Truck semi-trailer aerodynamic enhancements (Part 1)

Last year at the IAA commercial vehicle show in Hanover, Germany, I took great notice of the low-drag semi-trailer that Mercedes Benz displayed. It caused me to consider what the potential for aerodynamic improvement is on the Australian truck fleet.

Let's look at the enhancements that were on display. The Schmitz Cargobull trailer, which is shown in the photos, had side skirts on the trailer running from the back of the prime-mover to behind the trailer axle group; trailer side skirts that were slightly drawn in at the front; ducts at the rear that collect air on each side and deflect it into the low-pressure zone behind the trailer; a vent hole at the back allows air from underneath the trailer to flow into the trailer wake; the front of the trailer curved to allow close-coupling with the truck; rounded front edges; as well as boat-tail or rear-taper deflectors at the rear which 'soften' the rear edges of the trailer.

These developments are intended to firstly separate the tyres from the passing airflow and secondly, to introduce airflow into the low-pressure zone behind the trailer. Thirdly, they aim at reducing the turbulence zone spacing between the truck and trailer.

In addition, the prime mover and trailer are closely coupled, which reduces turbulence between the two vehicles. Side panels at the rear of the cabin also close-up the gap. The deflector on top of the prime mover is well matched to the trailer so that the air flow is streamlined between the truck and top-front of the trailer .

Mercedes Benz claims that this semi-trailer combination has a drag coefficient that is 18 per cent lower than a basic combination vehicle that has no aerodynamic styling. The breakdown of the improvements is:

- 1 per cent resulting from the close-coupling of the truck and trailer,
- 8 per cent reduction due to the side skirting on the truck and trailer,
- 1 – 2 per cent reduction due to the duct and diffuser low down at the rear of the trailer, and
- 7 per cent due to the rear taper at the back of the trailer.

Aerodynamic drag is about 30 per cent of the total drag of a long-distance highway truck. And mechanical losses in the engine, drivetrain and bearings make up the other 30 per cent. The total aerodynamic styling package is claimed to reduce the fuel consumption by 4.5 per cent compared to an untreated current-generation European truck-semitrailer combination. Let's assume that the truck consumes 1.1 litre/km (2.6 miles/gallon). If a litre of diesel costs $1.50, then the fuel saving is worth 7.4 c/km. If the truck has a one-million kilometre lifespan, the total saving in current Australian dollars is about $74,250! As fuel costs are likely to go up in the real terms, the saving will probably be much greater.

The full aero package might be a bridge too far. What about the benefit from side skirting on the trailer only? The benefit of total side skirting is estimated to be about 8 per cent and on the semi-trailer only the improvement is about 6 per cent. Assuming the same assumptions as used previously, the saving due to trailer side skirting is $24,750. This money has to be paid for up front, so there is an opportunity cost over ten years of about half this value. The net result is a modest saving.

But even if the benefit is revenue neutral, side skirting is worthwhile. Why? Firstly, because serious crashes involving pedestrians, cyclists and some cars (involved in glancing collisions) getting under the trailer wheels will be prevented. The reduction in serious collision risk for the highway truck is probably in the range 5-10 per cent. Notably, the European Union has adopted ECE Regulation 73, which mandates lightweight side under run protection barriers on new trailers. European semi-trailers need to have a barrier, so it might as well be an aerodynamic side skirt.

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Secondly, there is a greenhouse gas saving over the life of the trailer of about 8.25 tonnes of CO_2. The push for our industry to reduce greenhouse gas emissions will grow in importance over the coming years, irrespective of what the government thinks or does. The climate change argument is now settled. Climate change is real and man-made emissions of CO_2 are a significant factor in climate change. The heavy-transport logistics industry will need to respond with action. Aerodynamic streamlining of long-distance trailers could make a modest contribution. It would also be noticed by the travelling public.

In my next article, I will discuss the 1/3 scale truck-semitrailer model that Monash University Mechanical Engineering Department is currently testing in a wind tunnel.

This is one aspect of a significant research project that both PACCAR Australia (Kenworth and DAF trucks) and ARTSA are supporting. Monash is investigating 'third-generation' aerodynamic truck enhancements; which direct airflows at selected locations to reduce the turbulence and hence the drag of the truck.

Fortunately, Australia has a first-class research capability that is specifically directed at researching truck aerodynamic performance.

Peter Hart
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