SRF CASE STUDY

The results of the recent in-service testing of Waitrose trucks are in and Waitrose Transport Unit are very pleased with the resulting fuel savings…

The origins of the Centre for Sustainable Road Freight's aerodynamics project stem from earlier research into boat tailing carried out by Cambridge University students and Professor Holger Babinsky. The work began with systematic wind tunnel testing of various improved aerodynamic designs at Cambridge, aimed at optimising aerodynamic performance.

Further testing was carried out when the design was implemented under the TSB/OLEV funded Low Carbon Truck Demonstration Trial. This programme provided a total of £11 million to encourage road haulage operators in the UK to buy and test low carbon commercial vehicles. Waitrose has 6 tractors and 6 trailers trucks in service with the following modifications:

- A tapered 'boat tail' rear of trailer carefully designed not to reduce payload capacity or door opening.
- Lower overall vehicle ride height;
- Smooth trailer underside and open rear section to help air flow out from underneath;
- Tractor aerodynamic kit matched to trailer - with gaps filled.

These trucks were subject to coast down testing by SRF researchers [1] to determine the rolling resistance and aerodynamic drag coefficient. These can be used by a simulation tool to predict fuel consumption in normal operations. The results showed a 14% reduction in aerodynamic drag coefficient and a 3-6% reduction in rolling resistance coefficient for the modified vehicle; in comparison with the unmodified vehicle. Based on the SRF fuel consumption model[2], a 14% reduction in aerodynamic drag is expected to give approximately 7% reduction in fuel consumption when driving the modified vehicle at highway speeds.

In June 2015, after the coast down tests, Waitrose carried out back-to-back tests comparing fuel consumption between the same modified vehicle and reference un-modified lorry. To test the effect of the aerodynamic modifications on fuel consumption, Waitrose drove the trucks from Bracknell to Leicester Forest Services on the M1 – a 250 mile round trip. The drivers set off

5 minutes apart to eliminate slipstream as a factor and swapped vehicles half way to negate the effects of different driving styles.

Results

Waitrose measured a fuel saving of 7% by the modified vehicle in comparison to their standard vehicle. This was consistent with the a-priori predictions made by the researchers.

Actions and Improvements

Under the project, modifications were made to the design of Waitrose refrigerated vehicles. The use of refrigerated vehicles allowed researchers to design a 'boat-tail' solution which cut into the trailer's insulation, rather than lowering the door height, to accommodate the tapered profile. This meant that the capacity of the trailer was not affected and no cages were lost as a result of the modifications. Under direction from Waitrose, adjustments were made to the original aerodynamic design in order to accommodate the loading dock infrastructure whilst maintaining the optimum boat tail angle.

"Waitrose is seeing 7% savings in fuel from recent in-service tests."
-Justin Laney, Fleet Manager, JLP

In addition to this, side skirts were made to cover half the wheels with the aim of reducing the drag of the wheels. The half skirt design was developed in collaboration with Waitrose. The skirts were designed to have a hinged mechanism, differing from the standard bolted on skirts. This enables easier access to the underbody and wheel nut indicators without removing the skirt.

In December 2013, Waitrose introduced 6 of the new trucks into service with the aerodynamic modifications. Another 30 were brought into service in 2015. Warburtons also put 4 of the vehicles into service in 2014-15 and they are now standard specification for future purchases.

The trailers cost £4,500 more than the standard vehicles to produce, with an estimated payback period of 2 years and a lifetime of 10 years, making this a cost effective solution.

Benefits and Impacts

Industry benefits include:

- 7% Fuel savings and CO2 reduction
- Cost reductions
- Improved CSR performance

Benefits to Academia

The research demonstrates successful collaboration between academia and industry. It applies a carefully optimized solution in an economically viable way to show strong benefits.

Benefits to Government and policy:

Under the 2008 Climate Change Act, the UK is committed to reducing emissions by at least 80% by 2050 from 1990 levels.

Improving aerodynamic design minimises drag and leads to a reduction in fuel consumption and associated emissions. This research provides Government with a clear methodology for quantifying aerodynamic improvements and quantification of a best-practice approach.

References

[1] Midgley, W. J. and D. Cebon (2014). Coast-down Testing of Heavy Goods Vehicles. Centre for Sustainable Road Freight Technical Report CUED/C-SRF/TR06,ISSN: 2054-4081,University of Cambridge.

[2] Odhams, AMC, Roebuck, RL, Lee, YJ, Hunt, SW, and Cebon, D. 'Factors influencing the energy consumption of road freight transport'. Proc IMechE Part C, J Mech Eng Sci,Vol 24, No 9, 2010, pp 1995-2010.