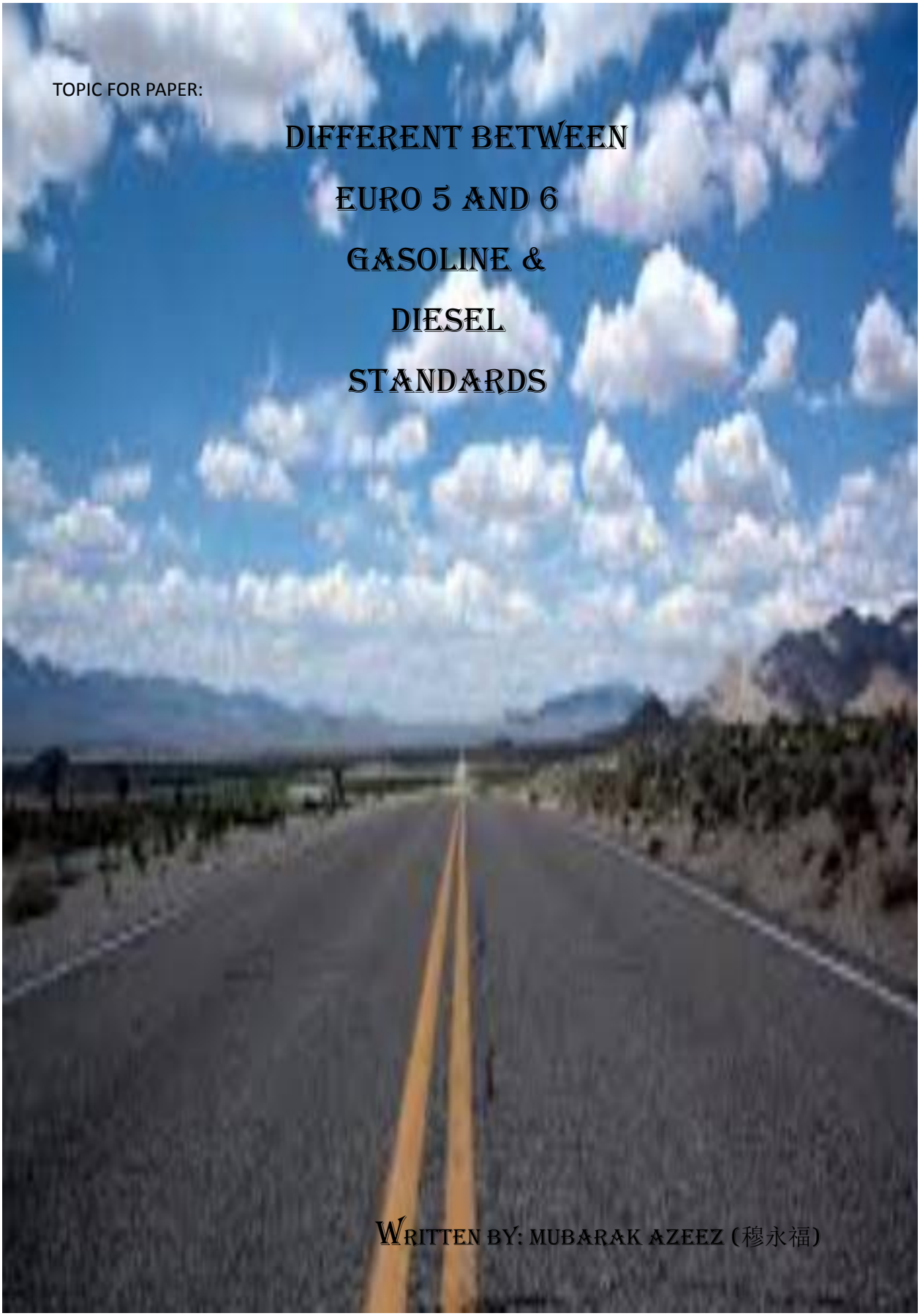

TOPIC FOR PAPER:

DIFFERENT BETWEEN EURO 5 AND 6 GASOLINE & DIESEL STANDARDS

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CONTENTS

ABSTRACT

Vehicle emission are a key talking point when it comes to environmental pollution. The ever-increase demand to move people and goods further, faster and the growth in freight vehicles are one of the many contributors to overall pollution. Consequently, increasing in adverse human health effects and climate changes as led government and legislative bodies across the world to clamped down on standard updates for European emissions. In this paper, I chose to focus on different between Euro V and VI gasoline and diesel standards and necessity for standard updates. What is actually required to meet the latest emissions legislation? And who sets the standards for car manufacturers to meet? In this paper, you will find latest standards and testing procedures as well as explaining what new standard update is scheduled to come into place to improve the abatement of emissions.

INTRODUCTION

European emission standards define the acceptable limits for exhaust emissions of new vehicles sold in EU and EEA member states. In the past, car makers used to produce cars that delivered greater and greater performance without any regard to the pollutants coming out of the exhaust. Now emission standards in regions with mature programs, such as the European Union (EU), the United States, and Japan, are generally set according to the reductions achievable by the best available technologies for the regulatory period considered. Other concerns, such as cost-effectiveness and safety, are also taken into consideration. For example, Section 202 of the U.S. Clean Air Act (CAA) clearly states that, to protect public health and welfare, the U.S. Environmental Protection Agency (EPA) administrator should adopt “standards which reflect the greatest degree of emission reduction achievable through the application of technology which the administrator determines will be available for the model year to which such standards apply, giving appropriate consideration to cost, energy, and safety factors associated with the application of such technology.”

The emission standards are defined in a series of European Union directives staging the progressive introduction of increasingly stringent standards. Euro engine emissions standards were introduced in the early 1990s to reduce pollutants from vehicles. Since 1993, continuously updated EU regulations from Euro 1 to the current Euro 6 legislation has led to a significant reduction of the emissions produced by vehicles including: carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx) and particulate matter (PM). These updates, in turn, can set back the economy. Premature mortality and morbidity reduce productivity, and money and resources must be diverted to treating preventable diseases and cleaning up the environment cause by these pollutants. Table 1.1 shows emission for diesel and gasoline from Euro I-V.

While vehicles are just one of many contributors to overall pollution, manufacturers are easy to regulate against as emissions reductions can be factored into regional vehicle production standards. Over the years, vehicle emissions have dropped as a result of ever-stricter legislation, although in recent years it has become clear that some car makers have struggled to meet legal requirements, as evidenced by the VW Group's emissions cheating scandal.

EMISSION STANDARDS FOR PASSENGER CARS

Since the Euro 2 stage, EU regulations introduce different emission limits for diesel and petrol vehicles. Diesels have more stringent CO standards but are allowed higher NOx emissions. Petrol-powered vehicles are exempted from particulate matter (PM) standards through to the Euro 4 stage, but vehicles with direct injection engines are subject to a limit of 0.005 g/km for Euro 5 and Euro 6. A particulate number standard (P) or (PN) has been introduced in 2011 with Euro 5b for diesel engines and in 2014 with Euro 6 for petrol engines. The table 1.1 and graph 1.1 of NOx and PM emission standards for diesel and gasoline cars, below gives the summary for emission standard for passenger cars and light commercial vehicles diesel and gasoline from Euro 1 down to Euro 6

Table 1.1- emission for diesel and gasoline from Euro I-V

Tier	Date	CO	THC	NMHC	NOx	HC+NOx	PM	PN [#/km]
Diesel								
Euro1†	July 1992	2.72(3.16)	-	-	-	0.97 (1.13)	0.14 (0.18)	-
Euro 2	January 1996	1.0	-	-	-	0.7	0.08	-
Euro 3	January 2000	0.64	-	-	0.50	0.56	0.05	-
Euro 4	January 2005	0.50	-	-	0.25	0.30	0.025	-
Euro5a	Sept. 2009	0.50	-	-	0.180	0.230	0.005	-
Euro5b	Sept. 2011	0.50	-	-	0.180	0.230	0.005	6×10^{11}
Euro 6	Sept. 2014	0.50	-	-	0.080	0.56	0.005	6×10^{11}
Petrol (Gasoline)								
Euro 1†	July 1992	2.72 (3.16	-	-	-	0.97 (1.13)	-	-
Euro 2	January 1996	2.2	-	-	-	0.5	-	-
Euro 3	January 2000	2.3	0.20	-	0.15	-	-	-
Euro 4	January 2005	1.0	0.10	-	0.08	-	-	-
Euro 5	Sept.2009	1.0	0.10	0.068	0.060	-	0.005**	-
Euro 6	Sept. 2014	1.0	0.10	0.068	0.060	-	0.005**	6×10^{11}***

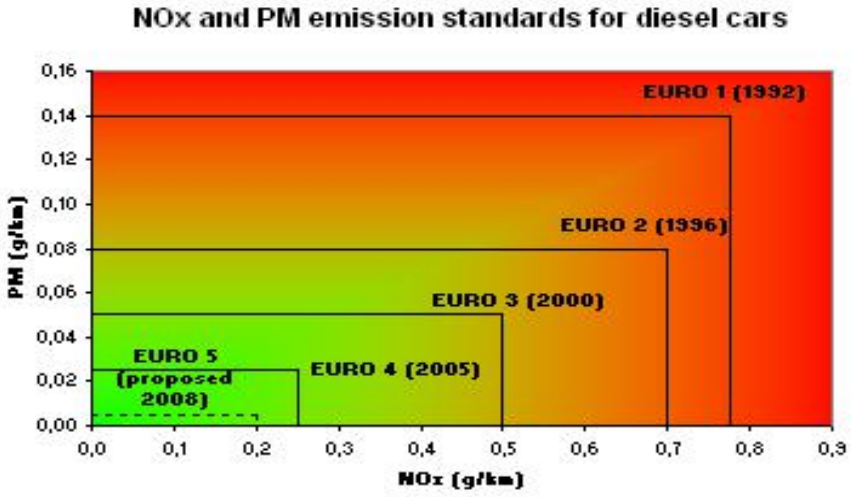
* Before Euro 5, passenger vehicles > 2500 kg were type approved as light commercial vehicles N1-I

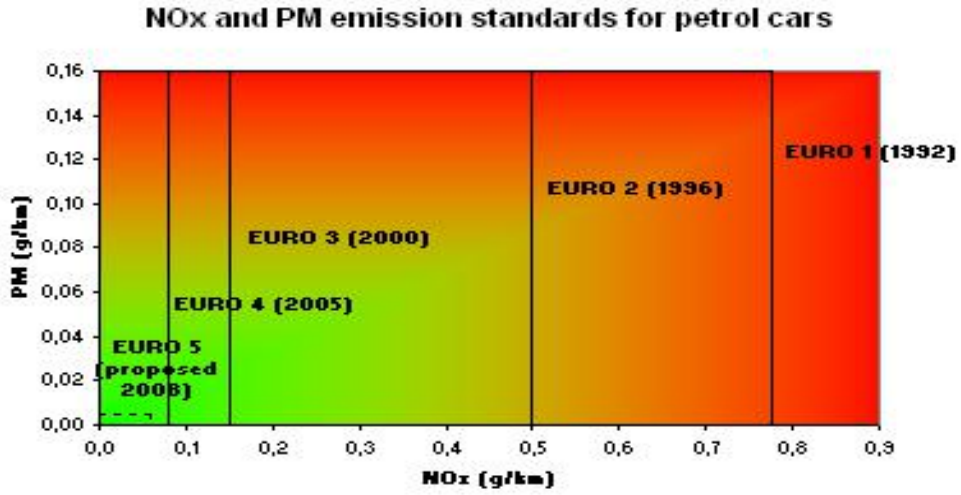
** Applies only to vehicles with direct injection engines

*** 6×1012/km within first three years from Euro 6 effective dates

† Values in parentheses are conformity of production (COP) limits

Graph 1.1





DIFFERENT BETWEEN EURO V and VI GASOLINE AND DIESEL

It is hard to imagine now, that only 21 years ago, there was no European emissions legislation. It was in 1993 that the Euro I levels were introduced, and these standards were achieved with small incremental changes. Euro V came three years after Euro IV, imposing further NOx, and PM reductions. Then in 2014, Euro VI came into effect, with the tightest emissions levels to date. To meet the regulations, OEMs have resorted to both SCR, and EGR, with a Diesel Particulate Filter (DPF).

Euro 5

Implementation date (new approvals): 1 September 2009

Implementation date (all new registrations): 1 January 2011

The big news for Euro 5 was the introduction of particulate filters (DPFs) for diesel vehicles, along with lower limits across the board. For type approvals from September 2011 and new cars from January 2013, diesel vehicles were subject to a new limit on particulate numbers.

DPFs capture 99% of all particulate matter and are fitted to every new diesel car. Cars meeting

Euro 5 standards emit the equivalent of one grain of sand per kilometre driven.

Euro 6

Implementation date (new approvals): 1 September 2014

Implementation date (all new registrations): 1 September 2015

The sixth and current incarnation of the Euro emissions standard was introduced on all new registrations in September 2015. For diesels, the permitted level of NOx has been slashed from 0.18g/km in Euro 5 to 0.06g/km.

A focus on diesel NOx was the direct result of studies connecting these emissions with respiratory problems. To meet the new targets, some car makers have introduced Selective Catalytic Reduction (SCR), in which a liquid-reductant agent is injected through a catalyst into the exhaust of a diesel vehicle. A chemical reaction converts the nitrogen oxide into harmless water and nitrogen, which are expelled through the exhaust pipe.

The alternative method of meeting Euro 6 standards is Exhaust Gas Recirculation (EGR). A portion of the exhaust gas is mixed with intake air to lower the burning temperature. The vehicle's ECU controls the EGR in accordance with the engine load or speed.

The table 1.2 below illustrate the different between European emission (Euro 5-6) standards for passenger cars (Category M*), g/km

Table 1.2 European emission (Euro 5-6) standards for passenger cars (Category M*), g/km

Tier	Date	CO	NOx	HC+NOx	PM	PN
DIESEL						
Euro 5a Euro 5b	Sept. 2009 Sept. 2011	0.50 0.50	0.180 0.180	0.230 0.230	0.005 0.005	 6×1011
Euro 6	Sept. 2014	0.50	0.180	0.170	0.005	6×1011
Petrol (Gasoline)						P [#/km]
Euro 5	Sept. 2009	1.0	0.060		0.005**	
Euro 6	Sept. 2014	1.0	0.060		0.005**	6×1011***

* Before Euro 5, passenger vehicles > 2500 kg were type approved as light commercial vehicles N1-I

** Applies only to vehicles with direct injection engines

*** 6×1012/km within first three years from Euro 6 effective dates

† Values in parentheses are conformity of production (COP) limits

AIM OF EMISSION STANDARD

According to the EU, "The air pollutant emissions from transport are a significant contribution to the overall state of air quality in Europe", with industry and power generation being the other major sources.

The aim of Euro emissions standards is to reduce the levels of harmful exhaust emissions, chiefly:

Nitrogen oxide (NOx)

Carbon monoxide (CO)

Hydrocarbons (HC)

Particulate matter (PM)

These standards are having a positive effect, with the SMMT (Society of Motor Manufacturers and Traders), claiming: "It would take 50 new cars today to produce the same amount of pollutant emissions as one vehicle built in the 1970s."

The SMMT has quoted the following figures in support:

Carbon monoxide (CO): petrol down 63%, diesel down 82% since 1993

Hydrocarbons (HC): petrol down 50% since 2001

Nitrogen oxide (NOx): down 84% since 2001

Particulate matter (PM): diesel down 96% since 1993

Because petrol and diesel engines produce different types of emissions, consequently they are subject to different standards. Diesel, for example, produce more particulate matter – or soot.

The EU has pointed out however that NOx emissions from road transport "have not been reduced as much as expected. Since emissions in real-life driving conditions are often higher than those measured during the approval test (in particular for diesel vehicles)".

As the UK government pointed out in December 2016, road transport still accounted for 34% of UK NOx emissions in 2015. The rate of reduction in atmospheric NOx has slowed down due to the increased contribution from diesel vehicles. Over the same time, average new car CO2 emissions have more than halved, going some way to meeting the target average of 95g/km by 2020. CO2 emissions are linked to climate change and subject to different regulations.

WHO ARE THE SOCIETIES OR GROUP BEHIND THE STANDARD UPDATE FOR CAR MANUFACTURERS TO MEET STANDARD

1. European emission legislation
2. New European Driving Cycle (NEDC)
3. SMMT (Society of Motor Manufacturers and Traders)
4. Environmental Protection Agency (EPA or sometimes USEPA)
5. Vehicle certificate agency (VCA)

MEASUREMENTS

UN Regulation 101

Several measurements are usually performed along the cycle. The figures made available to the general public are:

- Urban fuel economy (first 780 seconds)
- Extra-Urban fuel economy (780 to 1180 s)
- Overall fuel economy (complete cycle)
- CO2 emission (complete cycle)

The following parameters are also generally measured to validate the compliance to European emission standards:

- Carbon monoxide
- Unburnt hydrocarbons
- Nitrogen oxides

- Particulate matter
- UN Regulation 83

Some or all of the following parameters are measured depending upon the requirements of the region implementing the test:

- Mass of carbon monoxide (CO)
- Mass of total hydrocarbons (THC)
- Mass of nonmethane hydrocarbons (NMHC)
- Mass of oxides of nitrogen (NOx)
- Combined mass of hydrocarbons and oxides of nitrogen (THC + NOx)
- Mass of particulate matter (PM)
- Number of particulates (PN)

The region implementing the test defines limits for each of the pollutants, for instance the Euro level within the EU.

TESTING PROCEDURE

Currently all cars old in the UK are tested before going on sale under the New European Driving Cycle (NEDC) procedure. The New European Driving Cycle (NEDC) is a driving cycle, last updated in 1997, designed to assess the emission levels of car engines and fuel economy in passenger cars (which excludes light trucks and commercial vehicles). It is also referred to as MVEG cycle (Motor Vehicle Emissions Group).

The test procedure is defined in UNECE R101 for the measurement of CO2 and fuel consumption and/or the measurement of electric energy consumption and electric range in hybrid and fully electric M1 and N1 vehicles, and UNECE R83 for the measurement of emission of pollutants of M, N1 and M2 vehicles. It is maintained by the UNECE World Forum for Harmonization of Vehicle Regulations (WP.29), which also works on its successor, the Worldwide harmonized Light vehicles Test Procedures (WLTP).

REQUIREMENT BEFORE TESTING

1. The cycle must be performed on a cold vehicle at 20–30 °C (typically run at 25 °C).
2. To improve repeat ability, they are generally performed on a roller test bench (This type of bench is equipped with an electrical machine to emulate resistance due to aerodynamic drag and vehicle mass (inertia).
3. It best to perform the cycles on a flat road, in the absence of wind.
4. The test should be conducted with all ancillary loads turned off (Air conditioning compressor and fan, lights, heated rear window, etc.)

The NEDC is composed of two parts:

Urban driving Cycle and Extra-urban driving Cycle

Urban driving Cycle

The Urban Driving Cycle ECE-15 (or just UDC) was introduced first in 1970 as part of ECE vehicle regulations; the recent version is defined by ECE R83, R84 and R101. The cycle has been designed to represent typical driving conditions of busy European cities, and is characterized by low engine load, low exhaust gas temperature, and a maximum speed of 50 km/h.

When the engine starts, the car pauses for 11 s - if equipped with a manual gearbox, 6 s in neutral (with clutch engaged) and 5 s in the 1st gear (with clutch disengaged) - then slowly accelerates to 15 km/h in 4 s, cruises at constant speed for 8 s, brakes to a full stop in 5 s (manual: last 3 s with clutch disengaged), then stops for 21 s (manual: 16 s in neutral, then 5 s in the 1st gear).

At 49 s, the car slowly accelerates to 32 km/h in 12 s (manual: 5 s in 1st gear, 2 s gear change, then 5 s in the 2nd gear), cruises for 24 s, slowly brakes to a full stop in 11 s (manual: last 3 s with clutch disengaged), then pauses for another 21 s (manual: 16 s in neutral, 5 s in the 1st gear).

At 117 s, the car slowly accelerates to 50 km/h in 26 s (manual: 5 s, 9 s and 8 s in the 1st, 2nd and 3rd gears, with additional 2 × 2 s for gear changes), cruises for 12 s, decelerates to 35 km/h in 8 s, cruises for another 13 s, brakes to a full stop in 12 s (manual: 2 s change to the 2nd gear, 7 s in the 2nd gear, last 3 s with clutch disengaged), then pauses for 7 s (manual: in neutral with clutch engaged).

The cycle ends on 195 s after a theoretical distance of 994.03 meters, then it repeats four consecutive times. Total duration is 780 s (13 minutes) over a theoretical distance of 3976.1 meters, with an average speed of 18.35 km/h.

Extra-urban driving Cycle

The Extra-Urban Driving Cycle EUDC, introduced by ECE R101 in 1990,[1] has been designed to represent more aggressive, high speed driving modes. The maximum speed of the EUDC cycle is 120 km/h; low-powered vehicles are limited to 90 km/h.[6]

After a 20 s stop - if equipped with manual gearbox, in the 1st gear with clutch disengaged - the car slowly accelerates to 70 km/h in 41 s (manual: 5 s, 9 s, 8 s and 13 s in the 1st, 2nd, 3rd and 4th gears, with additional 3×2 s for gear changes), cruises for 50 s (manual: in the 5th gear [sic]), decelerates to 50 km/h in 8 s (manual: 4 s in the 5th and 4 s in the 4th gear [sic]) and cruises for 69 s, then slowly accelerates to 70 km/h in 13 s .

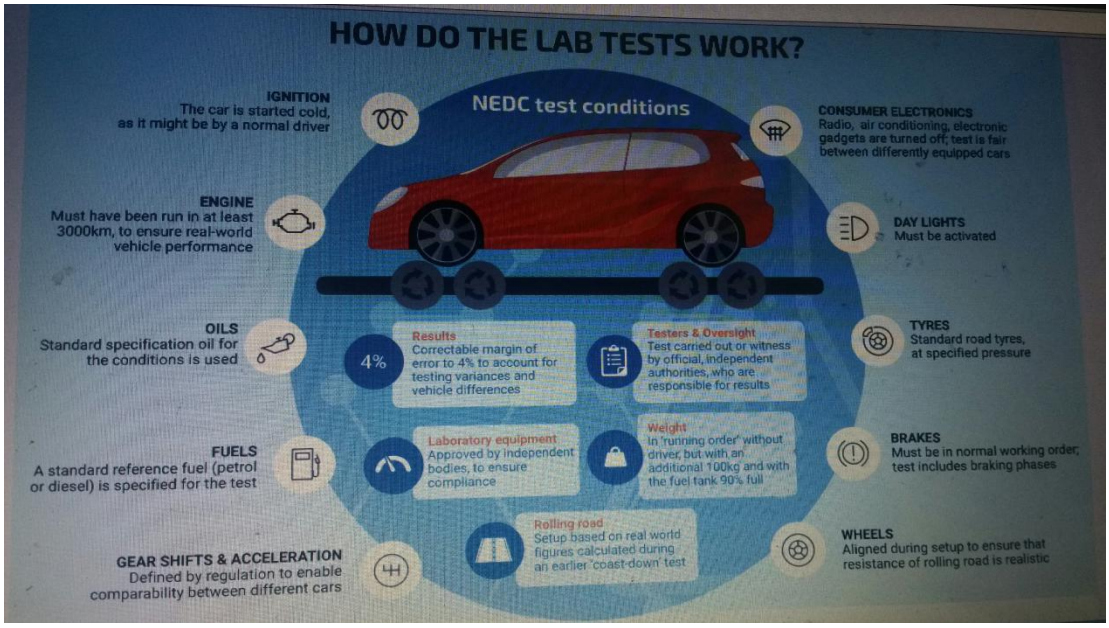
At 201 s, the car cruises at 70 km/h for 50 s (manual: in the 5th gear), then slowly accelerates to 100 km/h in 35 s and cruises for 30 s (manual: in the 5th or 6th gear).

Finally, at 316 s the car slowly accelerates to 120 km/h in 20 s, cruises for 10 s, then slowly brakes to a full stop in 34 s (manual: in the 5th or 6th gear, lat 10 s with clutch disengaged), and idles for another 20 s (manuual: in neutral).

Total duration is 400 s (6 minutes 40 s econds) and theoretical distance is 6956 meters, with an average speed of 62.6 km/h.

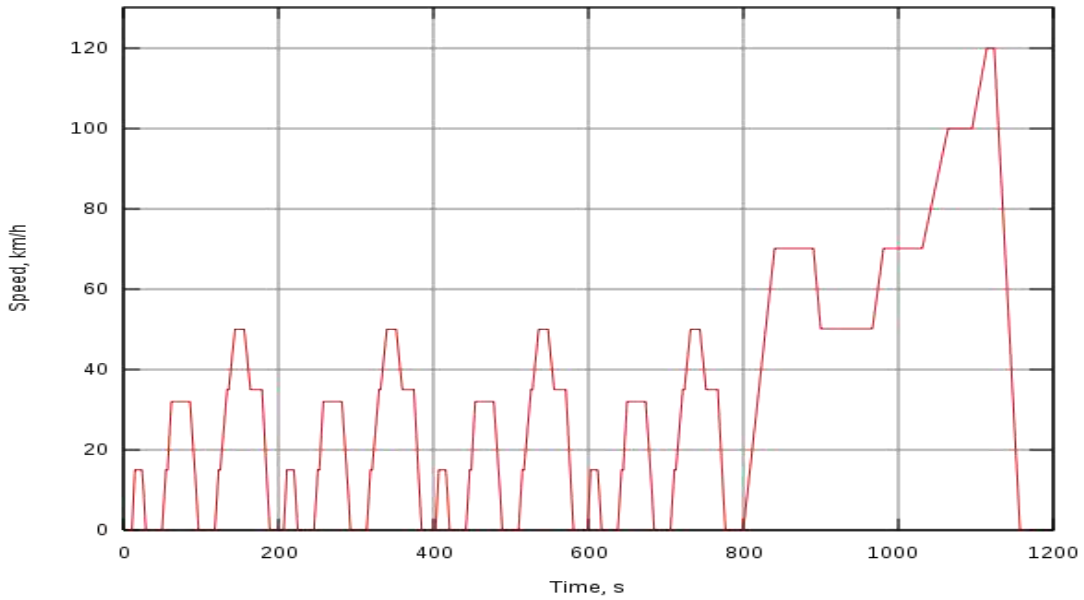
LABORATORY TEST

The New European Driving Cycle (NEDC) measures the emissions of passenger cars for both CO2 and pollutants in a laboratory setting. All conditions for vehicle set-up, testing and the handling of test results for cars are defined by EU law. This is important as it establishes a standard regulation that all car manufactures and other players must respect. Additionally, it allows for a standardized and repeatable procedure which enables customers to compare emissions between different car models.



IMPORTANT NOTE

The fuel consumption figures quoted in this guide are obtained under specific test conditions, and therefore may not necessarily be achieved under 'real life' driving conditions. A range of factors may influence actual fuel consumption - for example, driving style and behaviour, as well as the environment and conditions under which the vehicle is operated. Furthermore, since several different specifications (variants or versions) of a given model may be grouped together in the list, the figures used in this guide should be treated as indicative only.
A definitive figure for a given specification of vehicle will be available at the point of sale.

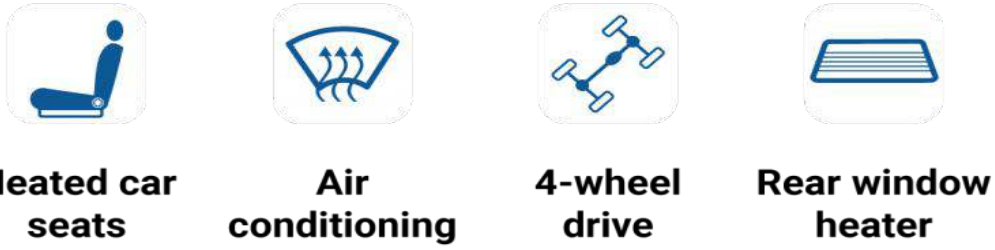


The NEDC is composed of two parts: ECE-15 (Urban Driving Cycle), repeated 4 times, is plotted from 0 s to 780 s; EUDC cycle is plotted from 780 s to 1180 s

LIMITATION OF CURRENT LAB TEST

The NEDC was designed in the 1980s and today, can be considered outdated due to several evolution in technology and driving conditions.

Today's cars come equipped with an increasing amount of new technologies that have a strong effect on fuel consumption (and with that consequently, CO2 emissions), for instance 4-wheel drive and a wide range of customer comfort systems (such as air-conditioning, rear window heater or heated seats and other electrical devices). These features are not accounted for using the NEDC test procedure, because they simply were not common when the test was designed.



Driving has also changed over the years with increased traffic congestion, resulting in more inefficient driving. Additionally, driving styles have also changed. In some countries new car sales are driven by company cars whose drivers receive a fuel card and who probably do not see fuel economy as their highest priority.

WHO DOES THE TESTING?

The emission standard testing is carried out either by independent test organizations, or by the vehicle manufacturers or importers themselves, usually at their own test facilities. In the UK, and before the results are officially recognized, the DfT will:

inspect the test laboratories and witness some tests being carried out, or;

check that the figures have been certified by a European member state national authority under the agreed arrangements for mutual recognition of test results.

WHAT NEXT?

While vehicle emissions have reduced, the so-called 'dieselgate' scandal highlighted that there's still work to be done, not least because carmakers felt the need to 'cheat' to meet the stringent standards. In light of the use of 'defeat devices', the EU is introducing a 'Real Driving Emissions' (RDE) test procedure, starting from 1 September 2017. It is hoped that this will better reflect the actual emissions on the road, reducing the discrepancy between real-world emissions and those measured in a laboratory.

EFFECT OF EMISSION

Since 1970, transportation, in particular the combustion of gasoline and diesel in vehicles, have received increasing attention as a source of air pollution at both local and global scales.

Local effects

Traffic represents one of the largest sources of primary air pollutants in urban areas. Large amount

of vehicle exhaust emissions will have seriously adverse effects on human health.

Assessing the effects of air quality management strategies in urban areas is a major concern worldwide. In addition, worldwide epidemiological studies show a consistent increase in cardiac and respiratory morbidity and mortality from exposure to vehicle exhaust pollution. Both in urban and residential regions, this has become the main areas of toxic compound emissions from the unrestrained use of vehicles burning fossil fuels. In these areas, the population is very sensitive to vehicular pollution.

Global effects

On a global scale, people are more concerned about air pollution and global climate change which are contributed to by vehicle exhausts. Combustion engines contribute to greenhouse gas accumulation in the atmosphere. There are many climate researchers who support the view that emissions of heat trapping gases into the atmosphere, particularly CO2, from the combustion of fossil fuel, cause global warming. The concentration of CO2 are currently rising by 2 ppm (parts per million) annually (Patrick and Damon, 2008).

Transport contributed to an estimated 19% of global GHG (greenhouse gas) emissions in 1971, but rose to 25% in 2006. Reductions of CO2 emissions from transport can be achieved by using energy saving vehicle technologies, which relies on cleanly produced biofuels, such as biodiesel and ethanol (Kockelman et al., 2009).

HOW TO IMPROVE THE EMISSION EFFICIENCY

1. Catalytic converters for gasoline exhaust: To reduce the vehicles emission example is three-way catalytic (TWC) converters used in gasoline vehicle emission control systems.

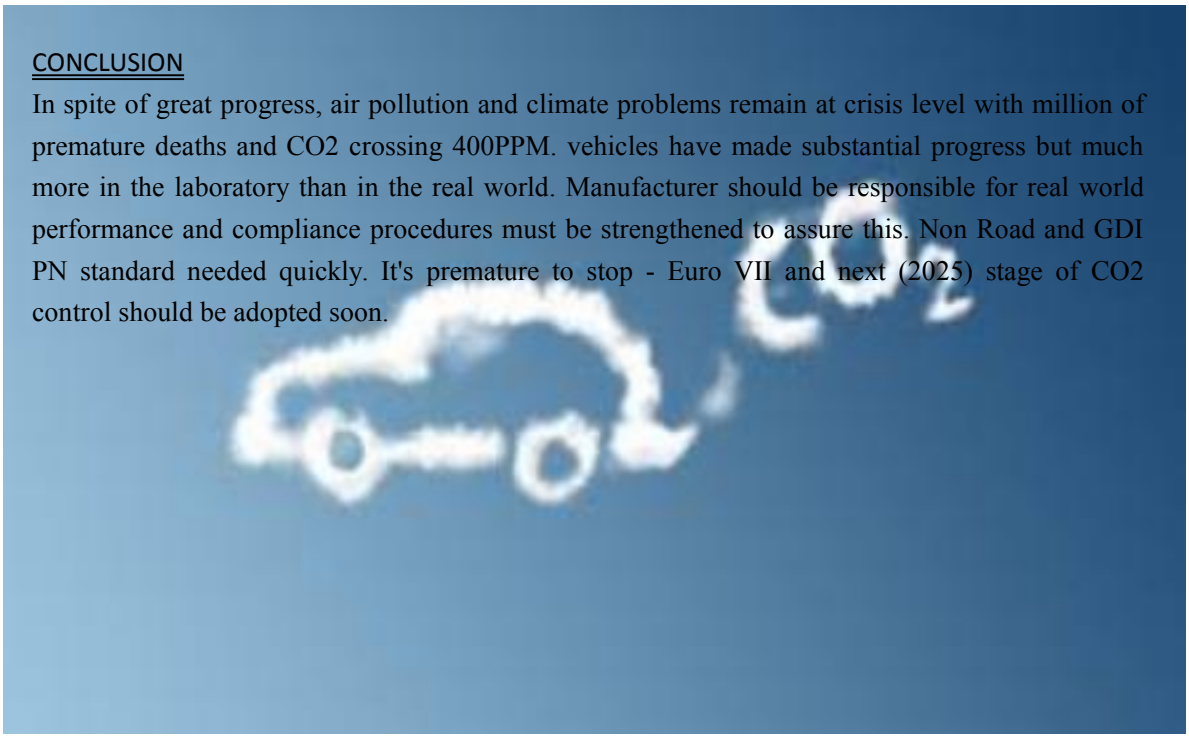
The three catalysis processes are described in the list below (Reduction in emissions with Catalytic Converters, 2009):

- Reduction of NOX to O2 and N2: $2NOx \rightarrow xO2 + N2$;
- Oxidation of CO to CO2: $2CO + O2 \rightarrow 2CO2$;
- Oxidation of unburned hydrocarbons (HCs) to CO2 and H2O:
  $CX\,H\,(2X+2) + [(3x+1)/2]\,O2 \rightarrow xCO2 + (x+1)\,H2O$.

2. Catalytic converters for diesel exhaust.
3. Improving the Exhaust Gas Recirculation (EGR).
4. Advanced new technology on particulate filters (DPFs)
5. Cycle beating: to optimize engine emission performance to the corresponding operation points of the test cycle.
6. Developing new global harmonized driving cycle, the World Light Test Procedure (WLTP).

RESPONSIBILITY OF AN ENGR. OR SCIENTIST TO IMPROVE ENVIRONMENTAL QUALITY

. Looking to the next step for standard update to Euro VII
. Planting or Constructing a forest.
. Reducing the use of diesel for cars
. Reducing harmful emissions from olefin manufacturing
. Introducing Selective Catalytic Reduction (SCR)



CONCLUSION

In spite of great progress, air pollution and climate problems remain at crisis level with million of premature deaths and CO2 crossing 400PPM. vehicles have made substantial progress but much more in the laboratory than in the real world. Manufacturer should be responsible for real world performance and compliance procedures must be strengthened to assure this. Non Road and GDI PN standard needed quickly. It's premature to stop - Euro VII and next (2025) stage of CO2 control should be adopted soon.

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NEDC