35TH MEETING

HELD AT

IOCL, MARKETING HQRS., BOMBAY

ON

AUGUST 28, 1996

No. J-13012/5/95-Gen.
Government of India
Ministry of Petroleum & Natural Gas

New Delhi, the 19th September, 1996

To

1. The members of the Scientific Advisory Committee on Hydrocarbons of the Ministry of Petroleum & Natural Gas (By name)

2. The Chief Executives of Oil Companies

Sub: Meeting of the Scientific Advisory Committee on Hydrocarbons of the Ministry of Petroleum & Natural Gas - Circulation of the minutes

Sirs,

I am directed to forward herewith a copy of the minutes of the 35th meeting of the Scientific Advisory Committee on Hydrocarbons of this Ministry held at IOCL, Marketing Hqrs., Bombay on 28th August, 1996, for information and necessary action.

Yours faithfully,

(Harpal Singh)
Under Secretary to
the Govt. of India
Tel.No. 3388764 (Off.)

Copy to :

Prof. M.M. Sharma, Professor of Chemical Engineering and Director of Chemical Technology, University of Bombay, Matunga, Bombay-400019.

Copy also to :

1. JS(E)/JS(R)/JS(M)/Adv.(E)/Adv.(R)/DS(CC)
2. ED, CHT, New Delhi.
3. FA&CAO, OIDB, New Delhi.
4. PS to Secretary (P&NG)

(Harpal Singh)
Under Secretary to
the Govt. of India

Dir(R)

Dir(E) - CHT 14/10

MINUTES OF THE 35TH MEETING OF THE SCIENTIFIC ADVISORY COMMITTEE HELD AT IOCL MARKETING HQRS., BOMBAY ON 28.8.96

List of participants is enclosed.

Shri Sudarsanam, Executive Director (Lubes), IOC, Marketing Division welcomed the Secretary (P&NG), Chairman, other distinguished members of the Scientific Advisory Committee (SAC) and invitees.

Prof. M.M. Sharma, Chairman, SAC thanked Shri Sudarsanam and IOC for hosting the meeting and requested Dr. Kelkar, Secretary (P&NG) to address the SAC before the agenda items are taken up.

Sceretary(P&NG) suggested that managements of oil companies should consider carrying out audit on the creative and innovative ideas which have been implemented in their respective companies. This, he felt would help the companies in the post liberalisation scenario. He also emphasised the need for the diffusion of Information Technology in the oil sector for its improved performance. SAC could look into the benefits that could be derived in the R&D sector with the help of information technology. He asked CHT to give a presentation to SAC on the action being taken for the utilisation of information of technology in the oil sector.

Secretary(P&NG) further stated that GAIL had been doing some work in the areas of Utilisation of Natural Gas, Curbing automotive emissions etc. and wanted the advise and direction of SAC in these efforts.

As there were no comments from members of the SAC, the minutes of the 34th meeting were taken approved as such.

The agenda items were taken up and the presentations were made.

35.1 Utilisation of Natural Gas

Dr. A. Rastogi, GAIL made a presentation on the supply-demand gap for natural gas and the various options for bridging the same. Two options considered are :

i) Import of LNG
ii) Import of Di-Methyl Ether (DME)

Import of LNG requires handling of product in huge tankers, cryogenic storage facilities at the unloading site, energy required for regasification etc. It was mentioned that the cost involved are high and the landed cost of LNG would in the range of 2.7 - 3.5 $ US per MMBTU.

DME which can be manufactured from natural gas has a higher boiling point than natural gas and will be in the liquid form at a pressure of about 14-15 kg. at room temperature. DME could be used as feedstock for petrochemicals, diesel replacement,

alternate to LPG, one step conversion to MS etc. It is non-toxic and also used as aerosol in perfumes. The observations of SAC members are as follows :

1) As diesel would continue to be in short supply even after new refineries have been installed in the country, it was felt that DME could be one of the supplementary fuel to diesel. Prof. M.M. Sharma advised that comparison of cost should be made between DME and the process developed by Shell for the manufacture of middle distillate from natural gas. Dr. S. Vardarajan desired the safety aspects with respect to storage, handling, distribution of DME in the filling stations should be more critically studied by OISD.

2) In the case of LNG import the regasification could be done in conjunction with processes which need refrigeration like bulk production of oxygen/nitrogen using the air liquification process as used in steel plant, ammonia plant etc.

3) The consortium of IOC-ONGC-GAIL should look for ownership of hydrocarbons (curde and natural gas) in middle east and the natural gas from this ownership could be used either for import as LNG or conversion to DME in middle east.

The process for conversion of natural gas to DME is yet to be established for large scale plants. In this direction a consortium of oil companies lead by AMOCO is carrying out pioneering work. Secretary (P&NG) informed the members that the consortium has shown its willingness to take a member from India in their project and wanted the advice of SAC in this connection. Dr. Varadarajan was of the opinion that commercial aspects are more important while joining the consortium since we cannot contribute by way of technical expertise in this project. He also suggested that we should also take up some preliminary work in the conversion of natural gas to DME and should join the consortium only at an appropriate time. However, the negotiations could be started to find out the various implications of joining the consortium and continue it till we decide to join the consortium.

35.2 Availability and utilisation of gas hydrates

This presentation was made by Dr. Budhiraja of GAIL. The gas hydrates are formed when sufficient quantity of natural gas is present alongwith water at certain temperature and pressure. It was mentioned that chance of gas hydrates formation is very high in sea beds at a depth of 800-1000 metres where large scale biological activities are present. The survey conducted off the Indian Coast indicated the presence of about 2000 trillion metric cube (tmc) of gas hydrates with 95% confidence level. Even if 1% is recoverable out of this huge reserve it will still be a sizeable quantity. One cubic metre of hydrate contains 146 M3 of gas and 0.8 M3 of water. A three well test programme is being undertaken by GAIL at a cost of Rs.150 crores for the exploitation of gas hydrates reserves.

SAC gave its full support to the activity. Further it was mentioned that since this is a multidisciplinary activity, necessary help can be extended by the various departments/agencies as and when required. Dr. Vardarajan indicated that Dr. Budhiraja of GAIL could discuss the matter further in detail with him for his advice.

35.3 Efforts in curbing automotive emission

This presentation was made by Dr. A Rastogi, GAIL. This presentation covered :

i) Fuel injection system for two stroke engine
ii) Smoke scrubber for diesel vehicles
iii) Alternate fuel for petrol vehicles
iv) Low emission restorative fuel

A copy of the paper circulated by GAIL is enclosed. The observation of SAC members are as follows :

1) Fuel injection system developed for two stroke engine should be subjected to more trial/test runs and two stroke ingine manufacturers may also be involved in this process.

2) As regards smoke scrubber for diesel vehicle, the remedial action should be focused to find out the cause for smoke generation and technological solutions for eliminating the same instead of going in for end of the pipe treatment.

3) As regards reduction of emissions through the use of petromulsion (emulsion of petrol and water) IIP was requested to make more detailed presentation on the same.

35.4 Biodegradable lube oils

IIP was requested to put up a project proposal on development of biodegradable lube oils in the next SAC meeting.

35.5 Desulphurisation of natural gas at Hazira

Shri U.S. Deshmukh, ONGC made a presentation on desulphurisation of natural gas at Hazira. This presentation mainly covered the removal of hydrogen sulphides (H2S) from natural gas, operational problems faced and how they overcame the same. EIL was asked to make a presentation on liquid catalyst developed by GNFC for sulphur removal and used in trial runs at ONGC, Hazira in the next SAC meeting. ONGC was also requested to make a presentation on the operational experiences of the sulphur recovery unit (using ARI technology) for the benefit of other refineries who are using the same technology.

35.6 Project proposal on Hydrodynamics of trickle bed reactor - Cold flow studies - Phase-II

Dr. Ram Babu of EIL (R&D) made a presentation on the above project proposal which is to be carried out by EIL(R&D), IOC(R&D) and IIT(Delhi). SAC advised to consider the option of using pressure swing adsorber in once through mode instead of recycle gas compressor if found feasible. SAC recommended the proposal for approval.

35.7 Project proposal on 'Development of advanced control package for sulphur recovery unit'

This project proposal was presented by Prof. Madhavan, IIT(Bombay). The advanced control package is to be developed by EIL (R&D) in collaboration with IIT(Bombay) for implementation at Mathura Refinery. Mathura Refinery has agreed to provide all the necessary data/information for the development of package and its implementation in their sulphur recovery unit subsequently. SAC recommended this project proposal for approval.

35.8 Other points

1) Progress on technology development for the production of high quality micro-crystalline waxes using short path distillation technology

Dr. A. Ghosh, Director, RRL, Jorhat apprised the Committee about the procedural delays in the procurement of pilot plant facilities for the above mentioned project. SAC recommended formation of a small group consisting of Advisor (R), Dr. Ghosh and one representative frrom EIL to help RRL, Jorhat in expediting the procurement.

2) Project proposal on 'Pilot plant studies for the production of LPG and high octane gasoline from naphtha/NGL'.

Dr. Prasada Rao, Director, IIP informed the committee that BPCL have shown interest in this project proposal and a meeting between the officials of IIP and BPCL is scheduled for 29th Aug.'96.

3) Project proposal on 'Production of feedstock for carbon black manufacture'

Dr. Prasada Rao, Director, IIP informed the Committee that HPCL is interested in this project and it is being pursued with them. Advisor (R) requested to expedite the progress.

4) Project proposal on development of computer based training at CAD Centre, IIT (Bombay)

CHT informed the committee that 5 refineries have given favourable response for this proposal. Chairman, SAC stated that this point may be discussed separately with him before it is put up to the SAC in the next meeting.

35.9 The Committee decided that next meeting of SAC will be held at MRL, Madras on 13th November, 1996.

LIST OF PARTICIPANTS OF THE 35TH MEETING OF SCIENTIFIC ADVISORY COMMITTEE HELD AT IOCL, BOMBAY ON 28.8.96

Chairrman :	Prof. M.M. Sharrma
Members :	Dr. S. Varadarajan
	Prof. K. Vasudeva
	Dr. R.S. Venkataraman
	Dr. A.C. Ghosh
	Dr. A.P. Kudchadkar
	Sh. K.P. Shahi
	Dr. T.S.R. Prasada Rao
MOP&NG	Dr. Vijay Kelkar
Invitees :	
CRL	Sh. Koshy Varghese
	Sh. M. A. Siddiqui
HPCL	Sh. G. Raghunathan
	Sh. P.K. Tripathi
	Sh. S.K. Pal
BRPL	Sh. B.K. Gogoi
	Sh. K.S. Rao
IIP	Dr. Himmat Singh
	Dr. V.K. Bhatia
	Dr. B.S. Rawat
EIL	Dr. S.J. Chopra
	Dr. Ram Babu
IIT, Bombay	Sh. K.P. Madhavan
ONGC	Sh. K.S. Deshmukh
	Sh. A. Basu
IBP Co. Ltd.	Sh. Vinod Moudgil
Biecco Lawrie	Jose K. Thomas
IOC(R&D)	Dr. A.K. Bhatnagar
	Dr. R.P. Verma
BPCL	Sh. M.B. Lal
	Sh. V.K. Agarwal

RRL, Jorhat	Dr. S.A.A. Rizvi Sh. J. Suryanarayana
LIL	Dr. A.S. Sarma
PCRA	Sh. Paramjit Singh
GAIL	Sh. Shyam Sunder Dr. A. Rastogi Dr. Bhudhiraja
CHT	Sh. M. Kannan

GAIL's INITIATIVES IN CURBING AUTOMOTIVE EMISSIONS

BY

DR. A. RASTOGI
SR. MANAGER (TECH)
GAS AUTHORITY OF INDIA LTD.

TO

SCIENTIFIC ADVISORY COMMITTEE ON HYDROCARBONS
MINISTRY OF PETROLEUM AND NATURAL GAS
ON 28TH AUGUST, 1996

GAIL'S INITIATIVES IN CURBING AUTOMOTIVE EMISSIONS

Vehicular pollution in urban India is severe and alarming. The steep increase in vehicle population has been the major contributor in deteriorating the air quality. In the past fifteen years, vehicular population in India has risen from 43.26 lakhs to 277.62 lakhs. In the same period, two wheelers multiplied by a factor of 8 while passenger cars and diesel vehicle population rose by about 3 times. According to a survey, there are 26 lakh vehicles in Delhi, which is more than the total number of vehicles in Calcutta, Bombay and Madras. The extent of deterioration in air quality due to automobile emissions in Delhi can be seen from the Table 1.

Table 1: Some Facts About Delhi

- Total number of vehicles in 1995-96 are 26.26 Lakhs
- 65 % of total air pollution caused by automobiles
- Vehicular emissions are 50% more than Bombay, nearly 75 % more than Bangalore, Ahmedabad, Pune, Madras and Calcutta
- Suspended particle matters (SPM) is 38.2 % more than the prescribed level
- Carbon monoxide is 90 % more than the prescribed level
- Oxides of nitrogen is 45 % more than the prescribed level
- Sulphur dioxide is 5.6 % more than the prescribed level
- In last eight years emissions of Carbon monoxide has gone up 132 times, hydrocarbons by 224 times, oxides of nitrogen by 18 times and lead particles by 100 times

Unlike most of the developed countries, the vehicular pollution problems in India are unique and varied in nature. Vehicular pollution in developed countries is mainly due to emissions from gasoline vehicles driven by four stroke engines. In India, however, the major factors which contribute to vehicular pollution are :- unburnt hydrocarbon and carbon monoxide emissions from two and three wheelers, smoke emissions from diesel trucks and buses and lead emissions from the use of leaded petrol. Figure 1 shows the percentage contribution of each of the above mentioned polluters. This indicates that direct application of technologies successful in developed countries may not be the answer to India's urban pollution problem.

GAIL believes that a comprehensive strategy is required to curb the increasing vehicular pollution in the nation. The comprehensive strategy would involve developing technologies in focussed areas where breakthroughs would lead to substantial reduction in vehicular emissions. GAIL has initiated a few projects in key areas keeping in mind that the cost to the user would be crucial in the successful implementation of the technology. The initial results from these initiatives by GAIL appear to be encouraging. The projects which have shown potential of reducing emissions and in some cases improving fuel efficiency are discussed in the following paragraphs.

FUEL INJECTION SYSTEM FOR TWO STROKE ENGINES

In India two and three wheelers are the preferred choice of transport for common men. It is estimated that there are 22 million two and three wheelers in India and their numbers are increasing rapidly every year. One of the main causes of increasing urban pollution is automotive exhausts from these vehicles which are mostly powered by out-dated two stroke engines.

Simplicity, low cost, high power to weight ratio and low NOx emissions are advantages of two stroke engines. However, they have serious draw backs like high specific fuel consumption and high unburnt hydrocarbons. This is because the present day two stroke engine design has no valves but only ports. In this design, in a process called scavenging, induction of fuel air mixture into the cylinder removes the product of combustion through the exhaust port. This leads to an inherent disadvantage of loss of fresh fuel during scavenging when both the inlet and exhaust ports are open simultaneously. Upto 48% of fresh fuel can be lost in a two stroke engine.

The loss of fresh fuel in a two stroke engine is the crux of vehicular pollution. The sheer number of these vehicles cumulatively waste India's precious fuel and are the single largest cause of urban pollution. It is estimated that two and three wheelers powered by two stroke engines number 19 million and contribute to 70 per cent of total vehicular unburnt hydrocarbon. It is estimated that two stroke engines consume 52 per cent of gasoline in India which directly accounts for loss of approximately 20 per cent of India's gasoline. Hence, two stroke engines impact not only the urban population's health but also drain unnecessarily the foreign exchequer.

Keeping in view the popularity of these vehicles as preferred means of individual transport , various institutes in India like IITs, ARAI, Pune and Indian Institute of Petroleum, Dehra Dun have been working to find a solution to overcome the deficiency of two stroke engines. GAIL's engineers believe that the inherent design problem of a two stroke engine would be solved by direct in-cylinder fuel injection. However, since time available for injection i.e. when the exhaust port is closed is only a few milliseconds, accomplishment of in-cylinder fuel injection is not an easy task. Dedicated research , however, provided a breakthrough and proved that the concept was workable. GAIL has now associated with G&T Yugo-Tech Pvt. Ltd. to develop a low cost retrofit. Work is now proceeding in Canada on a Bajaj autorickshaw to develop a micro processor based fuel injection system. The preliminary test results conducted so far have shown reduction in hydrocarbon emission upto 58 to 84 per cent and reduction in carbon monoxide upto 68 to 97 per cent as can be seen from Figures 2 & 3. GAIL has filed for an Indian patent and will be shortly applying for US and Canadian patents.

SMOKE SCRUBBER FOR DIESEL VEHICLES

Most of the buses, trucks and some of cars are driven by diesel engines. Diesel engines have high efficiency, emit lesser hydrocarbon and carbon monoxide gases as compared to petrol engines. However, exhaust from diesel vehicles carry significant amount of smoke. Smoke is largely carbon particles suspended in the exhaust gas. Smoke may be caused by liquid droplets of lubricating oil or fuel oil while starting from cold or when the piston rings are worn out. In diesel engine exhaust, particulate matter in the exhaust is significant as compared to invisible pollutants like carbon monoxide and hydrocarbon. Diesel smoke contains known carcinogenics and also

leads to lung congestion and other health problems.

There are various techniques for controlling the particulate in the exhaust from diesel engines. One, is by internal modifications to the engine and other by external treatment of the exhaust. Since internal modification to the engine would be more expensive and would require further maintenance, GAIL focussed on the idea of developing a '***Smoke Scrubber***' which would remove the smoke from the diesel exhaust.

Smoke scrubbing is a two step process. In the first stage, smoke is wetted or captured by drops of the scrubbing liquid. This often aided by agglomeration solves the problem of collecting tiny low mass particulates by creating particulates of greater mass. These are then separated from the gas stream in the second stage.

The concept testing of reducing the particulate by using a Smoke Scrubber was conducted by GAIL and the results were encouraging. The reduction in smoke level was upto 50 percent. Various methods are now being considered for increasing the smoke removal efficiency. Four types of design have been short listed and the developmental work is in progress to achieve upto 90 percent reduction in smoke level from diesel exhaust. Prototype testing would be done at Indian Institute of Petroleum, Dehra Dun on buses, trucks, cars and "Vikrams". GAIL has filed an application for patent in India.

ALTERNATE FUELS FOR PETROL VEHICLES

Petrol vehicles use leaded petrol which contain Tetra ethyl lead (TEL) which increases the octane number. Exhaust gases from petrol vehicles contain lead compounds which are harmful to the human body. To avoid lead emissions from petrol engines, unleaded petrol was introduced as a 'green fuel'. To compensate for reduction of lead additives in unleaded petrol, oil refineries add 'aromatic substances' such as benzene, toluene and xylene , commonly known as BTX. Though in India , it is now mandatory that un-leaded petrol can not be used in cars without catalytic convertors, the levels of carcinogenic BTX emissions are increasing in the air with the use of unleaded petrol. Alternative automotive fuels like Compressed Natural Gas (CNG), Propane, LPG, Ethanol and Methanol etc. do not contain lead and are fuels with high octane rating. Therefore, their use as alternative automotive fuels should be encouraged in India.

In India GAIL has taken the lead role in promoting CNG as an alternative automotive fuel for petrol and diesel vehicles. The growth of CNG utilization in India has been slow due to high cost of requisite infrastructure and conversion kit. Further, with presently available kits the power output of engine is reduced by 10-15 % and HC emissions do not meet 1996 regulations in case of two stroke engines. GAIL is now developing a low cost new generation CNG kit to overcome these deficiencies. With the setting up of City Gas Distribution in Delhi, the infrastructure cost for installing new CNG outlets would also be further reduced.

Propane is another alternative fuel which has been popular in various parts of the world. Propane was designated as clean alternative transportation fuel under US Energy Policy Act 1992. Of the more than 8.3 million alternative fuelled vehicles all over the world , there are 3.6 million running on propane alone. In Canada, there are approximately 5000 propane dispensing station as compared to 184 CNG refuelling outlets. The international acceptability of propane as an

alternative fuel has been due to certain advantages - lowest greenhouse gas emissions, low in air toxics, low ozone creating potential, low in sulphur dioxide.

As compared to CNG, propane has certain advantages. Lower infrastructure and conversion costs , quicker payback and longer distance per filling make propane more attractive to users. Recently, some of the OEMs like Ford have come out with dedicated propane kits. The weight of these kits are one-fourth that of CNG kits.

Conversion of passenger cars and buses on propane in India may not be as successful as it is in western countries, because major part of vehicular population in India is consisting of two and three wheelers run on two stroke engines. This again may not be feasible due to inherent problems of poor fuel economy and high unburnt hydrocarbon emissions of two stroke engines. Therefore, GAIL focussed on application of propane to two stroke engines coupled with fuel injection concept. GAIL, in association with G&T Yugo-Tech Pvt. Ltd., is developing a new generation micro processor based propane kit utilizing fuel injection concept for two stroke powered three wheelers.

GAIL is also promoting propane as an automotive fuel in India by making it available in increased quantities. GAIL is currently producing 1,30,000 metric tonne of propane per annum. By end of this year, the production of propane would reach to 2,14,000 metric tonne per annum.

LOW EMISSION RESTORATIVE FUEL

In the last decade, carbon monoxide emissions in urban India have increased by over 100 times. This has lead to a hazardous situation where the level is now almost twice the prescribed level. This is basically due to old and untuned vehicles plying on the Indian roads coupled with the problem of adulterated gasoline. GAIL has focused on this problem by formulating a new fuel termed as petromulsion.

Petromulsions are emulsions of fuel and water and can possibly be used in place of traditional fuels with minor modifications to the automobile. Reference to water fuel emulsions for reducing emissions have been made in the literature. GAIL has succeeded in formulating Petromulsions and have run them on automotive engines for several hundred hours. Initial test results on a four-stroke Honda engine indicates a substantial reduction in carbon monoxide levels as shown in Figure 4.

An improvement in fuel efficiency has also been observed. It appears that the increase in fuel efficiency is related to the amount of CO emitted. The per cent CO generated in an engine is a measure of its inefficiency of operation. It is speculated that the water in the petromulsion promotes the shift reaction of CO leading to further generation of heat due to the incremental heat of reaction. A patent application has been filed in India.

Further work needs to be systematically carried out to check the suitability of Petromulsions in automotive engines. This work with the conducted at IIP, Dehradun. In limited test runs conducted at GAIL, no corrosion and deposition problems have been observed in the engine.

CONCLUSION

The tremendous increase in the population of vehicles has led to unprecedented levels of urban pollution in India. This is directly in contrast to the developed countries where the quality of air in urban areas has improved considerably over the last few years. However, the pollution control measures which have been successfully applied in these countries can not be directly applied to India. This is because the vehicular pollution control technologies of developed countries are mostly applicable to electronically controlled fuel injected four stroke automotive engines, whereas in India, the types of vehicles are varied and consequently the nature of pollution caused by them is complex.

Therefore, the answer to the varied nature of vehicular emission problems in India requires a multi-pronged, comprehensive approach. The key lies in finding cost-effective but focussed solutions to pollution caused by older vehicles plying on the Indian roads. GAIL has recently initiated a number of technology programs to deal with specific pollution problems caused by vehicles in India. The initial results appear to be encouraging.

(Source : MoEF Report - 1994)

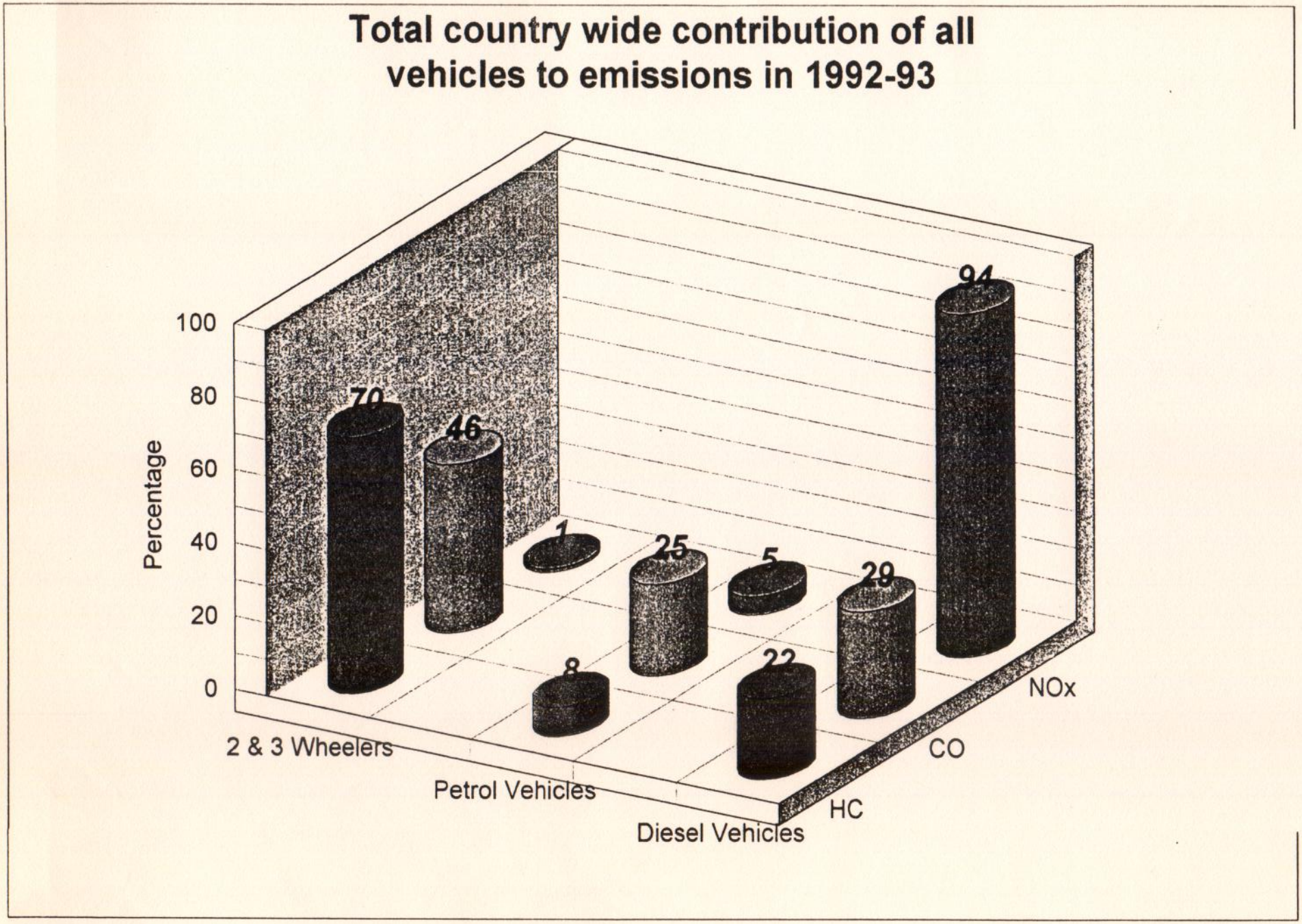

FIGURE 1

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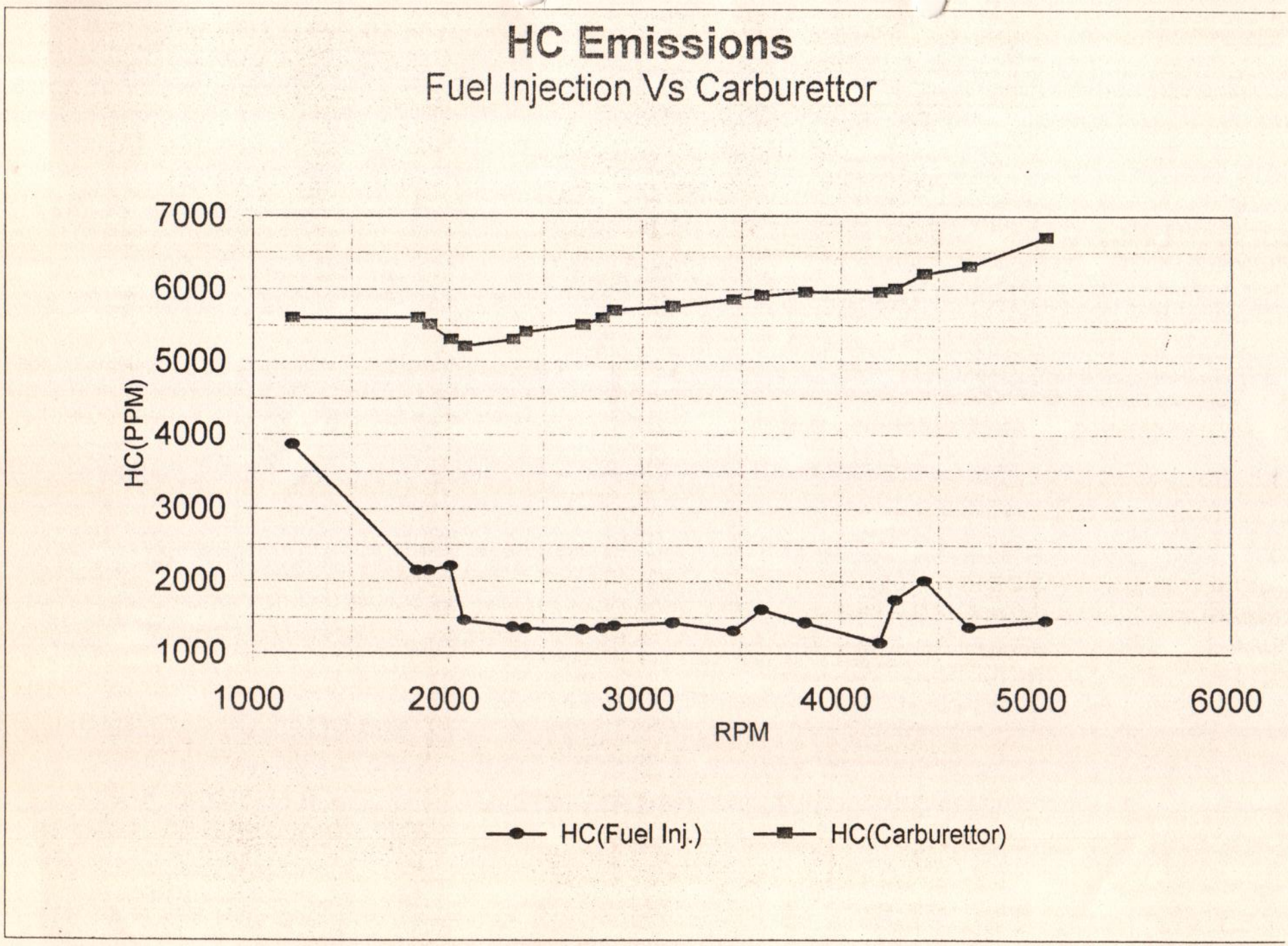


FIGURE 2

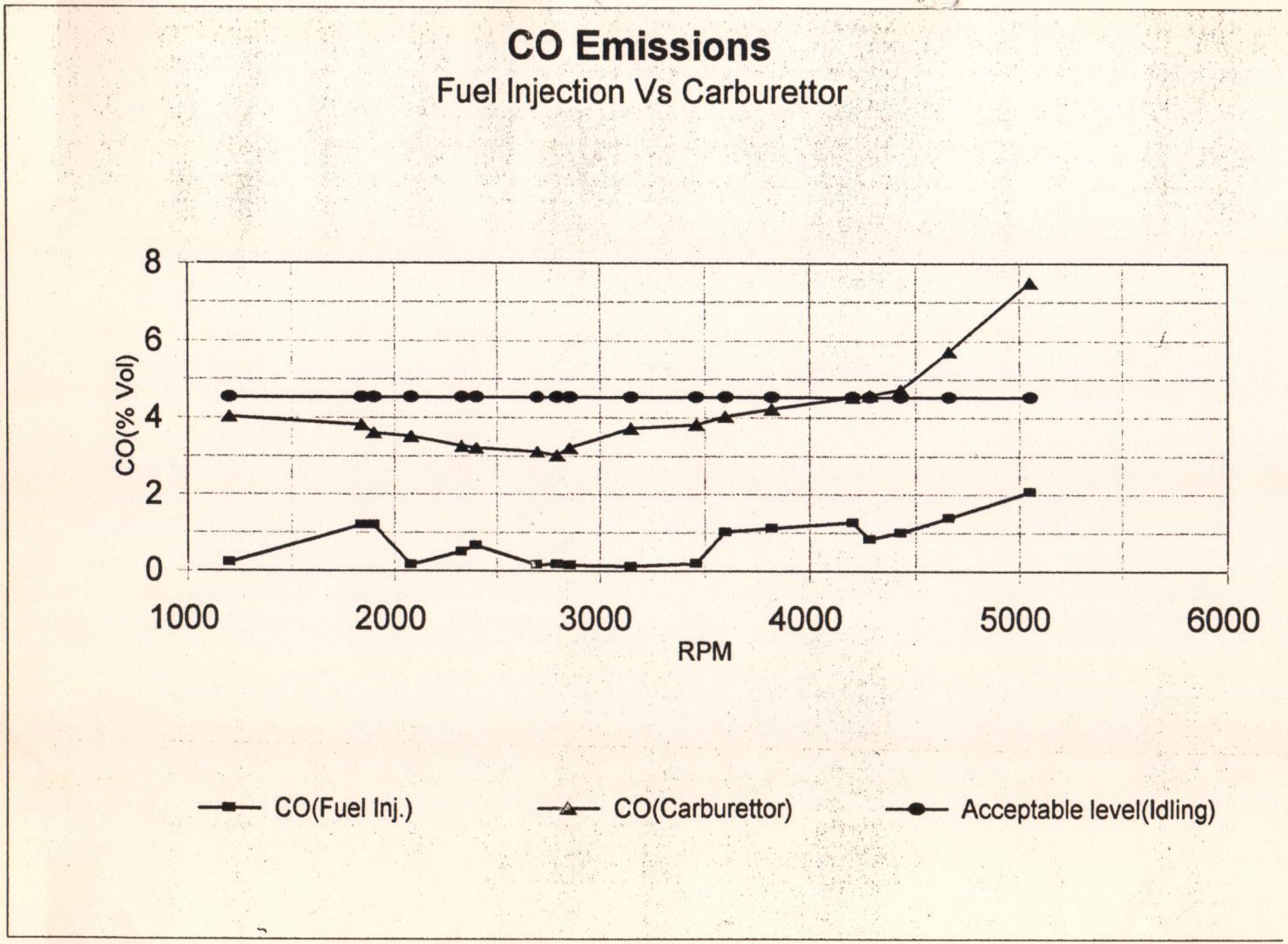

CO Emissions
Fuel Injection Vs Carburettor
CO(% Vol)
8
6
4
2
0
1000
2000
3000
4000
5000
6000
RPM
CO(Fuel Inj.)
CO(Carburettor)
Acceptable level(Idling)

FIGURE 3

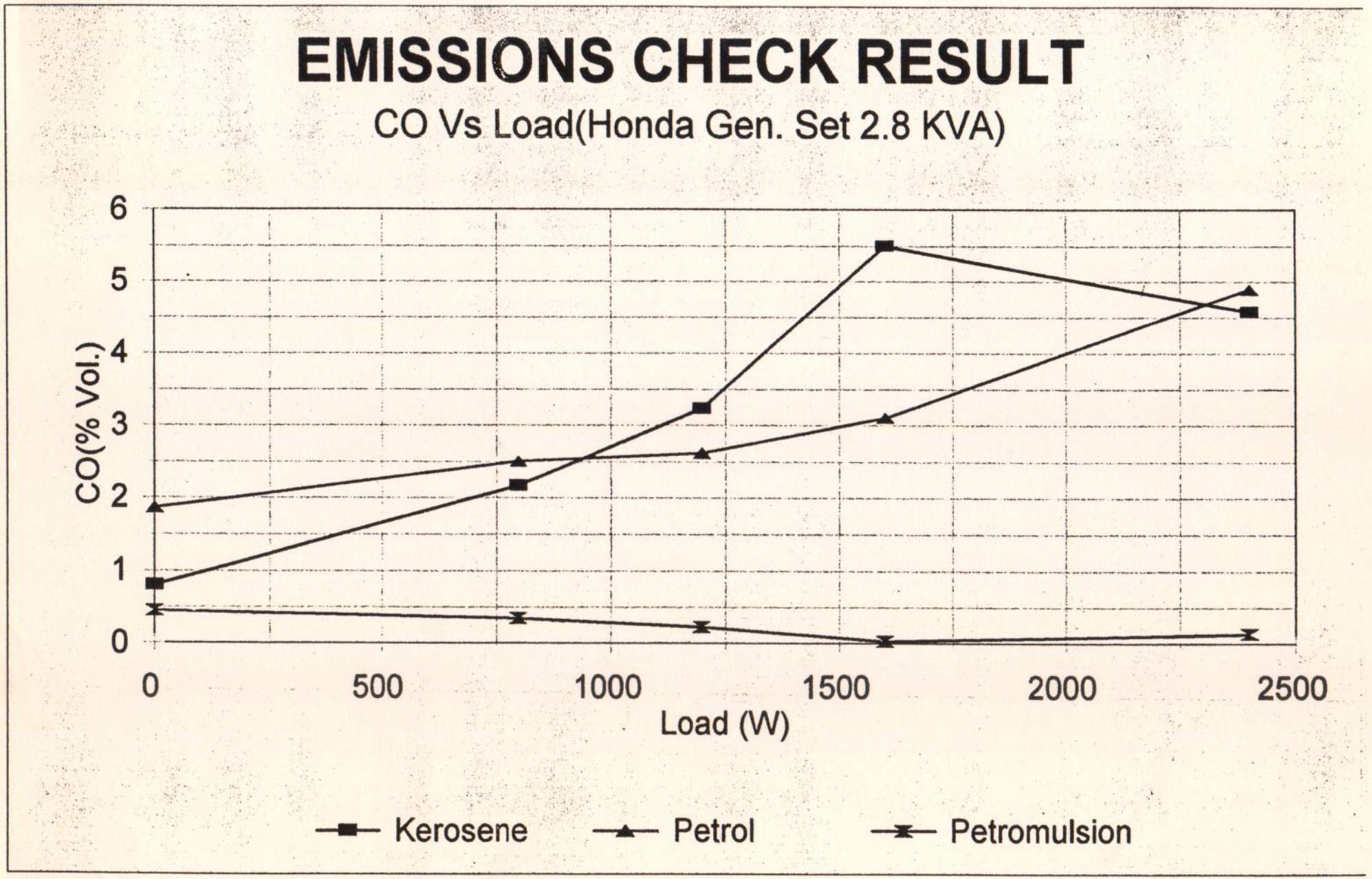
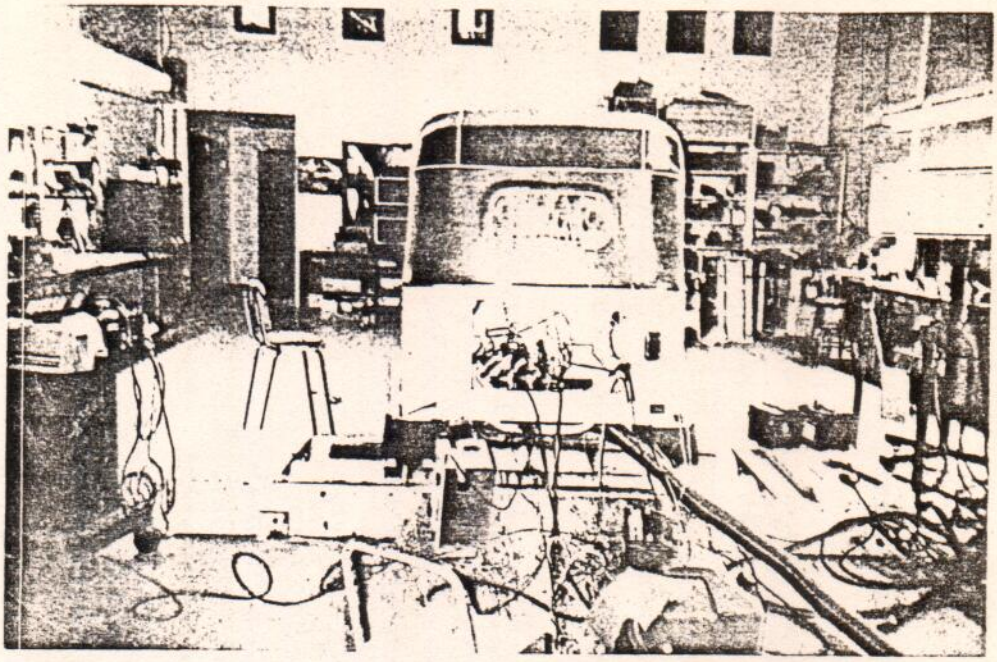
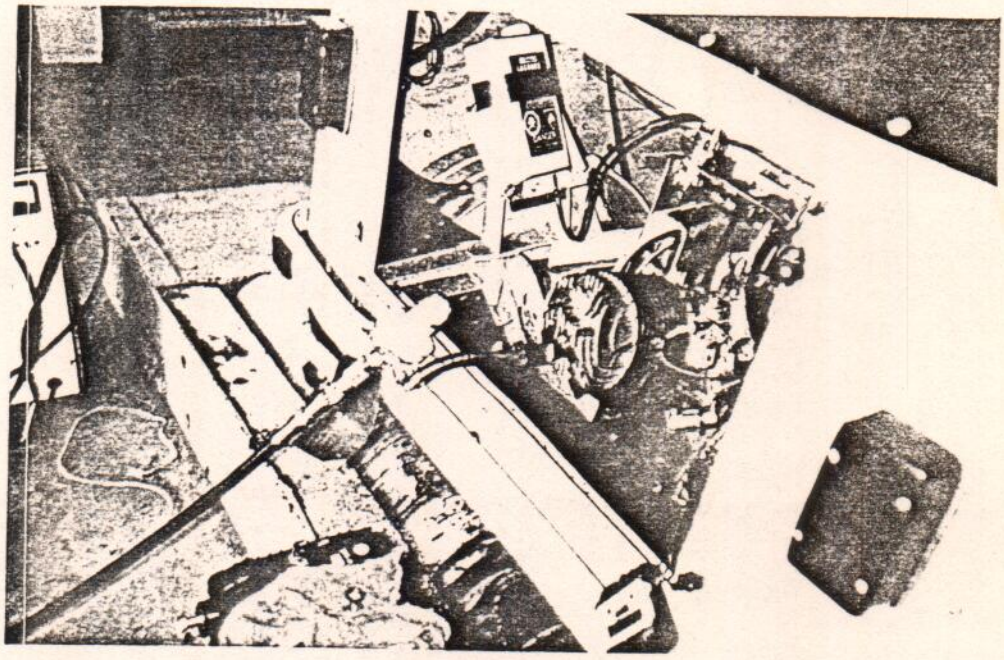
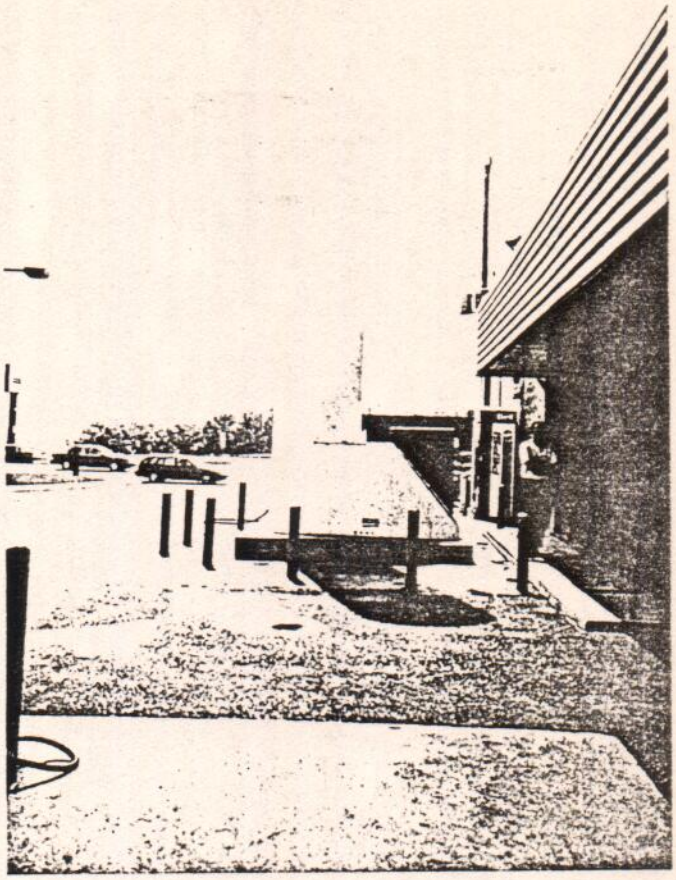

EMISSIONS CHECK RESULT
CO Vs Load(Honda Gen. Set 2.8 KVA)
CO(% Vol.)
6
5
4
3
2
1
0
0
500
1000
1500
2000
2500
Load (W)
Kerosene
Petrol
Petromulsion

FIGURE 4





MICROPROCESSOR BASED FUEL INJECTION SYSTEM FOR TWO STROKE S.I. ENGINE AT M/S. YUGO-TECH, CANADA



PROPANE DISPENSING STATION IN CANADA