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Driving to reduce exhaust emissions

This Factsheet looks at how driver behaviour can significantly affect their vehicle emissions. Educating drivers to these effects is being considered as part of the government's strategy to reduce air pollution.

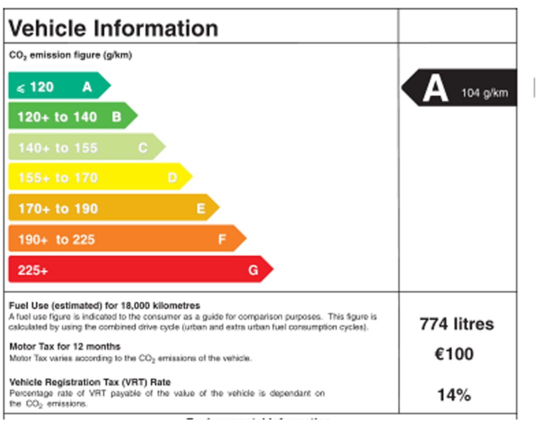
Of the 33 million vehicles on our roads, 27 million are cars. Even the shortest car journey releases a cocktail of toxic gases into the air:
- Carbon dioxide
- Carbon monoxide
- Nitrogen dioxide
- Sulfur dioxide
- Particulates
- Benzene
- Formaldehyde
- Polyaromatic hydrocarbons (PAHs)

The NHS estimates that these emissions are responsible for 24,000 premature deaths in the UK each year. The environmental impacts are diverse and severe – climate change, acid rain, reduced crop growth etc.

Governments invest in public transport systems that try to reduce individuals' use of private vehicles – it is usually more efficient to transport 50 people to work on a bus than to allow half of them to drive alone. But people love their cars and now the government have begun a programme to try to educate the public about how driving choices and behaviour can reduce emissions. The principle is that if we can't persuade people not to drive, then the next best thing is to force car manufacturers to make it clear about their vehicles' emissions and to educate the public about how to drive more efficiently.

All new cars must comply with strict EU vehicle emission standards covering carbon monoxide, hydrocarbons, nitrogen oxides, and particulates. The UK Government has introduced financial measures to encourage people to buy cars with lower CO_2 emissions. The annual Vehicle Excise Duty (VED) rate for new cars is based upon their CO_2 emission figure and the type of fuel used - discounts are available for alternatively fuelled cars, e.g. hybrids, gas and biofuels.

Car fuel economy label



All new cars now have a fuel economy label allowing people to choose models with high economy and low CO_2 output. Generally, the bigger the engine, the greater will be the emissions.

Emissions from new cars are measured in what is known as the New European Driving Cycle (NEDC). This is a series of accelerations, steady speeds, decelerations and idling periods conducted in robot-driven vehicles. The robots are programmed to drive the vehicles for exactly 19 minutes on a rolling road in a laboratory held at 20^0C.

It is designed to match typical urban driving. However, it doesn't take account of "real world" effects e.g.

- the use of car accessories such as air conditioning and heaters
- vehicle payload (only the driver +25kg is considered in the test, no passengers or further luggage)
- the impact of poor maintenance such as under inflated tyres (fuel consumption increases by 1% for every 3 PSI under pressure)
- gradients (tests effectively assume a level road)
- weather e.g. windiness
- passive or aggressive driving style

Because of these limitations, many scientists argue that the emissions data obtained is not representative of the emissions from any type of "real world" driving!

Driving behaviour

How we drive has a significant effect on fuel consumption and emissions. Strategies to minimise emissions include:

- Regular servicing - tuning, tyre pressure, brakes and fuel consumption
- Remove roof racks when not needed - roof racks add drag and the extra weight increases fuel consumption
- Vehicles tend to emit more pollution during the first few miles of the journey when their engines are warming up so the first few miles should be driven steadily.
- Fit low rolling resistance tyres
- Avoid using cars for short journeys
- Drive gently – racing starts and sudden stops increase fuel consumption
- Drive at a steady speed – at around 50mph (80 kph) emissions will be lowest, rising dramatically above 70mph (110 kph)
- Switch off the engine when stationary when stuck in traffic or stopping more than a minute
- Minimise use of air conditioning, heating and on board electrical devices
- Liftshare

Which fuel?

Different fuels have different environmental impacts (Table 1)

Table 1 Advantages and disadvantages of fuels

Fuel	Advantage	Disadvantage
Petrol	Lower NOx and particulate emissions than diesel	High CO_2 emissions
Diesel	Lower CO_2 emissions than petrol	Higher particulate and NOx emissions than petrol
Biofuels	More carbon neutral than petrol or diesel	Large land take to grow the crops
Liquid Petroleum Gas/ Compressed Natural Gas	Very low CO_2 and particulate emissions	Limited availability Low energy density requires large gas tank
Electricity	Virtually no emissions at the point of use	Batteries are heavy Were fossil fuels used to generate the electricity?
Fuel cell	Emit water!	Most hydrogen is generated from reforming natural gas

Aggressive and passive driving

Aggressive driving increases emissions. Typical characteristics of aggressive driving include:

- Rapid accelerations and heavy braking
- Keeping up with the vehicle in front at any cost
- Rapidly reaching maximum driving speed
- Reckless overtaking

Passive driving involves using moderate acceleration and braking and maintaining a steady speed below the speed limit. In a garage emissions are measured using a chassis dynanometer - a treadmill for cars (Fig.1)

Fig. 1 Chassis dynanometer

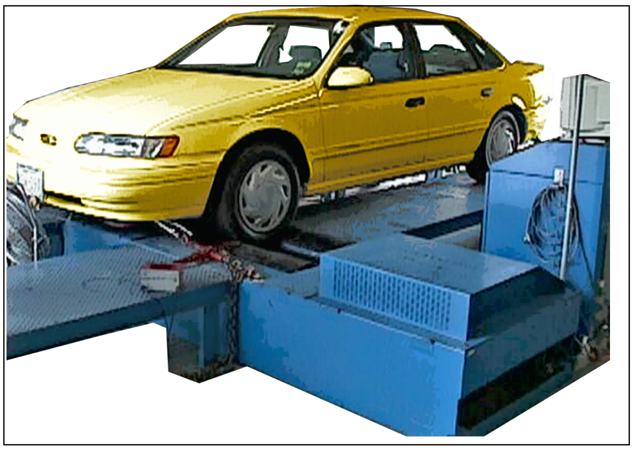
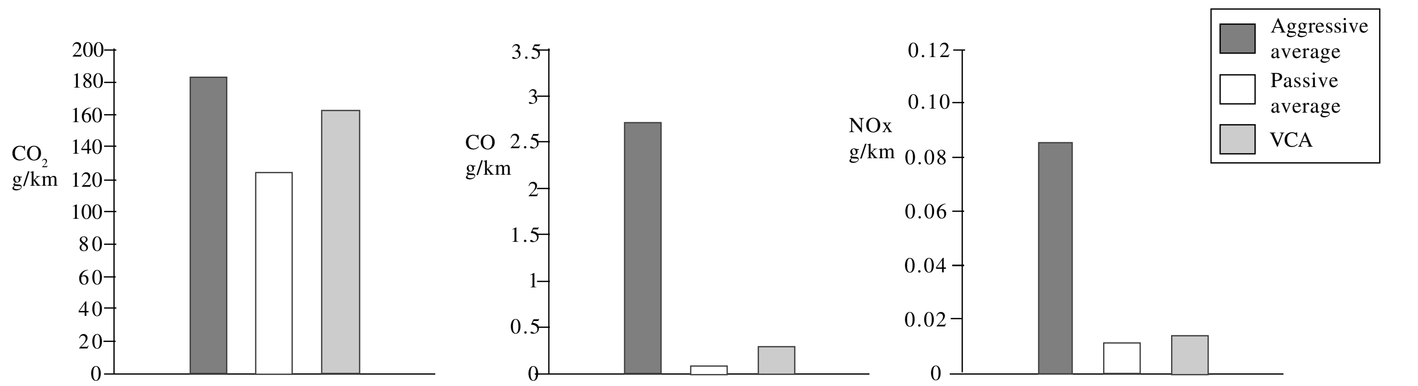


Fig. 2 shows the average emissions of carbon dioxide (CO_2), carbon monoxide (CO) and nitrogen oxides (NOx) for the official Vehicle Certification Agency (VCA) drive cycle and for aggressive and passive drive cycles.

Fig. 2 Average emissions of CO_2, CO and NOx and driving styles



Source: Felstead et al (2009)

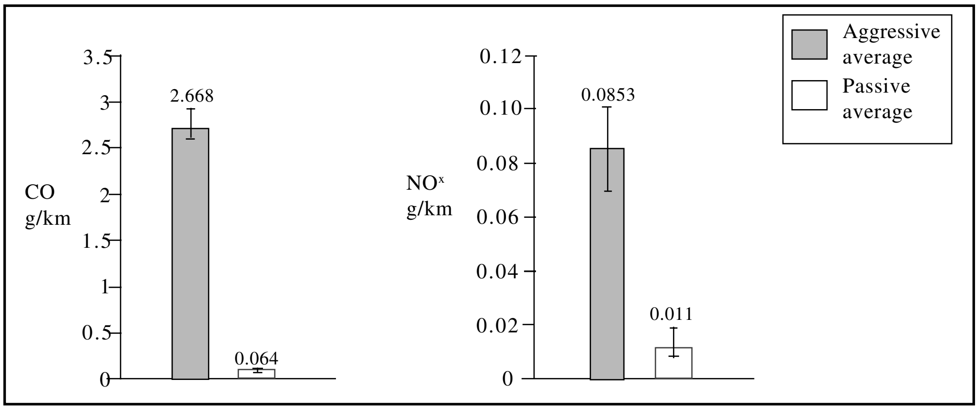
As you can see, compared to the average passive driver and the robot drivers in the VCA test, aggressive drivers end up releasing more of each type of pollutant. This is particularly worrying in cities, where increased levels of e.g. NOx, for even short time periods, can damage people's health.

Ministers are now considering driver - education programmes in which aggressive drivers are educated about the harmful health and environmental impacts of their driving styles. Whether this will stop the boy-racers and frustrated commuters from racing to and from the lights remains to be seen!

References: Felstead T, McDonald M, Fowkes M (2009) Transport. Vol 162 Issue 3 p141-148

Practice Questions

1. Scientists investigated the effect of driving style on car exhaust emissions. Two drivers followed the same three-mile route which included busy roads, junctions, traffic lights, speed humps and single and dual carriageways. Each drive test was carried out three times at different times of day. One driver was asked to drive aggressively and the other passively. The composition and volume of exhaust gases was electronically monitored in both cars. The results for carbon monoxide (CO) and nitrogen oxides (NOx) are shown in the graph.



(a) Suggest two ways in which the scientists tried to generate realistic and reliable data (2).
(b) Calculate the percentage increase in NOx emissions resulting from aggressive driving compared to passive driving. Show your working (2)
(c) Do the data provide any evidence that aggressive driving increases fuel consumption? Explain your answer (1).

2. Traffic calming using road humps aims to reduce speed to below 20 mph in order to reduce the number and seriousness of accidents.
As part of a cost-benefit analysis scientists investigated the effect of two schemes using road humps on exhaust emissions. The table shows the results.

	Change in emissions per car/%				Change in numbers of cars/%
	Carbon dioxide	Carbon monoxide	Nitrogen oxides	Hydrocarbons	
Scheme A	+8	+21	-11	+25	-36
Scheme B	+4	+10	-3	+14	-7

(a) Give one harmful effect on health of:
(i) carbon monoxide
(ii) nitrogen oxides (2).
(b) Suggest two reasons why the changes in emissions were so different in the two schemes (2)
(c) Suggest 3 factors that would be considered as part of the cost-benefit analysis in order to assess whether the introduction of the humps was financially sensible (3).

Answers

1. (a) variety of roads;
different traffic conditions/ times of day;
repeats;
(b) 0.0853 − 0.011 = 0.0743;
(0.0743/0.011) x 100 = 675%;
(c) Yes as more CO/NOx implies more fuel combustion;

2. (a) (i) binds to haemoglobin / prevents respiration;
(ii) asthma/breathing difficulties;
(b) average speeds before introduction of humps may have been different;
data measured at different times of year/day;
different measuring equipment;
different humps;
(c) cost of humps/introducing humps;
has traffic/accidents simply been displaced?;
decrease in fatal accidents?;
reduced costs of treating accidents;
hospital admissions/GP cases associated with air pollution;

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