Pertanika 9(1), 35 – 43 (1986)

A Study of the Problems Related to the Testing of Smoke Emission From Diesel Powered Vehicles in Malaysia

M.I. YAZIZ and RAVINDER K.
Department of Environmental Sciences,
Universiti Pertanian Malaysia,
43400 Serdang, Selangor, Malaysia.

Key words: Air pollution; diesel smoke; control of smoke emission; motor vehicle pollution.

ABSTRAK

Kajian ini dijalankan untuk memeriksa tahap pelepasan asap daripada kenderaan diesel serta masalah-masalah yang dihadapi dalam penguatkuasaan peraturan "Motor Vehicles (Smoke and Gas Emission) Rules 1977". Hasil kajian menunjukkan bahawa lebih kurang 35% daripada kenderaan lori yang diperiksa mengeluarkan asap yang berlebihan dibandingkan dengan 33% untuk teksi, 16% untuk bas dan bas mini, serta 13% untuk kereta. Penelitian data yang diperolehi tidak menunjukkan apa-apa kaitan di antara tahap pelepasan asap dengan parameter-parameter seperti umur dan penjagaan kenderaan, atau jangka masa pemeriksaan terakhir oleh pihak RTD. Pemeriksaan rekod penguatkuasaan oleh pihak DOE menunjukkan bahawa pada bilangan purata, hanya 52.7% daripada aktiviti-aktiviti penguatkuasaan yang dirancangkan telah dijalankan daripada 1979 sehingga 1983. Ini disebabkan oleh berbagai faktor seperti masalah tenaga manusia dan kewangan, peralatan, pengangkutan dan cuaca. Pemilihan lokasi penguatkuasaan selalunya terganggu oleh keperluan untuk memilih tempat yang tidak menyebabkan kesesakan jalan raya dan tidak mengikut bilangan kenderaan. Masalah terbesar yang dihadapi oleh pihak RTD ialah kekurangan tempat untuk menjalankan pemeriksaan. Hasil kajian ini juga mencadangkan bahawa sebilangan daripada pemandu-pemandu kenderaan mempraktikan cara-cara yang tidak sah seperti menyederhanakan injin kenderuan semasa pemeriksaan RTD ataupun menambah bahan cecair ke dalam tangki diesel untuk mengurangkan tahap pelepasan asap untuk jangka masa yang singkat.

ABSTRACT

This study was carried out to examine the smoke emission level from diesel powered vehicles plying Malaysian roads and the problems related to the enforcement of the Motor Vehicles (Smoke and Gas Emission) Rules 1977. The results show that approximately 35% of the lorries examined had excessive smoke emission compared to 33% for taxis, 16% for buses and mini buses, and 13% for cars. Further examination of the data did not show any relationship between the degree of smoke emission and parameters such as age and maintainance of the vehicle, or duration since the last mandatory inspection by the RTD. A study of the past records of enforcement carried out by the DOE showed that an average of only 52.7% of the planned exercises were actually carried out during 1979 to 1983. This was due to various reasons including manpower and budget problems, equipment, transportation, and weather. The selection of suitable sites for curb-side enforcement is nearly always hampered by the need to select locations which would not cause severe traffic problems and hence did not necessarily match the traffic flow. The main problem faced by the RTD is the lack of space to carry out inspection of the motor vehicles. The results also give a strong indication that some drivers of diesel vehicles may adopt underhand tactics such as tempering with the engine parts or adding volatile additives into the fuel tanks to achieve short term reductions for smoke emission during the RTD tests.

INTRODUCTION

Studies conducted both, within Malaysia and in other countries have established that motor vehicles constitute one of the major sources of air pollution especially in the urban centres. These pollutants in the form of carbon monoxide, particulates, hydrocarbons, oxides of nitrogen, sulphur dioxide and lead compounds may cause a variety of health related problems in humans and animals, and secondary pollutants such as photochemical oxidants can also cause appreciable damage to metal parts, fabrics, and building surfaces (Pitts, 1981). Diesel powered vehicles in particular, produce considerably more particulate matter per unit volume of fuel used than petrol driven vehicles (Kresel, 1981). The major part of the particulates consist of carbon and soot particles whose sizes are in the submicron respirable range and are therefore more likely to be deposited in the lungs (EPA, 1979). The findings that the diesel exhaust emission may be carcinogenic and mutagenic strongly suggests that action should be taken to effectively control smoke emissions from diesel engines (Choudhury and O'Doudney, 1981).

In Malaysia, control of diesel smoke emission is realised through the formulation and enforcement of the Motor Vehicles (Smoke and Gas Emission) Rules 1977. These rules were gazetted under the Road Traffic Ordinance 1958, and brought into force of 15 March 1978. The enforcement of these rules is carried out jointly by the Road Transport Department (RTD) in the Ministry of Transport, the Department of the Environment (DOE) in the Ministry of Science, Technology, and the Environment, and the Royal Malaysian Traffic Police.

This study was carried out to evaluate the smoke emission patterns from different categories of diesel powered vehicles plying Malaysian roads, and to study the problems faced by the RTD and the DOE in enforcing the Smoke Emission Regulations under the Motor Vehicles (Control of Smoke and Gas Emission) Rules 1977.

Under these Rules, an emission standard of 50 Hartridge Smoke Units (HSU) was stipulated under free acceleration test conditions carried out by an authorized officer. The smokemeter specified by the Rules is the Hartridge MK3. The meter should also be tested and calibrated annually by an authorised body. In the enforcement exercises carried out by the DOE, all diesel powered vehicles are waved aside by the traffic police and a visual inspection is first carried out in which the smoke emission from the exhaust is observed visually while the engine of the stationary vehicle is accelerated to maximum. Those vehicles which do not emit visible smoke are allowed to proceed while those that emit dark smoke will be asked to proceed to the next stage of testing where the Hartridge Meter test is carried out. If the smoke emission is found to be within the range of $50-60$ units, the driver of the vehicle is given a verbal warning but if it exceed 60 units, a summons is issued by the traffic police. The vehicle owner can either have this offence dealt with at a police station or choose to appear in court.

MATERIALS AND METHODS

Apparatus

For the measurement of smoke emission, the Hartridge Smokemeter MK3 was used. It was supplied and manned by officers of the DOE. The tests carried out at the RTD site were performed using similar equipment by the RTD officers.

Location of Study

Enforcemet exercises with the DOE mobile monitoring unit were carried out in the Kuala Lumpur – Petaling Jaya area, notably at Jalan Kampung Baru near Jalan Ipoh and at Jalan Munshi Abdullah. Pertinent background information of each of the vehicles tested was obtained from the relevant public agencies.

Procedure of the Study

The enforcement procedure of the DOE consists of curb-side checks on diesel powered

vehicles. The RTD enforces the Rules by incorporating the smoke emission test in their routine inspection of motor vehicles. All commercial vehicles are required by law to undergo inspection once every six months to ensure that the vehicles are in roadworthy condition. This inspection is carried out at the RTD office in each state.

For this study, two on-the spot DOE exercises were carried out. In these outings, observations were made with regard to the procedures followed in the enforcement exercises and the result of the Hartridge Smokemeter test was recorded together with the registration number of each vehicle tested. The problems encountered during the conduct of these exercises were also recorded.

For problems related to the enforcement of the law, the relevant officers of the RTD and DOE were interviewed. Additional information was also obtained by observing the routine enforcement work carried out at the RTD site as well as from previous records of enforcement by both organizations.

All data obtained was examined and analysed using the Statistical Package for Social Sciences (SPSS) programme at the computer centre in UPM (Nie, 1975). Linear and multiple regression analyses were employed. The F-test was carried out to determine the significance of relationships between the Hartridge Meter readings with other parameters.

RESULTS

Enforcement Exercises by the DOE

Table 1 shows the frequency of enforcement exercises carried out by the DOE mobile unit for the period 1980 to 1983. During this period exercises were most frequently carried out in the larger cities and towns on the West coast of Peninsular Malaysia. The highest number of exercises was carried out in Kuala Lumpur followed by Pulau Pinang, Petaling Jaya, Malacca and Kuantan, and Klang and Seremban. An examination of the RTD Yearbook (1982) showed that the greatest number of diesel vehicles (e.g. lorries and taxis) are registered in the Kuala Lumpur-Selangor area and this

TABLE 1
Enforcement exercises by the DOE during 1980 to 1983

Town/City	Period *1980	1981	**1982	1983
Kuala Lumpur	31	14	14	26
Petaling Jaya	7	3	5	9
Klang	6	1	6	9
Seremban	4	5	2	10
Melaka	—	7	6	10
Muar	6	6	—	5
Batu Pahat	6	4	—	4
Johor Bahru	—	10	—	6
Ipoh	5	8	—	5
Pulau Pinang	20	21	—	9
Seberang Perai	4	6	—	8
Alor Star	5	8	—	5
Kuantan	8	10	—	5
Kuala Terengganu	—	—	—	3
Kota Bahru	—	—	—	6
Total	102	103	33	120

*Data for the months of April, May and June not available.
**Data of the enforcement exercises of one unit only.

probably accounts for the greater surveillance in this locality. Nonetheless, another important factor in deciding the intensity of surveillance are complaints received from the public concerning smoke emission from motor vehicles. This was partly the reason for the greater number of exercises in Pulau Pinang which has a free trade zone and consequently a large traffic flow. The least number of exercises was carried out in Kota Bahru and Kuala Terengganu where enforcement exercises began only in 1983.

Detailed analysis of the results show that most of the exercises were carried out in the first eight months of the year notably during June to August with very few in the remaining months. This was mainly attributed to exhaustion of the budget allocated for the enforcement exercises. In 1980 and 1983, several intensive campaigns were launched in Kuala Lumpur and Pulau Pinang against smoky vehicles. As a result, more vehicles were stopped and checked during these two years compared to other years (Table 2).

Forty-five per cent of the vehicles stopped in 1980 were tested using the Hartridge Smokemeter when they failed the visual inspection. Of these, 67% were summonsed and the rest released, some with a warning to maintain their vehicles so that no visible smoke would be emitted. The highest number of vehicles stopped was in 1983 where a total of 12,084 vehicles were examined and of which, 20.8% was summonsed. A breakdown of the vehicles summonsed in Kuala Lumpur in 1983 (Table 3) showed that diesel powered lorries and taxis topped the list at 35.3 and 32.8 per cent. Cars, buses and mini buses came up to 29.4% followed by vans and pick-ups.

Further analysis showed that proportionately more lorries, taxis, and buses were in breach

TABLE 2
Breakdown of vehicles stopped, tested, summonsed, warned, or released during the period 1979 to 1983.

Year		Vehicles Stopped	Tested	Summonsed	Warned	Released
1979	Nos.	2,389	1,612	760	445	407
	% (a)		67.5	31.8	18.6	17.0
	% (b)			47.1	27.6	25.2
1980*	Nos.	7,700	3,469	2,325	557	587
	% (a)		45.1	30.2	7.2	7.6
	% (b)			67.0	16.1	16.9
1981	Nos.	5,779	2,056	1,516	182	358
	% (a)		35.6	26.2	3.1	6.2
	% (b)			73.7	8.8	17.4
1982**	Nos.	2,982	793	589	83	121
	% (a)		26.6	19.8	2.8	4.1
	% (b)			74.3	10.5	15.3
1983	Nos.	12,084	2,897	2,509	331	57
	% (a)		24.0	20.8	2.7	0.4
	% (b)			86.6	11.4	2.0

*Data for April, May, June not available.
**Data for one enforcement unit only.
% (a): Percentage of vehicles tested, summonsed, warned or released against the numbers stopped.
% (b): Percentage of vehicles summonsed, warned or released against the numbers tested.

TABLE 3
A categorical breakdown of vehicles summonsed in Kuala Lumpur during 1983

Type	Lorry	Buses	Mini Buses	Taxis	Cars	Vans
Nos.	222	58	42	206	85	16
%	35.3	9.2	6.7	32.8	13.5	2.5

of regulations compared to other vehicles. Thus, true to popular opinion, the greater percentage of smoke emission in urban Kuala Lumpur comes mainly from the commercial vehicles i.e. lorries, taxis, buses, and mini buses all of which are diesel powered.

The data in Table 4 show that not all of the planned enforcement exercises were carried out throughout any year. An exercise may be cancelled for a variety of reasons as shown. In 1980, 77.9% of the planned exercises were carried out compared with 46.4% in 1981, 41.9% in 1982 and 48.6% in 1983. The majority of the cancellations was due to police personnel and transport problems. There were also cases of equipment being repaired and still in the workshop because of the problem of spare parts, weather and budget constraints, and problems of unscheduled leave and holidays. In 1983, 5.5% of the cancellations was due to faulty equipment. Since the DOE, then, only possessed 3 sets of equipment (one in East Malaysia), such breakdowns have severe repercussions on the enforcement exercises. The smokemeter is also very sensitive to humidity and cannot be used on rainy days. In 1983, approximately 4 per cent of the planned enforcement exercises were cancelled due to weather constraints.

To gain an insight into the relationship between the Hartridge meter reading and the condition of the motor vehicles, two exercises were conducted in the Kuala Lumpur area between February and May 1984 (Table 5). Several factors were taken into consideration during the planning of these exercises. Firstly, the enforcement exercise was not carried out in busy commercial areas to avoid the creation of traffic jams. Secondly, it should be located in an area where vehicles can be prevented from turning back on realising that an enforcement exercise is in progress.

A common problem encountered was the anxiety displayed by the drivers of the vehicles. Many were concerned about the effect of the test method on their engines (i.e. when the accelerator pedal is pressed down to the maximum with the engine switched on). It has been discovered that some drivers try to reduce smoke emission by pulling out the choke or, as in the case of bus drivers, to place a piece of wood or pad between the floorboard and the accelerator

TABLE 4
Illustration of the number of planned exercises, those actually carried out, and some reasons for the cancellation of the others

				Reasons for Cancellation						
Year	Plan. exer.	Carr. out	Cancelled	Pol.	Budg.	Equipt.	Trans.	Wea.	Hols.	Others
1980	149	116	33	20	—	1	5	2	5	—*
1981	222	103	119	31	—	2	69	7	8	2
1982	74	31	43	11	—	—	20	1	—	11
1983	247	120	127	38	44	7	6	5	—	120

TABLE 5
Number of vehicles stopped and summoned in two exercises in 1984

Vehicle type	Numbers stopped	Numbers summoned	Percentage summoned
Taxis	28	20	71.4
Buses	56	20	35.7
Mini Buses	75	21	28.0
Lorries	45	7	15.6
Private Cars	9	2	22.2
Vans	7	1	14.3
Tractors	14	11	78.6

pedal. Both actions tend to reduce the amount of smoke emitted. Passengers in the buses and taxis also tend to get irritated by the delay in their travel. The duration of each exercise is determined by the officer incharge and normally does not exceed 3 hours.

The two exercises conducted in 1984 (Table 5) showed that in proportion to the number of diesel powered cars stopped and summoned, the highest number of offending vehicles comprise taxis, followed by buses, mini buses, diesel cars, lorries, and vans. The mean age of some of the vehicles together with the Hartridge meter readings are presented in Table 6.

The median age of the taxis summoned was about 1.9 years with a range in age from 0.2 to 6.4 years. Similar observations were recorded for the buses and mini buses in that failure of the smoke emission test was not restricted to older vehicles only.

The results show that the summonsed vehicles may emit excessive amounts of smoke with readings in excess of 80 Hartridge Smoke Units regardless of age. Only limited information was available for the lorries summoned and thus the data was not included in the analysis. Of interest also is the fact that some of the vehicles which were summonsed had either only recently passed the RTD inspection or were due to undergo inspection soon. In a few instances, several vehicles which were stopped during the *in situ* enforcement exercises and found to have excessive smoke emission had passed the official test only a few days prior to the exercise (Table 7).

TABLE 6
A breakdown of some of the vehicles compounded in two exercises in 1984 in relation to their age, Hartridge meter reading and the duration to the next RTD test date

Parameter	Vehicle type	Nos. exam.	Mean	Median	Min.	Max.
Age (yrs)	Taxis	20	2.4	1.9	0.2	6.4
	Buses	20	4.9	4.0	1.0	13.0
	Mini buses	21	4.3	4.0	1.0	8.0
Hartridge Meter Reading (HSU)	Taxis	20	87.8	95.0	48.0	98.0
	Buses	20	76.7	81.0	25.0	98.0
	Mini buses	21	82.7	81.3	48.0	98.0
Duration to RTD test Date (mths)	Taxis	20	3.5	3.6	1.0	6.0
	Buses	20	2.6	1.7	1.0	6.0
	Mini buses	21	2.7	2.3	1.0	5.0

TABLE 7
Data selected to show the time lapse between the last date of official inspection and the date of compoundment of vehicle

Vehicle type	Date passed RTD test	Date of summons	Duration (days)	Hartridge Meter read. (HSU)
Taxi	10-10-83	12-10-83	2	98
Mini bus	08-10-83	12-10-83	4	98
Mini bus	30-09-83	06-10-83	6	95
Lorry	21-09-83	06-10-83	15	98

Examination by the RTD

The RTD carries out examination of smoke emission during its routine inspection of new and used commercial vehicles at its test site in Petaling Jaya, Selangor. About 130 – 150 vehicles are inspected daily. The procedure for the Hartridge Smokemeter test is similar to that described earlier but the driver of the vehicle runs the engine and presses the accelerator pedal. No visual inspection for smoke emission is carried out prior to the Hartridge meter test and the vehicle owners are informed on the next test date on the same day – six months in advance.

Problems Faced by the RTD

One of the most acute problems faced by the RTD is the lack of adequate space. Since about 130 vehicles are inspected daily, a large number of vehicles crowd the small compound resulting in traffic congestion.

There is also concern about the accuracy of the Hartridge meter readings taken off the vehicles. Discussions held with the officers concerned indicated several means by which drivers of vehicles may mislead the test results. These include (a) adding volatile chemicals into the diesel fuel thereby making the combustion process more complete through a more efficient distribution of the fuel droplets in the combustion chamber and hence reducing smoke emission, (b) by fine-tuning the engine so that less fuel enters the combustion chamber which therefore reduces particulate emission, and (c) pulling out the choke during the test. The data in Table 7 supports the concern and suspicions expressed by the officers.

DISCUSSION

Smoke emission from diesel vehicles is not an isolated problem but one found in most South-east Asian countries (Middleton, 1982). There are many factors which contribute to smoke emission from diesel engines, such as the type of fuel used, the type of engine and its maintenance, the extent of enforcement of smoke emission regulations, vehicle loads, and the mode of driving of the vehicle. This study further demonstrates some of the problems related to the testing of smoke emission from motor vehicles under the existing legislations.

Frequent unavailability of traffic police manpower was identified as a major reason for the cancellation of the planned exercises during 1980 to 1983. This is because the assistance of the traffic police is required to stop motor vehicles off the roads. This power is currently not available to officers of the DOE. Since it is unlikely that the traffic police manpower situation will be changed significantly in the near future to lend additional support for the activities of the DOE, one way of overcoming the problem is give officers of the DOE the authority with legislative powers to carry out the curb side exercises without the presence of the traffic police. Revisions to this effect have been included in the recently proposed ammendments to the Environmental Quality Act 1974. These officers should have distinct uniforms for easy identification by drivers.

Budget allocations for the enforcement exercises should be increased accordingly.

To alleviate the problem of faulty or the lack of equipment, inter-agency loans could be made between the DOE and the RTD which has more instruments.

The large number of vehicles inspected both, by the DOE and the RTD, has resulted in an enormous number of files. Thus, cross checks and verification checks within or between agencies with regards to the condition of particular vehicles or for the purposes of improving surveillance strategies or administration matters are difficult and time consuming. In these instances, systematic computerization of the records will greatly improve the planning process and other activities carried out by the agencies concerned. Currently, both departments have started to implement this system.

Sufficient competent manpower did not appear to be a major problem in both agencies. Nonetheless, space problems are still acute at the RTD test site in this study. To reduce this problem the test sites may be decentralised to several locations on the outer city limits.

Public and driver education with regard to exhaust smoke emission should also be improved generally. During the *in situ* exercises, many drivers claimed ignorance of these issues (many commercial vehicles are company owned). Replies to questions about frequency of engine servicing, overhauling, and general vehicle maintenance did not receive meaningful responses and therefore was not included in the analysis. Mileage indicators, for instance, were not a reliable parameter since they were found to be jammed in many vehicles, or had already undergone several rounds. This shows a need for a public campaign to inform drivers about smoke control regulations, and the hazards of excessive smoke emission as well as the accompanying increases in fuel consumption. Persistent and obstinate drivers should be strongly penalised. The fines imposed on offenders should also be standardised and not vary among states as at present. Vehicles which emit excessive smoke should be suspended from public roads until repairs are made to control smoke emission in order to prevent vehicle owners paying a fine and continuing to use their vehicles.

On a wider scale, dealers of new and second-hand vehicles should be required to examine their vehicles for smoke emission before it can be sold and allowed onto the road. Motor mechanics and garages should be encouraged to install facilities for checking smoke emission on their premises. In addition, the national car manufacturing project which is envisaged to start rolling off stocks in September 1985 may well include measures to reduce exhaust smoke emission.

ACKNOWLEDGEMENT

The authors wishes to thank the staff of the DOE and the RTD as well as members of the Traffic Police Corps for their cooperation and active participation in carrying out this study.

REFERENCES

CHOUDHURY, D.R. and O'DOUDNEY, C. (1981): Salmonella Microsome Mutagenicity Assays of Exhaust Emissions From Diesel and Gasoline Powered Motor Vehicles. *Environment International,* 5: 255 – 261.

E.P.A. (1979): The Diesel Emissions Research Programme. EPA Programme Report by the Mobile Source Research Committee.

KRESEL, W.E. (1981): Toxicological Assessment of Diesel Smoke Emission and their Technological Control. WHO/UNEP BiRegional Workshop on Planning for Control of Emission from Motor Vehicles.

MIDDLETON, J.T. (1982): Motor Vehicle Pollution Control. Assignment Report to the WHO Western Pacific Regional Centre for Environmental Planning and Applied Studies, Malaysia.

NIE, N.H. *et al.* (1975): SPSS-Statistical Package for the Social Sciences. Ed. Nie, N.H. Mc Graw Hill, New York.

PITTS, J.N. *et al.* (1981): Interaction Between Diesel Emission and Gaseous Co-pollutants in Photochemical Air Pollution — Some Health Implications. *Environment International,* **5:** 235 – 242.

R.T.D. (1982): Jabatan Pengangkutan Jalan: Year Book 1982. Road Transport Department, Ministry of Transport, Malaysia.

(Received 22 June, 1985)