THE De-NO_X SYSTEM

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The struggle to establish a cleaner and healthier environment has been the hunt of all concerned persons. To achieve this, we address the issues of automotive exhaust emission. The increase of internal combustion engines burning fossil fuels, in the recent years has put this sector in the forefront as a serious polluter. We at **ECM Overseas**, have helped in the development of a system that can be OEM as well as Retrofit, for both petrol and diesel driven engines. This paper is to introduce this product and see its effective use in all sectors of the automotive world.

SECTION 1: INTRODUCTION

1.1. The introduction of mobile internal combustion engines eased our transportation problems and mankind cut distances, but it also brought about the gravest and most serious of our problems, in the way the environment got polluted.

1.2. The amount of toxicity in the atmosphere saw a marked increase in the recent years. Along with its damage to the environment and humans around the globe.

1.3. The increase in cardiopulmonary diseases highlights this toxicity.

1.4. A quick and serious review has become important and the resultant solution should be given undivided attention.

1.5. This solution should be enforced and implemented, to correct and repair, or at the least prevent further damage from being done.

1.6. We believe that Mother Earth has her own natural ways in correcting this, if and only if we assist in stopping further damage from being done.

1.7. We are assured that engine manufacturers are doing their part, and new prototypes, using various alternative fuels have been considered.

1.8. Vehicles using these alternative fuels have not proven itself as yet due to constrains in efficiency and cost.

SECTION 2: UNDERSTANDING EXHAUST EMISSIONS

2.1. "Engine emission" refers primarily to pollutants in the exhaust gases.

2.2. The components of exhaust emission and their effects on the environment are shown in the table below:

CO - Carbon Monoxide - Lethal CO2 – Carbon Dioxide – Greenhouse gas. NOx - Oxides of Nitrogen, NO2 – Lethal: N2O- Greenhouse Gas UHC - Unburnt Hydrocarbon SOx - Oxides of Sulfur – Acid Rain. PM - Particulate Matter – Pulmonary and Bronchial Diseases _

SECTION 3: CARBON MONOXIDE (CO)

3.1. Fuels are often mixtures of Hydrocarbon with bond between Carbon Atoms and Hydrogen Atoms.

3.2. During combustion these bonds are broken and new bonds are formed with Oxygen Atoms, accompanied by the release of chemical energy. The principal products of complete combustion are Carbon Dioxide and Water.

3.3. CO is a poisonous gas which, when inhaled replaces the Oxygen in the blood stream so that the body's metabolism cannot function properly.

3.4. Small amounts of CO concentration, slows down physical and mental activities and produce headaches, while large amounts can kill.

3.5. Since the Hydrogen in the fuel has great affinity for Oxygen; the H2 will take up all the O2 it needs leaving the Carbon with deficiency for O2. As a result a percentage of C will be converted to CO and the rest as unburnt Carbon.

3.6. The amount of CO produced is about 8% for an 11:1 air fuels ratio. The amount of Co produced will purely depend on weather the engine is running on a rich or lean mixture.

SECTION 4: UNBURNED HYROCARBON (UHC) & PARTICULATE MATTER

4.1. Unburned Hydrocarbon (UHC) in a properly regulated Diesel engine comes from two sources:

1. The perimeter of the reaction zone, where the mixture is too lean to burn &
2. The fuel retained in the nozzle sac (Space between the nozzle seat and spray hole) and the spray hole itself. Fuel from these sources can enter the combustion chamber late in the combustion process.

4.2. Carbon Particulate is formed by the thermal decomposition (cracking) of large Hydrocarbon Molecules, soot particulate form by agglomeration.

4.3. The formation of smoke is strongly dependent on the engine load. As the load increases, more fuel is injected and this increases the formation of smoke for these reasons:

1. The duration of diffusion combustion increases.
2. The combustion temperature increases and
3. Less oxidation of soot occurs during the expansion stroke, since there is less time after the end of diffusion combustion, and there is less Oxygen.

4.4. Smoke generation is increased by high temperatures in fuel rich zones, during diffusion combustion.

4.5. Incomplete combustion due to partial oxidation of the Hydrocarbon fuel also produces products such as acelylene and aldehydes. These products when expelled leave an unpleasant smell.

SECTION 5: OXIDES OF NITROGEN (NOx)

5.1. The Air Fuel mixture entering the cylinder contains large amount of air, which mainly consists of 75.5 % Nitrogen and 23 % Oxygen by mass.

5.2. When Nitrogen and Oxygen are subject to high temperatures and pressures, they react to form oxides of Nitrogen.

5.3. Oxygen and Nitrogen tend to combine when immediate temperatures exceed 1093 deg. C. (2000 deg. F) and during combustion process the temperature in the cylinder go well beyond this value.

5.4. In weak mixtures the excess O2 (which has not been taken up in the combustion process), at a very high temperature is able to combine with Nitrogen, which constitutes ¾ of air to from Oxides of Nitrogen.

5.5. NOx produced is about 100 PPM, at 11:1 air fuel ratio.

5.6. One method of reducing this is to lower the temperature.

5.7 This can be achieved by introducing an inert gas e.g. CO2, Nitrogen or Water vapor into the combustion mixture.

5.8. This will dilute the mixture and therefore reduce the peak temperature.

5.9. It has been estimated that a 16 % lowering of the peak temperature, would produce roughly 85 % reduction in the Oxides of Nitrogen Concentration.

5.10. Other means of reducing the flame temperature is to reduce the burn duration, by retarding the ignition, which will have adverse effects on the engine power output.

5.11 . Let us consider the effects of Exhaust Gas Recycling (EGR), Catalytic Converters and Diesel Particulate Traps.

SECTION 6: EXHAUST GAS RECYCLING (EGR), CATALYTIC CONVERTERS AND DIESEL PARTICULATE TRAPS

SUBSECTION 6.1: EXHAUST GAS RECYCLING (EGR)

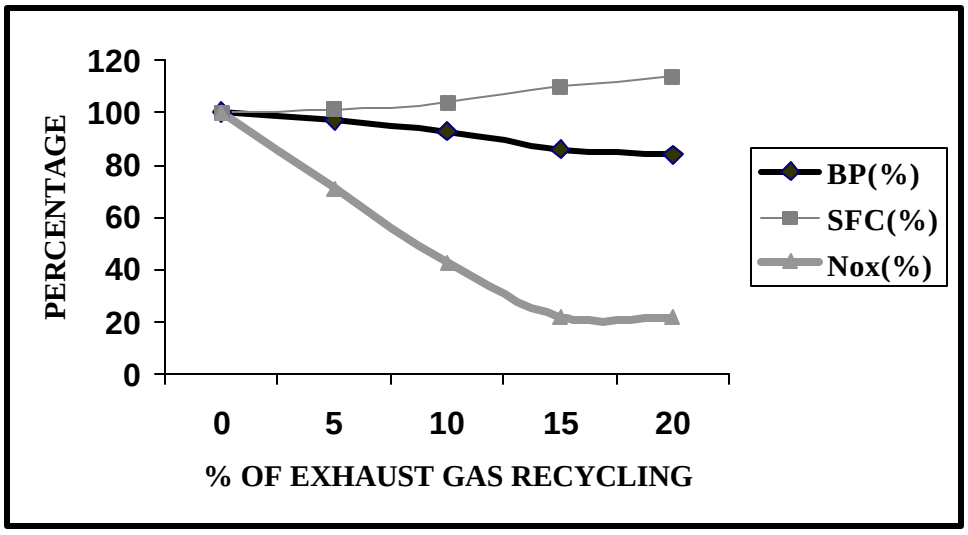


Table 2: Effects of Gas Recycling

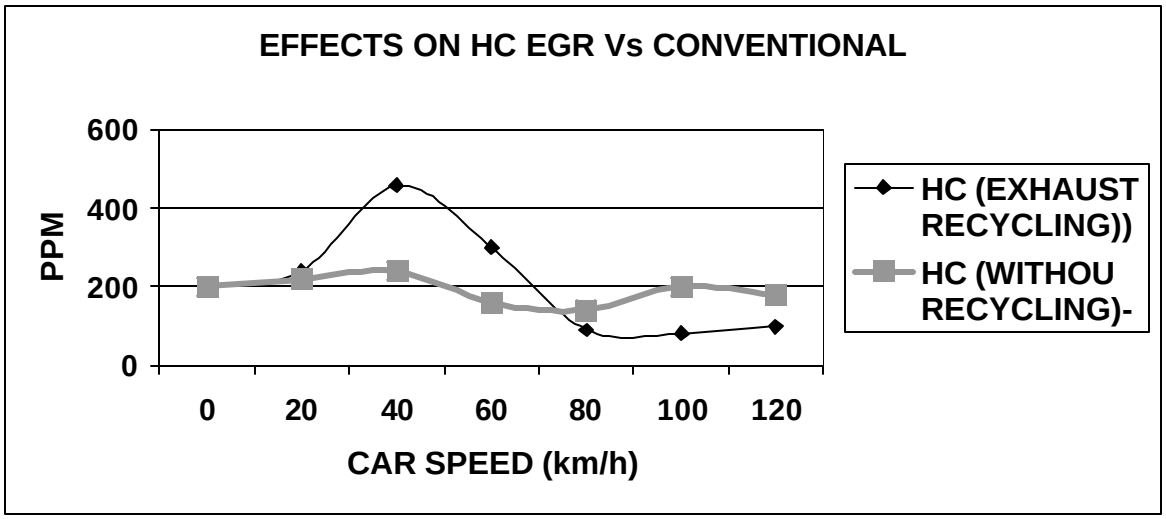
6.1.1 On 15 % re-circulation, the NOx decreases and shows tendencies to level out. There is little advantage to go beyond the 15 % EGR rate.

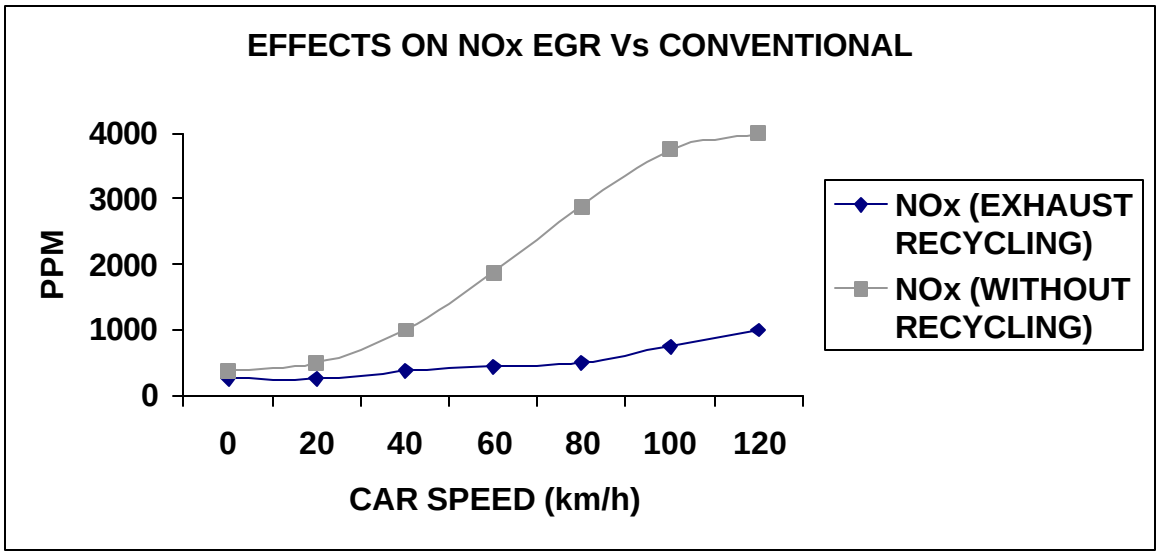
6.1.2 The reduction at this rate is roughly 88 %, but with a power loss of 16 % and fuel consumption increase of around 14 %.

6.1.3 The plotted results against % EGR show, as the % of EGR increases the engine power progressively decreases, whereas the specific fuel consumption increases.

6.1.4 A comparative study between EGR and conventional system shows the following results:

1. NOX are considerably reduced with EGR.
2. HC produced a classic hump at speeds of roughly 60 km/h. (average city speed limits).
3. CO showed a marked increase in the exhaust emission.





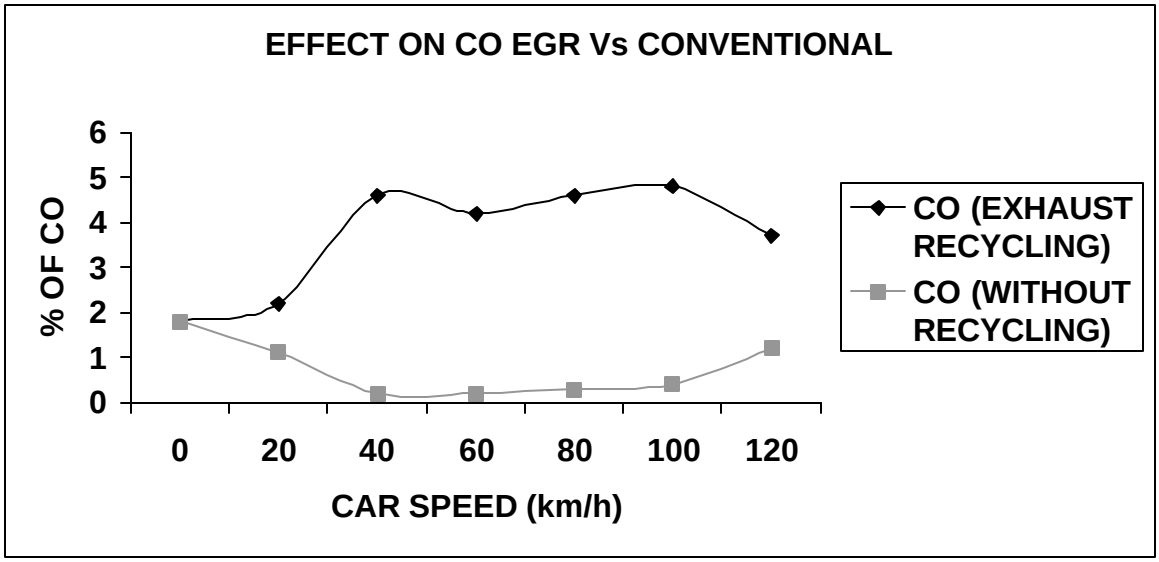


TABLE 3: COMPARISION EGR Vs CONVENTIONAL

SUBSECTION 6.2 CATALYTIC CONVERTERS

6.2.1. Ideal working temperature for catalytic converter is 400 deg. – 800 deg. Centigrade.

6.2.2. A catalytic converter operating under ideal condition can expect to have a moderately high conversion efficiency life of roughly 100,000 KM. (60,000 Miles).

6.2.3. However if the engine backfires or misfires, maybe due to operating with a very lean mixture at a particular speed and load, may cause the exhaust temperatures to rise temporarily. If this rise should exceed 1400 deg. C., the substrate material will melt, thus completely destroying the catalytic activity in the honeycomb passages.

6.2.4. At temperatures below 300 deg. C. the catalytic converter is practically ineffective.

6.2.5. Catalysts loose their effectiveness due to deterioration of the active materials exposure to the hot gases caused due to contamination and sintering caused by operating at very high temperatures for prolonged period.

6.2.6. Prolonged contact with antiknock agents (lead) and Phosphorous in oil additives also prevent active conversion

6.2.7. For a Catalytic Converter to perform satisfactorily it has to be operating above its' light - off temperature. Since diesel engines have comparatively cool exhaust, the catalytic converters do not attain their light – off temperatures.

6.2.8. Catalytic Converters that might be fitted to diesel engines are oxidation catalysis, which do not reduce the NOx emission. However, before a catalysis system can be considered, it is necessary to reduce the Sulfur in the diesel fuel to 0.05 % by mass or less, or this will lead to the formation of Sulfur Trioxide (SO3) and Sulfuric Acid (H2SO4).

SUBSECTION 6.3: DIESEL PARTICULATE TRAPS

6.3.1. Particulate Traps or any other filtering media in the exhaust system must increase the exhaust gas backpressure, which correspondingly reduces the engine power.

6.3.2. The exhaust backpressure increases as more particulate become trapped in the filter passages.

6.3.3. Ignition and oxidation of these particulate is the almost impossible, when operating over normal speed and load range of the engine.

6.3.4. When oxidation does occur, it must be carefully controlled to prevent the temperature of the exhaust gases rising to dangerous levels, which would damage the filtering media.

WHAT THEN IS THE ALTERNATIVE ????

WATER, STEAM AND THE De-NOx SYSTEM

SECTION 7: WATER

7.1. Changing or eliminating a process that produces polluting air emission is often easier than trying to trap effluent. Process maybe modified to achieve better emissions.

7.2. Engineers have been aware of the cleansing effect of water in the Combustion Chamber.

7.3. Improvement in the efficiency is claimed for injection of water/fuel emulsions, for example, by using an emulsion contain 10 % water improves economy of 5 – 8 % are reported.

7.4. It is acknowledged that a 20 % water emulsified fuel will result in the reduction of NOx by 80 – 85 % and particulate matter by 85 – 90 %.

7.5. Water is also known as an antiknock agent and will thus act as an Octane/Cetane number improver.

7.6. For a given quantity of fuel – a Fuel emulsion will have greater momentum and could lead to better air fuel mixing.

7.7. When small droplets of water in the fuel droplets evaporate, they do so explosively and breakup the fuel droplets.

7.8. Since evaporation and subsequent dissociation of water takes place, it reduces the peak temperatures.

7.9. But the act of water being directly mixed with fuel or injected into the combustion chamber has not been successful and efficient, due to water's own properties, resulting in extensive engine damages.

SECTION 8: THE De-NOx SYSTEM

8.1. The Department of Fuel And Energy; University Of Leeds, United Kingdom, under the leadership and guidance of Dr. Gordon E. Andrews, did extensive research on the use of steam in lieu of water.

8.2. The result of this research is what you have in the De-NOx Smoke Emission Control System.

8.3. The system or process is quite simple and is known to achieve amazing results.

8.4. Plain water is used to generate steam by harnessing the waste heat from in the exhaust system; water boils at 100 deg. C. that is quickly achieved, within minutes of starting the engine.

8.5. The steam so produced is mixed with air in a chamber (Air Steam Mixing Unit) and inspired by the engine through the air intake manifold.

8.6. The engine inspires the amount of steam it requires with no external pressure or force.

8.7. The steam, which enters the combustion chamber, acts just the same way as water, but without the negative properties of water.

8.8. The steam will immediately reduce the percentage of NOx by reducing the peak temperature.

8.9. Further more the steam will " Steam Clean" the engine of Carbon deposits and increase the combustion efficiency by effectively bringing about better mixing of fuel.

8.10. Presence of steam in the combustion chamber may inhibit flame propagation and thereby subdue the violent pressure rise, which causes the characteristic, clatter in engines.

8.11. It is acknowledged that the presence of oil saturated carbon gives rise to the amount of UHC and Particulate Matter. Steam cleaning the engine removes these carbon deposits and reduces the formation of soot and particulate matter.

8.12. The process brings about other advantages such as better fuel economy, better power and a smoother engine.

SECTION 9: CONCLUSION

9.1. Various research and scientific bodies have tested the effectiveness of steam in the engine and, the following test results will clear all doubts (See attachments).

9.2. For a cleaner and healthier environment it is our sincere conviction that

THE De-NOx SYSTEM

is the solution to our internal combustion smoke emission problems.

ATTACHMENTS

TEST REPORTS

MINISTRY OF TRANSPORT **UNITED KINGDOM** **HORIBA TEST** **DAEWOO** **1500 C. C** **Odometer Reading: 5270KM**				
CO	**CO2**	**NOx**	**THC**	**O2**
-38.1%	**-8.08%**	**-19.03%**	**-39.0%**	**+4.7%**

SIRIM INSTITUT STANDARD DA PENYELIDIKAN PERINDUSTRIAN MALAYSIA PROTON SATRIA 1600 C.C			
EMISSION @ 2970 RPM			
CO	**CO2**	**THC**	**O2**
-35.7%	**-1.4%**	**-0.8%**	**+20%**
EMISSION @ 2990 RPM			
CO	**CO2**	**THC**	**O2**
-32.14%	**-1.4%**	**-2.4%**	**+7.7%**

PETRONAS RESEARCH & SCIENTIFIC SERVICES; MALAYSIA PROTON SATRIA 1600 C.C			
COLD START TEST			
CO	**THC**	**NOx**	**FUEL**
-48.10%	**+15.4%**	**-36.4%**	**-1.5%**
HOT START TEST			
CO	**THC**	**NOx**	**FUEL**
-41.3%	**+7.8%**	**-36.6%**	**-2.2%**

A QUICK LOOK AT SMOKE DENSITY RESULTS

TESTS CONDUCTED BY PUSPAKOM MALAYSIA

OPACITY READING BEFORE AND AFTER INSTALLATION

MAKE	MODEL	VEHICLE REG No:	DATE OF INSTALLATION	TEST BEFORE	TEST AFTER
TOYOTA	**NINJA**	**WFQ 77**	**27TH. JUNE 99**	**72%**	**32%**
HINO	**EF609B**	**PCM 3737**	**23RD. SEPT. 99**	**71%**	**25%**
PERKASA	**150T**	**BAF 3240**	**3RD. NOV 99**	**25%**	**16%**
SCANIA	**P93ML**	**BEC 4406**	**10TH. DEC 99**	**60%**	**26%**
HINO	**EF750**	**PDD 8159**	**15TH. DEC 99**	**69%**	**33%**
PERKASA	**150T**	**CAX 2739**	**28TH DEC 99**	**41%**	**33%**