



An Introduction to Aerodynamics

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Introduction

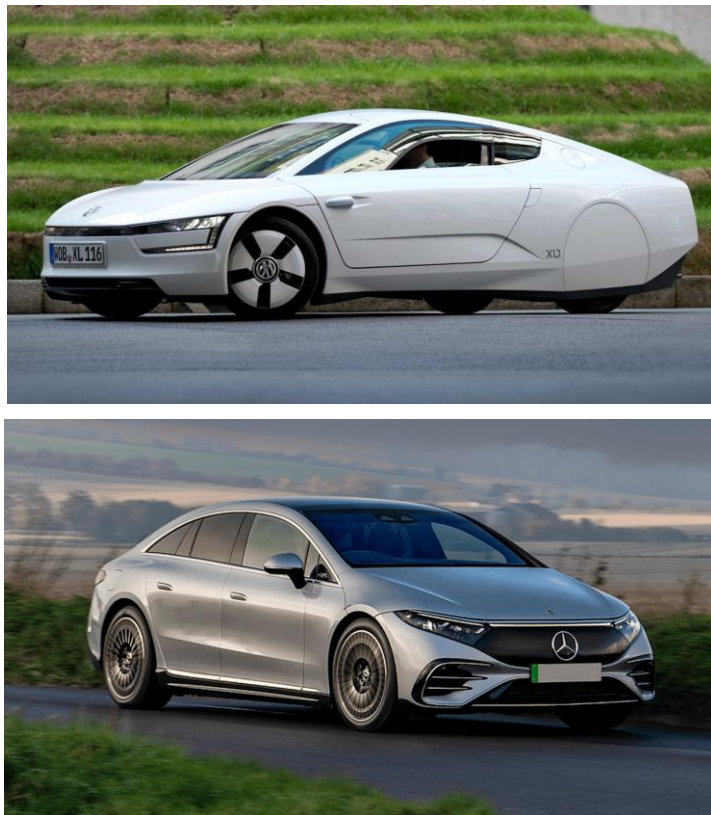
Vehicle aerodynamics are important for multiple reasons. The aerodynamics of a vehicle can improve its fuel economy, increase speed, improve handling and improve its overall stability. The keyways that aerodynamics improves a vehicle is by reducing drag and generating downforce.



Example of the Vauxhall Corsa getting tested in a wind tunnel. (nationwide vehicle contracts)



Rear wing of a McLaren P1 GTR. (Photo by Angel Luciano on Unsplash)



Examples of the Volkswagen XL1 (2015-16) featured above and the Mercedes-EQS (2021-present) featured below. (Photo from carwow)

Downforce against Drag

- Downforce is the force that pushes your car towards the road.
- Drag is the resistance a vehicle experiences while moving through air.

Finding the balance between downforce and drag is extremely important. The issue with downforce is that the more it increases the more drag you get.

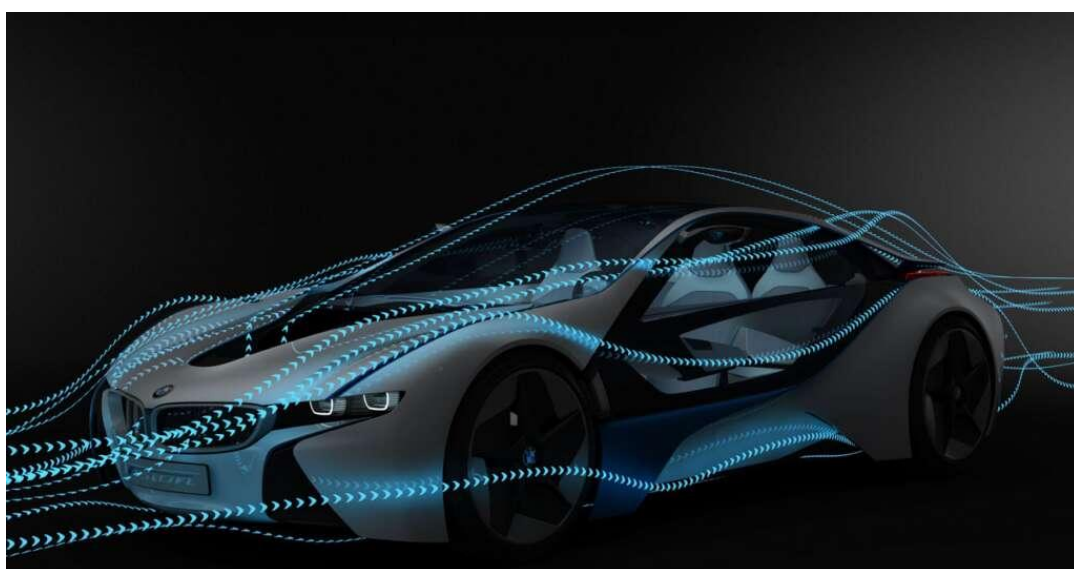
Drag Coefficient

In general, the drag coefficient can be explained as how aerodynamic a shape is. As seen in the diagram on the right the smoother the shape the less drag coefficient there is. This means that;

- Less energy is required to push the shape.
- There is less air resistance pushing on the shape.
- Known as a “cd” figure.

Shape		Drag Coefficient
Sphere		0.47
Half-sphere		0.42
Cube		1.05
Streamlined Body		0.04
Streamlined Half-body		0.09

Aerodynamic drag coefficient for different shapes. (example from x-engineer)



BMW Vision of Efficient Aerodynamics (example from BMW)

Wings and Spoilers

- Wings generate their own downforce. The angle of the wing is important, too high and it creates more drag and too low it creates less downforce.
- Spoilers manage the airflow of the car to reduce drag and lift. The spoiler also helps with improving the stability of the car at high speeds.

Wind Tunnels

A wind tunnel is used to:

- Replicate real world conditions.
- Measure lift and downforce.
- Simulate wind conditions.

Wind tunnels can be used on regular vehicles or scaled down models for a cheaper alternative. The results of a wind tunnel can allow a manufacturer to make adjustments to reduce the air resistance on a vehicle.

Front Splitters and Rear Diffusers

- Front splitters are designed to push air under and over the vehicle to improve frontal downforce.
- The frontal downforce helps to achieve better control on the steering.
- Rear diffusers helps the airflow underneath the car to go faster.
- The improved airflow creates a zone of low-pressure which improves the vehicles rear grip.

Real-world application

- The Volkswagen XL1 is considered the most aerodynamic commercial vehicle.
- It boasts a drag coefficient of only 0.199.
- Unfortunately, it only had a production of 250 units.
- The Mercedes-EQS is the current most aerodynamic commercial vehicle still in production.
- It boasts a drag coefficient of 0.202.

The importance of the real-world application is that it helps with the fuel economy of commercial cars.

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