vehicles.

1.0 INTRODUCTION

Indian Commercial Vehicle Industry operates at a much lower power to weight ratio with 150 hp, 180 hp & 250 hp engines for 16.2 / 25 ton, 40 and 49 ton GVW applications respectively.

The Indian customer base and market are driven by parameters like fuel economy, operating cost and serviceability and in such cases any initiative taken for improving these factors would lead to customer delight.

With ever demanding customer needs and aspirations, there is a need for continuous improvements in our products with innovative features that lead to both tangible and intangible benefits to customers on day-to-day basis.

Continual Improvement & Innovation is a way of life in Automotive Industry to keep them competitive. Existing braking system design in commercial vehicles are basically air assisted, which utilizes the compressed air from reservoir and is being replenished based on requirement by a positive displacement compressor, driven directly by vehicle power pack (Engine). This is a potential opportunity to reduce the load on engine.

Commercial trucks in India are majorly packaged with Semi Elliptical Type Leaf Spring Suspension & shackle arrangement, which are basically intended to meet the loading requirements. There is an opportunity to trap the latent energy and also to improve ride.

2.0 BRIEF OVERVIEW OF EARLIER WORK

Though this area has not been of much interest to the researchers, however a patented design [Patent No: KR900004455B] by Lee Eon Goo [1] of Hyundai Motor Company Limited was found to be quite interesting. An electromagnetic linear generator and regenerative electromagnetic shock absorber is disclosed which converts variable frequency, repetitive intermittent linear displacement motion to useful electrical power. The innovative device provides for superposition of radial components of the magnetic flux density from a plurality of adjacent magnets to produce a maximum average radial magnetic flux density within a coil-winding array. Due to the vector superposition of the magnetic fields and magnetic flux from a plurality of magnets, a nearly four-fold increase in magnetic flux density is achieved over conventional electromagnetic generator designs.



Documents

Document Sharing Hub

with a potential sixteen-fold increase in power generating capacity.

As a regenerative shock absorber, the disclosed device is capable of converting parasitic displacement motion and vibrations encountered under normal urban driving conditions to a useful electrical energy for powering vehicles and accessories or charging batteries in electric and fossil fuel powered vehicles. The disclosed device is capable of high power generation capacity and energy conversion efficiency with minimal weight penalty for improved fuel efficiency.

3.0 CONCEPT PROPOSAL & BENEFITS

3.1 ENERGY EXTRACTION MECHANISM – A THOUGHT

The idea is to extract energy from vertical oscillations of road wheels that is experienced while operating on various road profiles. A mechanism that would capture the vertical oscillation of road wheel can be assigned to actuate a positive displacement (PD) pump. The PD Pump is connected to a reservoir unit to store energy in the form of pressure energy (Compressed Air). The stored energy is utilized by integrating the same with braking circuit of vehicle, thereby reducing the load of conventional braking system.

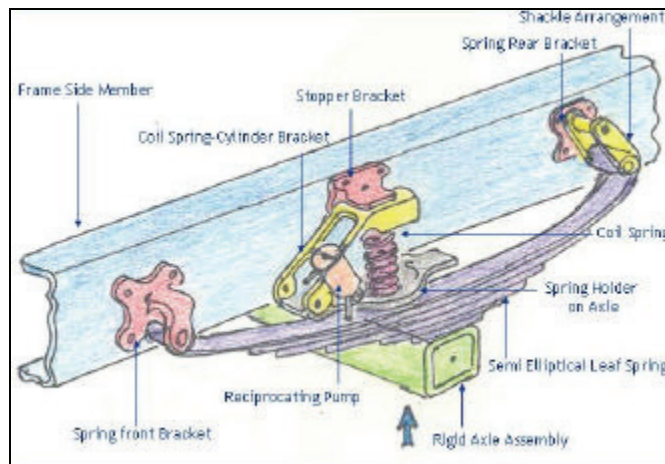


Fig 1: Initial Concept Sketch

A concept as shown in Fig 1 is proposed to reduce the power extracted from the engine to drive the compressor unit to meet the compressed air requirement that supports conventional braking system. Endeavor would also focus on improving the ride of the vehicle by introducing air damping effect onto mechanical suspension and tuning the overall suspension to create a balance between load carrying capability and improved ride characteristic.

3.2 BENEFITS OF THE NOVEL DESIGN

1. Reduction in charging load on air compressor and thereby on Engine by integration of vehicle braking system with novel energy source

2. Improvement on efficiency of Braking Circuit due to reduced input from engine, keeping the output same or better.
3. Improvement in Vehicle Ride by an Improved Suspension System design with air damping effect.
4. Entrapping a latent energy source, which may be explored further.
5. Reduction in the operating cost with a potential of improving fuel economy of vehicle with minimal weight penalty.

4.0 AXLE BEHAVIOUR STUDY FOR A TIPPER

4.1 DATA ACQUISITION

A preliminary axle displacement study is made from actual data acquired from SLF Viking Chassis on torture track at Ashok Leyland Technical Centre. The data selected for initial study was for an interval of approximately one minute (65,496 data points) on a normal road, which is assumed to be the worst-case criterion for the performance of the novel design.

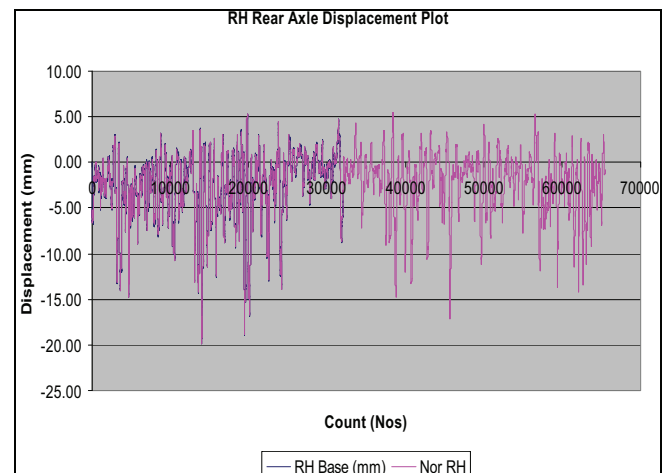


Fig 2 Axle Displacement Data - TTDT (Courtesy -ALL)

The above graph shows the rear RH axle displacement values (absolute) for one-minute interval. The same data was re-sampled (approximated) for 5 mm least count of displacement using macros developed in Microsoft Excel®.

This data was plotted to understand the pulsation or strokes distribution that would be available for extraction of work from axle displacement. The above torture track data of axle displacement on a straight road enkindles some confidence on the feasibility of the novel idea as these graphs substantiate potential energy extraction; however the same cannot be used for detailed study or calculation as these data points are not suitable for performance studies.