УДК 629.3.017.5

TESTING OF A HYDRAULIC HYBRID HEAVY GOODS VEHICLE

© William J.B. Midgley[1] and David Cebon[2]

e-mail: w.j.midgley@lboro.ac.uk

[1] *Loughborough University, UK*

[2] *Cambridge University, UK*

Introduction

Heavy goods vehicles can save energy if they are used for urban delivery instead of smaller vehicles [1]. However, electric machines and batteries are unsuitable for hybridising semitrailer axles, and hydraulic systems are preferable [2]. A hydraulic hybrid regenerative braking system, integrated with trailer steering axles was designed and built for a semitrailer [3–5]. This paper describes some of the results from testing.

Method

The system was built as described in [4]. Several component tests were undertaken to determine system parameters such as pressure drops and heat transfer coefficients for the high- and low-pressure accumulators. The vehicle was tested at Bourn Airfield in Cambridgeshire, UK over a series of stop-start cycles. These results were then used to validate a computer model, which was used for further analysis over a range of drive cycles.

Results

During testing, the hydraulic hybrid system reduced the fuel consumption of the vehicle by 17.5% over a simple stop-start cycle. This reduction does not consider the added mass of the regenerative braking system, which is estimated at 1,868kg. Under simulation, it was found that the hydraulic components reduced the fuel usage by 7.4% per tonne.km of freight transport. However, if the prototype hardware were replaced with a “commercial” system using carbon fibre accumulators, it is expected that the benefits would increase to a 11% fuel saving over a simple stop-start cycle.

The lighter-weight design was then simulated over a range of urban test cycles, both with and without engine stop-start (turning the engine off when the vehicle is stationary), which is enabled by the ‘launch assist’ characteristic of the hydraulic system. Under these conditions, the system reduced fuel usage by 6.5-18.1%, depending on the cycle.

There are significant fuel usage gains when moving from rigid vehicles (20t maximum total mass) to articulated vehicles (44t maximum total mass) [1]. These gains can be achieved by the trailer steering technology implemented on the test vehicle [3]. This is also true when looking at regenerative braking – when moving from rigid vehicles to articulated vehicles with regenerative braking and trailer steering, it is apparent that 23%-42% of fuel can be saved, depending on the characteristics of the urban cycle.

Conclusions and Further Work

A hydraulic regenerative braking system for a heavy goods vehicle was designed, built and tested. The system saved 17.5% fuel when tested over a simple stop-start cycle. In modelled scenarios, a “commercial system” using carbon fibre accumulators could save up to 42% fuel when compared to a rigid goods vehicle.

As electric systems have become lighter and more powerful, the case for hydraulics is no longer as clear-cut. The authors suggest further studies into the viability of hydraulic regenerative braking, and the development of a commercial system for in-service testing.

References

1. A. M. C. Odhams, R. L. Roebuck, Y. J. Lee, S. W. Hunt, and D. Cebon, “Factors influencing the energy consumption of road freight transport,” Proc. Inst. Mech. Eng. Part C-Journal Mech. Eng. Sci., vol. 224, no. 9, pp. 1995–2010, 2010.

2. W. J. B. Midgley and D. Cebon, “Comparison of regenerative braking technologies for heavy goods vehicles in urban environments,” Proc. Inst. Mech. Eng. Part D J. Automob. Eng., vol. 226, no. 7, pp. 957–970, 2012.

3. W. Midgley and D. Cebon, “Architecture of Regenerative Braking Systems for Heavy Goods Vehicles,” AVEC 10. Loughborough, UK, 2008.

4. W. Midgley and D. Cebon, “Specifying a hydraulic regenerative braking system for an articulated urban delivery vehicle,” in 2011 IEEE Vehicle Power and Propulsion Conference, VPPC 2011, 2011.

5. W. J. Midgley and D. Cebon, “Control of a hydraulic regenerative braking system for a heavy goods vehicle,” Proc. Inst. Mech. Eng. Part D J. Automob. Eng., vol. 230, no. 10, pp. 1338–1350, Sep. 2016.