FUEL EFFICIENCY STARTS WITH AERODYNAMICS

The right tractor-trailer model outfitted with proper aerodynamic devices can give you significant fuel savings.

BY MIKE ROETH

SHELL
LUBRICANT SOLUTIONS

> **CHASSIS FAIRINGS CAN OFFER 2–4% IMPROVEMENTS** IN FUEL ECONOMY AND TRAILERS WITH SKIRTS OFFER **A FURTHER 1–5% FUEL SAVING** COMPARED WITH THOSE WITHOUT.

Over the past few decades, aerodynamic tractors have become standard. Truck makers have worked constantly to improve tractor-trailer aerodynamics, and flagship models have been optimized at the complete vehicle level to provide the best performance for a significant portion of customers.

Improving fuel economy is the primary motivation for using aerodynamic devices. However, there are other benefits from using these devices, including slightly improved vehicle stability, decreased splash and spray and reduced driver fatigue.

Tractor aerodynamics increase fuel efficiency by lowering air resistance so that less fuel is needed to move the vehicle along the road compared with a vehicle with greater drag. Although it takes more fuel to drive at higher speeds, the fuel-efficiency benefit associated with better aerodynamics increases at higher speeds. The fuel economy benefits of optimizing tractor aerodynamics can be high – classic sleepers use up to 30% more fuel than modern, aerodynamically optimized tractors, according to the North American Council for Freight Efficiency (NACFE).[1]

Once a fleet has selected an aerodynamic tractor, the next step is to tackle the next three areas with the greatest potential for improving aerodynamics: the tractor-trailer gap, the underbody area and the trailer rear (Figure 1).

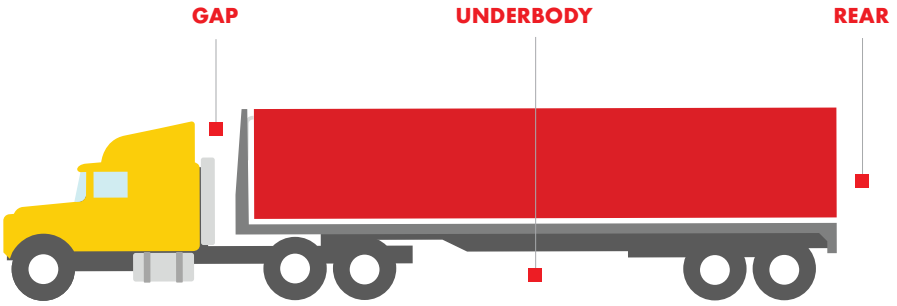

FIGURE 1. The three areas for aerodynamic improvement.

The elements of an aerodynamic tractor are illustrated in Figure 2. Aerodynamic tractors have high roofs and well-tuned trailing edges such as cab extenders, trim tabs and bridge fairings, which are being added to the rear of some roof fairings. Such tractor devices have largely reduced the importance of trailer aerodynamic gap devices. However, multiple studies and tests have shown that, as the trailer gap gets longer, overall aerodynamic drag increases.

Aerodynamic devices, including extenders and fairings for the sides, roof and chassis of the tractor, are available to help reduce the tractor-trailer gap. Extenders help to close the tractor-trailer gap by extending the vehicle's side surfaces over the gap without interfering with the trailer swing and dip motion that may occur at loading dock aprons. Their purpose is to restrict air flow entering the gap by shortening the space between the tractor and the trailer and directing the air over the gap to the trailer side. Without extenders, air leaving the rear edge of the tractor hits the front edge and face of the trailer, thereby increasing drag. Crosswind conditions, sometimes referred to as yaw, would likewise increase drag without extenders.

1. Bumper with air dam and rounded ends
2. Rounded hood leading edges
3. Sloping hood
4. Rounded A-pillars and curved windsheilds
5. Aerodynamic mirrors and mounting arms
6. Low profile or integrated flush marker lamps
7. Aerodynamic roof
8. Aerodynamic roof rear extensions
9. Aerodynamic extenders
10. Wheel covers
11. Gaps filled
12. Chassis fairings
13. Flexible fairing ground effects strips
14. Close fitting fenders
15. Conformal headlamps

FIGURE 2. The various aerodynamic tractor elements. (Source: Peterbilt, cited in NACFE Confidence Report: Tractor Aerodynamics.[1])

Chassis fairings are underbody devices designed to provide a clean aerodynamic surface on tractor sides. They eliminate the multiple forward-facing steps of exposed chassis components. These devices are also designed to kick air slightly outboard of the tractor drive wheels, so that it does not directly impact on the faces of the tires. Chassis fairings can offer 2–4% improvements in fuel economy for aerodynamic tractors pulling 53-ft van trailers.

Drive wheel fairings also help to improve aerodynamics. They are mounted between and behind the drive wheels of the tractor to streamline the airflow around the rotating tires and to direct airflow as it leaves the tractor.

For the trailer underbody, skirts are the most popular drag-reduction devices. Trailer underbody skirts extend the trailer sidewalls closer to the ground, preventing wind from entering under the trailer and flowing into the non-aerodynamic trailer bogie. Trailers with skirts offer a 1–5% fuel saving compared with those without.

Although skirt performance varies with wind conditions, skirts benefit most operations by reducing overall fuel use. The absolute saving achieved differs by user and depends on a variety of factors. Trailer skirt designers focus on providing lightweight yet robust products that can withstand the rigors of trucking. Most skirts on the market today are flat sheet materials bracketed to the underside of the trailer floor structure. The sheets can be composite, metal or both. Some manufacturers offer formed or molded panels. In 2015, nearly 30% of trailers were equipped with skirts. Today, 50% use skirts to improve underbody aerodynamics.[2]

Another type of underbody device is the bogie fairing, which moves the air away from the trailer bogie. The benefit of the bogie fairing is that it provides greater clearance and better access under the trailer than full skirts.

The generally smooth air flowing along the large flat sides of the trailer detaches as it passes the sharp rear corners of the trailer box, thus generating a series of vortices that create a low-pressure region, thereby adding to tractor-trailer drag.

Rear-mounted trailer devices are generally called boat tails or trailer-wake devices. They modify the air flow as it leaves the trailing edges of the sides and top surfaces of the trailer. The goal is to reduce the wake field following the trailer, which can affect the air some distance from the back of the trailer.

Typical tail devices stow flat against the rear-swinging doors. An automated system enables easy deployment of the devices to their on-highway configuration and locks them in place. About 5% of trailers are now equipped with tail devices.[2] New trailer tail devices mitigate or eliminate issues with first-generation devices and should help to increase their use.

There are other aerodynamic devices that can be added to a tractor or trailer that will result in incremental gains in fuel economy. Wheel covers for both tractor and trailer, vented mud flaps, vortex generators, roof extenders, and replacing mirrors with cameras are some of the more popular options.

FIGURE 3. Tractor-trailer with chassis fairing and trailer skirt.

[1]NACFE Confidence Report: Tractor Aerodynamics
https://nacfe.org/technology-guide/tractor-aerodynamics/

[2]NACFE Confidence Report: Trailer Aerodynamics
https://nacfe.org/technology-guide/trailer-aerodynamics/

U.S. Department of Energy Technology Roadmap for the 21st Century Truck Program
https://www.energy.gov/sites/prod/files/2014/03/f8/21ctp_roadmap_2007.pdf

Society of Automotive Engineers Practical Devices for Heavy Truck Aerodynamic Drag Reduction
https://www.sae.org/publications/technical-papers/content/2007-01-1781/

www.shell.us/fleetadvantage