Teardrop™

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What Is The Teardrop™?

The Teardrop™, first conceived in 2006, is a unique commercial vehicle shape that mimics the natural and perfect aerodynamic properties of a liquid teardrop. The streamlined shape generates a 10%* fuel saving and a 10% increase in cubic capacity. The concept is not complex or new. As early as 1921, the aerodynamic shaping of automobiles was developed initially by a German inventor called Edmund Rumpler, who subsequently launched the "Tropfenauto" or "teardrop car".

Today, although you may not be consciously aware of it, the teardrop shape is all around us. Modern examples include the Toyota Prius and Honda Insight; both of which have exceptionally low aerodynamic drag. Brick-shaped cars no longer exist except in the garages of the most enthusiastic of collectors.

Why then, almost a century later, has the proven technology not been used in commercial vehicles? Why is it that HGV's continue to be some of the least aerodynamic shapes found on the planet and contribute one of the largest proportions of our countries emissions?

The Teardrop™ significantly reduces fuel consumption without affecting internal capacity. For those that now own them, they proudly stand out amongst the crowd; representing companies that demand better efficiency and care about their impact on the environment…

…companies that are perhaps now more attractive to those they supply.

▲ The 1921 Edmund Rumpler "Tropfenauto"

▲ Toyota Prius: Cd = 0.26

▲ High Speed Cycle Helmet

▲ Teardrop™ Trailer

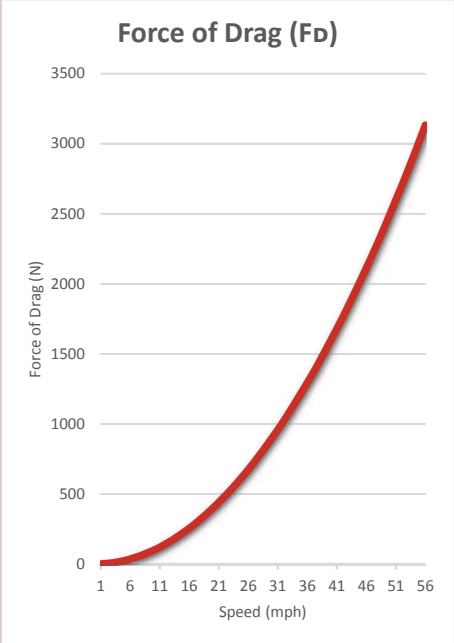
Patents: GB2443035 and GB2474379.
Community Registered Designs: 000867593-0001, 000709423-0002 and 000709423-0001.

*Based on average of independent 3rd party case studies.
Actual Teardrop™ trailer fuel saving average: 11.3% at time of publishing.

Why Does This Affect You?

"One standard tractor/trailer combination travelling 60,000 miles in a year at an average of 8.5mpg will consume 32,080 litres of diesel and create 84 tonnes of CO_2 at a cost of over £31,400*.

As fuel can represent 1/3rd of your transport operation cost, a 10% fuel saving can make an impact on the profitability of the company as a whole by 3.3%."



▲ Force of drag experienced by a trailer as it moves through air.

* based on 96 pence per litre.

Fuel Consumption: A Basic Guide

Fuel consumption is primarily attributable to 3 things:

(1) Inertia

A vehicle at rest contains inertial energy and in order to accelerate, a force must be applied continually. This force is provided by additional throttle (fuel) which generates more power from the engine. Once the vehicle has reached a constant speed, the engine power is only required to counteract the 2 remaining forces. Hence a vehicle that is continually accelerating/ decelerating will consume considerably more fuel. This can be improved with driver training and route planning.

(2) Rolling Resistance

(a) Internal and transmission losses: Within the engine/gearbox/propshafts and axles, there are numerous components that move and come into contact with other parts - creating further friction. Engine, truck and axle manufacturers continually improve on this area.

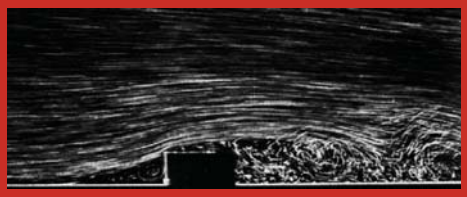
(b) Tyre Friction: As a vehicle passes over a road surface, the tyres create friction and energy is converted into heat which disperses naturally. A pneumatic tyre flexes as it revolves and comes into contact with the road surface: draining momentum energy. Energy efficient tyres create less friction and will therefore save a proportion of fuel.

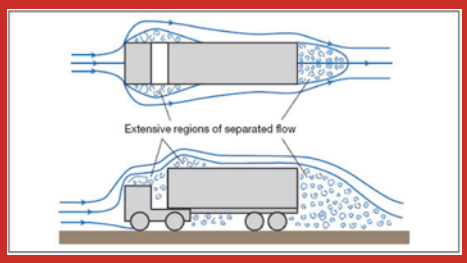
(3) Aerodynamics

As aerodynamics accounts for a major part of fuel consumption at cruising/trunking speeds and, as Don-Bur has little control over inertia or rolling resistance, this is the area Don-Bur has focused on.

Aerodynamics applies next to, and around an entire vehicle (Tractor-trailer/ Rigid chassis-bodywork). With this in mind, Don-Bur not only had to consider the effect created by the trailer, but also had to understand the airflow created from the tractor as well.

▲ "Brick" Wind Tunnel Analysis





▲ Aerodynamic "Profile" Drag

▲ Natural Teardrop

▲ The Teardrop™ Shape

The key, and most influential aerodynamic factor is Form/ Profile Drag. In the case of a common household brick, air flowing over it is disrupted to the point where virtually all airflow: before, over and behind it, is turbulent and creating drag. This is due to the fact that air cannot slide smoothly over any of its surfaces and becomes unstable and chaotic.

Applied to a tractor/ trailer combination, this can be applied to 6 main areas:

(1) Frontal Cab Area
(2) Tractor/Trailer Gap
(3) Sub-chassis
(4) Roof
(5) Sides
(6) Rear

By streamlining a vehicle, you minimise the turbulence, reduce drag and lower fuel consumption.

If a liquid is placed on a flat surface and passed through the air, it will naturally form an inverse teardrop shape as the air moulds it and the forces acting on each surface reach equilibrium. Similar to an aerofoil, the tear-drop is the aerodynamic ideal for an object travelling over a surface.

The new aerodynamic "Teardrop™" tractor-trailer shape mimics the perfect aerodynamic lines of a teardrop and significantly reduces the co-efficient of drag (Cd) by incorporating a specially designed continuous full-length curve on the roof. Beginning at a height to suit the cab top deflector, the roof gradually curves upwards before gently tapering off at the rear: main-taining a generous rear aperture. The smooth roof line encourages airflow to "hug" the surface and reduce the low pressure cavity at the rear.

Standard Trailer

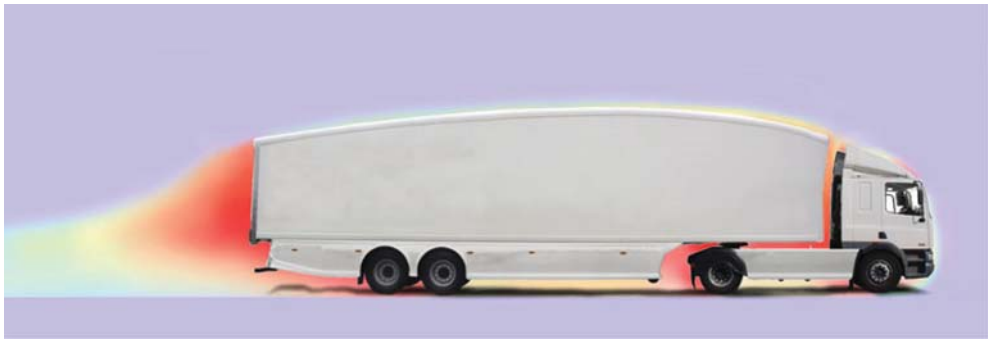
Wind Tunnel Illustration

Turbulence Illustration

Teardrop™ Trailer

Wind Tunnel Illustration

Turbulence Illustration



$Fd = Cd\ A\ \frac{1}{2}p\ V^2$

Fd: The overall force being applied to an object as a result of aerodynamic drag.

Cd: Coefficient of Drag: how "streamlined" an object is.

A: Total frontal area that the airflow hits.

p: Density of air.

V: Velocity

Cd Values for 3D shapes

The Relationship Between Aerodynamics & Cubic Capacity

For many operations, internal capacity is just as critical, if not more so, than fuel savings; hence the success of double deck trailers despite their poor fuel efficiency.

The problem that arises when you round off the corners of a box is that internal cube reduces. The question then is "If I increase the size of the box, what effect does that have on the aerodynamics?"

The answer is explained using an accepted formula (shown left):

From this, we can initially see that a simple increase in height will increase the force of drag; however, we can also deduce that streamlining has an equally, if not more powerful effect.

The challenge then is to improve the streamlining to the point where it counteracts and exceeds the negative impact of raised height. Surprisingly, this is not difficult.

Despite an example increase in height of 300mm, the overall aerodynamic drag force acting on a Teardrop™ trailer reduces by almost 36%.

By taking rolling resistance and drive line losses into account, we can calculate a total reduction in force of circa 18% at a constant speed. This 18% means a theoretical fuel reduction of 18%; however, a constant speed is never practical and each operation is subject to varying routes, driver skills, tyre specifications and weights.

3rd Party Trials

Below is a summary of all verified trials conducted to date:

Box Van Teardrop™ Trials	**% Fuel Saving**
Commercial Motor Teardrop™ Track Testing	23.7
Gist: Mira Track Tests	8.02
DHL Marks & Spencer	10.14
Multiple Retailer: Designer Garments/ Soft Furnishings	12.37
Multiple Retailer: Car/Bike Accessories	6.36
Multiple Retailer: Computer Hardware & Accessories	5.5
FMCG Retailer: Garment Operation - Multi-Drop To Supermarkets	12.3
Multiple Retailer: High Street Garments	10.04
Multiple Retailer: Value High Street Department Stores	12.2
High Street Convenience Store Chain	15.3
Multiple Retailer: Health & Beauty - Trunking Operation	18
Major Parcel Operation	19.82
Major Brand: Electrical Brown Goods	7.89
FMCG Retailer	4.5
Multiple Retailer: Catalogue Department Stores	15
Multiple Retailer: Garments	4.03
Multiple Retailer: Baby/Childrens Dept	8.2
Multiple Retailer: House & Home	16.22
Major 3PL: Technology Arm	18.54
Multiple Retailer: Office Products	4.75
Multiple Retailer: Budget Homewares	11.37
Blue Chip Department Stores	4.5
Major 3PL: Parcels	15.4
Blue Chip Multiple Retailer	16.5
Healthcare Logistics	10
Average (Not Including Track Tests)	11.26

Curtainsided Teardrop™ Trials	
Gist: Mira Track Tests	15.25
Major 3PL Consumer Net	5.69
Major Brand: Biscuit Manufacture	8.53
Major 3PL: Beverages	14.7
Multiple Retailer: House & Home	8.16
Manufacturer: Plaster, Plasterboard	5.65
Manufacturer: Plaster, Plasterboard	9
Logistics & Distribution	23
Packaging Supply Chain	14.7
Average (Not Including Track Tests)	11.18

Other Teardrop™ Operators

Rigid Teardrops™

Following the success of Teardrop™ trailers, Don-Bur extended the concept to Rigid Bodywork. Aerodynamic effect is at its greatest at higher speeds and, although some Rigid Bodies are limited to urban routes only, many commonly face comparatively long runs from out-of-town distribution centres before completing their urban delivery runs.

Results from Teardrop™ Rigid trials show that fuel savings can reach 8%, although the highest figure quoted by one operator was 9.5%.

Rigid Teardrop™ Operators

Summary

Achieves optimum aerodynamic efficiency and reduces fuel consumption.

- Cuts CO_2 Emissions
- Increases Cubic Capacity: Potential to increase load fill (If applicable) and reduce delivery frequency.
- Retains durable aerodynamic design simplicity in the bodywork itself.
    - GRP add-on moulds damage more easily.
- A cost-effective product with a rapid pay-back period.
- A product that is seamlessly compatible with the fleet.
- Same 26 GKN pallet footprint does not alter existing payload layout.
- Maintains a striking, aesthetically pleasing design.
- Now available with the following options:
    - Box Van Trailers
    - Curtainsided Trailers (including Pillarless & EN 12642-XL)
    - Low height, European Specification
    - Straight or step frame designs
    - Double Decks
    - Rigid Bodywork
    - Temperature Controlled
    - Draw-Bars
    - De-Mountable Bodywork

Thank You

If you have any questions about this document, or would like to discuss your operational requirements, please call the Don-Bur sales department on 01782 599 666

Established in 1981, the Don-Bur Group has become internationally recognised for its innovative development of trailers and rigid vehicle bodies, designed to minimise operational costs and increase efficiency.

Don-Bur has committed to research and develop solutions with primary focus on aerodynamics and optimum utilisation of available cubic capacity.

Based in Stoke-on-Trent in the West Midlands, Don-Bur has a 500 strong flexi workforce and generates a group annual turnover of £50 million. Vertically integrated divisions include an 18 acre primary manufacturing site, curtains and load restraint division, graphics house and two after-sales service sites (repair, servicing, refurbishment and ATF Station).

The comprehensive structure provides a complete and fully accountable solution for clientele, catering for all commercial vehicle needs throughout their lifespan.