CHAPTER-IV

VEHICULAR EXHAUST STUDIES AND SURVEY

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4.1 Introduction

Vehicular air pollution is a serious public health problem in most of metropolitan cities of the world. Delhi, the capital city of India is one of them ranked fourth-polluted city in the world (WHO/UNEP, 1992).

Studies by Nagendra and Khare (2006) presented an overview of Vehicular Exhaust Emissions (VEEs) scenario in Delhi city including sources of VEEs, types of vehicular air pollutants and their formation, followed by health effects of VEEs and national ambient air quality standards for control of air quality in the Delhi city. The automobile discovery appears to satisfactorily combine a human desire for rapid transportation with the desire for independence and flexibility. However, rapid proliferation of motor vehicles, in both developed and developing country, poses a serious threat to the urban air quality (Mayer, 1999). Delhi is one of them, suffering serious urban air quality problems caused due to VEEs (WHO/UNEP, 1992).

Vehicular pollution sources can be classified into four categories :(i) exhaust emissions; (ii) evaporative emissions; (iii) refuelling losses; and (iv) crankcase losses. Out of the four categories, the exhaust emissions account for about 70 % of the vehicular pollution; whereas, crankcase emissions account for about 20 % and evaporation from tank and carburettor accounts for the remaining part of pollution percentage (CPCB, 1999a, b).

Particulate matter (PM10) is a major pollutant from diesel engines exhausts. In developing countries, transport sector accounts for 53 % of

CO emissions (Onursal and Gautam, 1997). Most effective reduction of CO can be achieved by using catalytic converters (Keoleian, *et al*, 1997).

4.2 Automobile Pollution

Air pollution from motor vehicles in developing countries does not yet present a serious problem of the magnitude reached in some of the developed countries. However, as urbanization and industrialization develop in these countries the contribution to air pollution from motor vehicle emissions could increase very rapidly. More so since the vehicles in service will be on the average older and less well maintained, and have as high weight-to-horsepower ratio; the resulting pollution will be out of proportion to the number of vehicles. Diesel engines, an attractive alternative to petrol powered motor vehicles in some developing countries, have the advantage that they produce virtually no hydrocarbons that can take part in photochemical reactions and no carbon monoxide is evolved. Unless correctly maintained, however, they can produce smoke, odour and noise (W.H.O., 1969).

Economic development has always accompanied with the problems of environmental pollution. With an improved standard of living and increased demand on the transport sector, automobile related pollution is fast growing into a problem with serious dimensions in our cities. This is caused not only by rapid rise in the automobile population, but also due to the narrow roads, slow moving traffic, unfavourable driving cycles, poor enforcement of laws relating to vehicle road-worthiness, fuel adulteration, poor emission control measures etc. (Dave, 1978). This builds up a high concentration of pollutants in the lower atmosphere, close to the ground surface, due to restricted dispersion of pollutants and becomes more dangerous.

The two automobile types responsible for pollutants emission are the (1) spark ignition engines using petrol as fuel, and (2) the compression ignition engines using diesel oil as fuel. Two and thee wheelers, motorcycles, scooters, auto rickshaws, and tempo are powered by small two-stroke spark ignition engines and are most serious offenders from an air pollution standpoint. Passenger cars and jeeps powered by four-stroke spark ignition engines are less serious offenders of air pollution. Compression ignition engines, that propel trucks, buses, railway locomotives and of course now cars and jeeps have lower concentrations of pollutant emissions than spark ignition engines, although their exhaust is responsible for higher particulate emissions and has an offensive odour level (Rao, 1979).

4.3 Vehicular Exhaust Pollution in Kolhapur

After formation of Kolhapur Municipal Corporation (KMC), Municipality city limit was increased by 66.82 km. City Development Plan (DP) was sanctioned, however, the developmental activities, such as road broadening, new road construction, widening of narrow roads, alternate ring roads surrounding city for heavy vehicles etc. to eliminate their extra load on city traffic, are long overdue.

In the city roads like station road, S. T. Stand road, Rankala stand road, Tarabai road, Mahadwar road, Bhavani mandup, Shivaji chowk, Bhausingi road, Subhash road, Mirajkar tikati, Baicha putala, Bindu chowk and Sambhaji nagar are the points of bottle neck for traffic congestion. Today there are over 107 km long roads in the city but all are without side lane or footpath, so the pedestrians have to face great difficulties to walk on these roads and negotiate the erratic traffic (Plate-IV, d).

As per KMC information new roads, of 47 km length, are proposed to be constructed at 425 Cr. Rupees cost and the project is awaiting

sanction. Out of this 220 Cr. Rupees are for development of 9 main roads. It is expected that after completion of this project, existing traffic problems in city may be solved to some extent. For maintaining the existing 107 km roads there should at least be 3 Cr. Rupees annual budget provision by KMC. Considering Kolhapur is a district place and the main regional market, heavy outside traffic of all kinds of vehicles is also witnessed through out the year. Due to bad roads condition and poor vehicle maintenance eventually this leads to traffic congestion and even minor and major accidents. Similar scenario is also expected in the district (Plate-III, b, c).

To manage road traffic control in the city there are only 18 traffic signals, namely at the following sites. Malkar corner, Gangavesh, Rankala tower, Kondaoole, Ford corner, Uma talkies, Parvati talkies, Janata bazar rajarampuri corner, Takala corner, Lishan hotel, Panchashil hotel, Dabholkar corner, Vinus talkies, Durga hotel, Bindu chowk, CPR corner, Mahanagar palika and Swayambhu ganesh mandir. These prove to be most inadequate even when they are functioning. Due to electricity shortage and power cut situations most of them function partially even during busy hours (Plate IV, a).

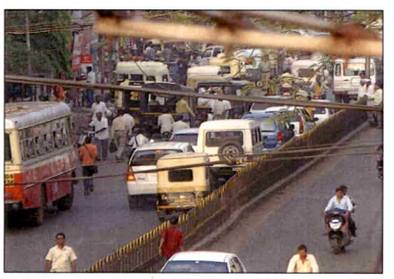
The poor traffic condition in the city is also reflected in the implementation of the traffic rules, as only 75 traffic police handle and regulate vehicular traffic in the city. Out of them often 5 are busy in office work, 10 are normally sanctioned leave, 10 are for arrangements of minister or VIP visits, and only 40 traffic police are available to manage traffic in the city on any normal day.

From this it is clear that at present there is insufficient staff to handle the existing traffic. Most of the city bus stops are near traffic signals and at road turns and pose congestion problem. Ironically the city

Plate-III

a) Inadequate car parking, a common problem in Kolhapur

b) Two wheeler parking at road junction reducing road width



c) Traffic Congestion on narrow roads causing severe air pollution

d) Unruly two wheeler traffic at road junction

bus stop are the only main obstacles on the roads as they are constructed as such by blocking or narrows the roads and the buses stop in the centre of the roads. There is not a single bus dock even on the broad main roads to minimise traffic blocks. During peak hours there is movement of trucks in commercial area through residential areas. This besides aggravating traffic congestion contributes damaging of fragile roads and adds to noise and air pollution. Laxmipuri market area, Mahanagar Palika area, Shahupuri area and now Rajarampuri are some of the examples (Plate IV, c).

- During festivals like Diwali, Ganesh festival, Gudhipadhawa etc., shop owners extend their counters on roads for hoarding, display of products and sell. Use of earlier footpaths by hawkers, digging of roads by concerned service departments and private vehicle parking is a most common feature in the city. This is mainly responsible for traffic jams. Unauthorized private auto rickshaws stop, any where on the road, for passenger without warning, generates increased chances of road accidents. Parking of private buses near Central Bus Stand (CBS), and unauthorised jeeps and cars (Wadap) at prominent junctions further aggravates the problem.

Survey made by city traffic police shows that 250 buildings in the city have no parking facility. In the KMC area there are 36 parking zones, out of which 27 are in E-ward. Interestingly all the pay and park practices introduced in the city, including some main zones have been terminated due to politically motivated public pressure. Table 4.1 gives the list of parking zones in the city (Plate III, a).

Table 4.1: Ward Wise Parking Zones in Kolhapur

Ward	Parking Zones
A	3
B	1
C	4
D	1
E	27

According to (Patil 2008) out of vehicular owners, 26% have no parking facility so that they have to park their vehicles on road which blocks traffic on the already narrow roads. On the other hand 30% owners do not have parking facility at work place. Over 24% owners had to park their vehicles in common open areas, which is neither safe for the vehicles nor for the obstructed traffic on the roads (Plate III, b).

Study conducted by Dr. D. Y. Patil Engineering college (Joshi, 2008) revealed that the major reasons for poor traffic conditions in Kolhapur were attributed to lack of checking of RTO rule implementation by traffic police, wrong arrangement of traffic signals, vehicle population, road conditions, road encroachment by commercial activity and other encroachments on road, lack of road transport rules and regulation, and insufficient traffic police staff. When enquired it was learnt that 42 % of the respondents park their vehicles in the basement of residential area, 32% peoples have to park their vehicles in common parking area in open. Only 46% people were able to park their vehicles at work place. The study also revealed that the number of vehicles moving on major roads per hour in Kolhapur is as follows (Table 4.2). (Plate III, a, b).

Table 4.2: Number of Vehicles per hour on Different Roads in Kolhapur City

Way of Vehicles / Routs	Vehicles / hour
R.S.Jwellers to Babubhai parikh pull	4291
R.S.Jwellers to Dabholkar corner	4190
Wateshwar mandir to S.T. Stand (one way)	1497
Mabhuri backery to Deval club	5481
Commerce college to Khasbhag	3958
Khasbhag to Commerce college	2317
Commerce college to bindu chowk	5574
Mirajkar tikati to Madhuri bakery	9416
Janata bazar to Maruti mandir	1855
KMT bus route	1046
Maruti mandir to lucky bazar	867

(Patil, 2008)

There is also a serious concern about the increasing number of road accidents in Kolhapur district in the past few years. This is attributed to along with increasing number of two wheelers, reckless driving by youth with or without licence, lack of proper driving ethics on highways, poor road conditions etc. The table No 4.3 gives the five-year (2001 – 2005) accident record for the Kolhapur district (Plate III, d).

Table 4.3: Accident Record of Kolhapur District.

Year	No. of Accidents	Fetal
2001	205	22
2002	276	32
2003	287	28
2004	273	18
2005	209	24

(Patil, 2007)

According to one report (Panditrao, 2007) In Kolhapur district from 1st January to 31st May 2007 i.e. in 150 days there were more than 600 accidents. In which 143 people lost their lives and 677 were seriously injured. There are many reasons attributed to this mainly like narrow roads, risky turns, deteriorating road side tracks, absence of signals and traffic police at many important points, uncontrolled vehicle speed, untrained private vehicle drivers, alcoholism, lack of footpaths, increasing commercial encroachment etc.

Table 4.4: Growth of Auto Vehicles in Kolhapur City in Ten Years (1994 To 2005)

Year	Two Wheelers	Three Wheelers	Four Wheelers	Heavy Vehicles	Total
1994	57105	5043	7899	6954	77001
1995	61205	5404	7853	8452	82914
1996	68668	5982	8792	9211	92653
1997	74355	6965	9507	11495	102322
1998	82328	8181	10732	12035	113276
2001	108357	7908	10985	8439	135689
2002	120809	8222	12043	9170	150244
2003	106323	8638	13663	9720	138344
2004	109369	8648	17960	9757	145734
2005	121961	8322	19458	10821	160562

(Joshi, 2008)

There has been phenomenal increase in the number of vehicles in the city in recent past. Table 4.4 gives the annual increase in the vehicle population in ten year period from 1994 to 2005 which is over 47.95%. Since 2005 considering the annual growth rate the current vehicular population growth trend in the city is estimated over 2.1 lakh. The table No.4.5 also reflects the increase in the revenue of Kolhapur RTO through vehicle registration fees in the last two decades. Which also reflects the growth in vehicular population in the city (Plate-V, a).

Table 4.5: Increase in Kolhapur RTO Income from Vehicle Registration during 1987 to 2007

Year	Income in Rs.
1987	5,10,84,000/-
1997	22,13,00,000/-
2007	48,32,01,000/-

It is necessary for the town planner to project the possible future scenario of traffic growth in the city in order to provide infrastructure to cope up with the growth. Table 4.6 gives the figures given by M.S.R.D.C. about the traffic coming into city / day from the seven checkpoints as an indication of the load of vehicular traffic in the city from 2003 and the projections at specific intervals till 2034. These projections clearly indicate the trends and the amount of vehicular pollution the city will be subjected to if proper precautions are not taken (Plate-IV, b).

Table 4.6 Projection of the Old, Present and Future Traffic coming from all the Seven Checkpoints to the city per day

Place	2003	2010	2015	2020	2025	2030	2034
Shahu Naka	21546	25987	28692	31678	34975	38616	41799
Rajputwadi	39710	47895	52880	58384	64460	71169	77036
Phulewadi	28521	34400	37981	41934	46298	51117	55330
Vashinaka	9461	11411	12599	13910	15358	16957	18354
Kalamba Naka	6175	7448	8223	9079	10024	11067	11979
Tope	11730	14147	15620	17245	19040	21022	22755
Shiroli Naka	58677	70770	78136	86269	95248	105161	113830
Total	**175820**	**212058**	**234131**	**258499**	**285403**	**315109**	**341083**

4.4 Testing of Two Wheeler Air Pollution

During the present investigations a total of 103 two wheelers were tested for their exhaust emissions to confirm the air pollutants such as CO and HC. Also the vintage i.e. year of manufacture, of the two wheelers tested was noted to review whether the old vehicles make more pollution. The vehicles manufactured from 1981-1990, 1991-2000 and 2000-2007 were tested in three batches. The results are given in the tables below.

Table 4.7: Exhaust Values for CO% and HC ppm of Two Wheelers Manufactured in 1981 to 1990

Sr. no.	Model	Name of Vehicle	Vehicle no.	CO %	HC ppm
1	1985	Bajaj Super	MXK 7011	6.5	5890
2	1987	Bajaj M-80	MH-09 B 9503	2.8	2340
4	1987	Bajaj M-80	MH-10 C 1164	2.9	2370
5	1987	Bajaj Super	MH-09 G 6924	2.8	2340
7	1987	Bajaj Super	MH-09 H 9618	3.5	3620
8	1987	Bajaj M-80	MH-09 H 8933	3.2	2910
9	1988	Bajaj Auto	MH-09 H 6151	4.2	4250
10	1988	Bajaj Super	MH-09 J 3194	4.0	3250
11	1989	Bajaj Auto	MH-09 J 3543	3.3	2880
12	1989	Bajaj Super	MH-09 J 5068	5.2	5170
13	1989	Bajaj Super	MH-09 Q 8081	4.5	4380
14	1989	Bajaj Super	MH-09 S 5120	3.5	3200
15	1989	Bajaj Super	MH-09 N 5236	5.2	4890
16	1989	Bajaj M-80	MH-09 S 9096	4.8	4580
17	1990	Bajaj Super	MH-09 P 3697	3.3	2920
18	1990	Bajaj Super	MH-09 Z 2303	4.0	4200
Average				**4.0**	**3699**
Maximum				**6.5**	**5890**
Minimum				**2.8**	**2340**

The average, maximum and minimum values from 1981 to 1990 period show that the values were average (4.0), maximum (6.5), and minimum (2.8) of CO % and average (3699), maximum (5890), and minimum (2340) HC ppm respectively. (Table 4.7)

Plate-IV

a) Idling of vehicles at road signals adds to air pollution

b) Air pollution due to exhaust emission a common sight in city

c) Buses and heavy vehicles contribute to air pollution levels in city

d) Narrowing of roads and bad roads add to the problem of air pollution

Table 4.8 Exhaust Values for CO% and HC ppm of Two Wheelers Manufactured in 1991 to 2000

No.	Model	Name of Vehicle	Vehicle no.	CO %	HC ppm
1	1992	Hero Honda CD 100	MH-09 B 2360	2.8	2460
2	1992	Bajaj Super	MH-09 C 5287	2.8	1460
3	1994	Kinetic Style	MH-09 C 5353	3.7	2840
4	1994	Bajaj Super	MH-09 C 6837	2.8	2490
5	1995	Bajaj Super	MH-10 C 7745	1.8	1170
6	1995	Hero Honda CD 100	MH-09 E 7342	3.3	2180
7	1995	Hero Honda CD 100	MH-09 E 3834	2.2	1820
8	1995	Hero Honda CD 100	MH-09 E 8972	3.0	2150
9	1996	Hero Honda CD 100	MH-09 F 9725	3.9	2960
10	1996	Hero Honda CD 100	MH-09 G 6724	2.5	1630
11	1996	Hero Honda CD 100	MH-09 G 9133	3.4	2630
12	1996	Kinetic Dx	MH-09 M 4232	1.3	1230
13	1997	Bajaj M-80	MH-09 M 8560	2.2	1820
14	1997	TVS Scooty	MH-09 P 1185	2.8	2850
15	1997	Hero Honda CD 100	MH-09 R 5248	1.8	1850
16	1997	Hero Honda CD 100	MH-09 R 4199	3.0	2110
17	1998	Hero Honda CD 100	MH-09 T 5782	1.8	1720
18	1998	Hero Honda CBZ	MH-10 T 8591	3.5	2680
19	1998	Suzuki Max 100	MH-09 V 870	1.3	1410
20	1998	Bajaj Super	MH-09 V 9033	2.3	2150
21	1998	Bajaj Boxer	MH-10 V 4293	2.4	1980
22	1998	Hero Honda CD 100	MH-09 V 685	1.3	920
23	1998	TVS Scooty	MH-10 V 9957	4.2	1870
24	1998	Bajaj Boxer	MH-09 W 5553	5.7	4520
25	1998	Bajaj Spirit	MH-09 W 2165	1.2	760
26	1999	Hero Honda Splender	MH-09 X 7987	1.3	1160
27	1999	Hero Honda Street	MH-09 X 2135	3.0	2270
28	1999	Bajaj Boxer	MH-09 Y 8959	1.2	560
29	1999	Bajaj M-80	MH-09 Y 2343	1.3	960
30	1999	TVS Scooty	MH-09 Y 757	4.3	2140
31	1999	Bajaj Spirit	MH-09 Y 8158	5.2	3940
32	1999	Hero Honda CBZ	MH-08 Z 3438	2.7	1860
33	1999	Hero Honda CD 100	MH-09 Z 1747	3.8	3870
34	1999	Kinetic Style	MH-09 Z 9092	5.1	3780
35	1999	Hero Honda Splender	MH-09 Z 5083	3.8	4760
36	2000	Bajaj Boxer	MH-09 AA 9421	1.0	630
37	2000	Bajaj Spirit	MH-09 AA 5295	2.2	1910
38	2000	Hero Honda Splender	MH-09 AA 9541	2.6	2480
39	2000	Kinetic honda	MH-09 AC 2431	1.8	970
40	2000	Suzuki Max 100	MH-09 AC 9168	2.1	1970
41	2000	Bajaj M-80	MH-09 AC 9512	2.2	1470
42	2000	Hero Honda Splender	MH-09 AC 6234	1.5	1210
43	2000	Hero Honda Splender	MH-09 AD 3521	3.0	1600

44	2000	Hero Honda Splender	MH-09 AD 7812	2.2	1530
45	2000	Hero Honda Splender	MH-09 AE 5227	2.0	1140
46	2000	Bajaj Spirit	MH-09 AF 6898	3.2	1870
47	2000	Bajaj Spirit	MH-09 AJ 8641	2.0	1890
48	2000	Hero Honda CD 100	MH-09 AJ 8087	3.2	2420
Average				**2.7**	**2043**
Maximum				**5.7**	**4760**
Minimum				**1.0**	**560**

The average, maximum and minimum values for the batch of 1991 to 2000 period, the values were average (2.7), maximum (5.7), and minimum (1.0) of CO % and average (2043), maximum (4760) and minimum (560) HC ppm respectively. (Table 4.8)

Table 4.9 Exhaust Values for CO% and HC ppm of Two Wheelers Manufactured in 2001 to 2007

Sr.no.	Model	Name of Vehicle	Vehicle no.	CO %	HC ppm
1	2001	TVS Scooty	MH-09 AA1130	3.2	2450
2	2001	Bajaj Spirit	MH-09 AA 6715	1.5	1220
3	2001	Honda Activa	MH-10 AB 6532	1.7	1620
4	2001	Honda Activa	MH-09 AC 2219	2.2	2280
5	2001	Hero Honda Splender	MH-09 AE 6221	1.1	870
6	2001	Bajaj Pulsar	MH-10 AF 9320	3.2	2840
7	2001	Hero Honda CD 100	MH-09 AF 9521	2.5	1260
8	2001	Hero Honda Splender	MH-09 AF 9785	1.8	1010
9	2001	Hero Honda Splender	MH-09 AF 5641	1.9	1670
10	2001	Hero Honda Splender	MH-09 AH 6227	1.5	1370
11	2001	TVS Scooty	MH-09 AK 701	1.2	1820
12	2001	Hero Honda CD Down	MH-09 AK 9490	1.5	1720
13	2001	Hero Honda Splender	MH-09 AK 2665	1.7	1210
14	2001	Bajaj Spirit	MH-09 AK 1702	1.4	1230
15	2001	Hero Honda CD Down	MH-09 AM 8211	1.1	1110
16	2001	Bajaj Pulsar	MH-09 AM 0220	1.5	980
17	2001	Hero Honda Splender	MH-09 AM 4489	2.1	2600
18	2002	Hero Honda Splender	MH-09 AM 6052	1.1	1420
19	2002	Hero Honda Splender	MH-09 AN 4907	1.0	1140
20	2003	Bajaj M-80	MH-09 AN 8419	1.3	1510
21	2003	Honda Activa	MH-09 AN 8563	2.7	1210
22	2003	Hero Honda Splender	MH-09 AP 8425	1.1	1120
23	2003	Hero Honda Splender	MH-09 AP 6244	1.3	1230
24	2003	Bajaj Super	MH-09 AP 8635	2.7	1930
25	2003	Bajaj Pulsar	MH-09 AP 558	1.2	1220
26	2004	Hero Honda CBZ	MH-12 CP 1208	2.1	1830
28	2004	Hero Honda CD 100	MH-09 AR 7246	2.0	1920

29	2004	Bajaj CT 100	MH-09 AR 2977	1.3	1150
30	2004	TVS Scooty	MH-09 AS 628	1.6	1820
31	2005	TVS Scooty	MH-09 AS 7978	2.8	2310
32	2005	Bajaj CT 100	MH-09 AS 7960	1.1	1100
33	2005	Hero Honda CD Delux	MH-09 AT 5218	1.7	1220
34	2005	Hero Honda Passion	MH-09 AT 9778	1.5	1200
35	2006	TVS Scooty	MH-09 AU 2291	2.3	1970
36	2006	Honda Activa	MH-09 AW 4108	1.8	1110
37	2007	Hero Honda Super Splender	MH-09 AY 2461	1.4	1140
Average				**1.8**	**1523**
Maximum				**3.2**	**2840**
Minimum				**1.0**	**870**

The average, maximum and minimum values for the third batch i.e. 2001 to 2007 period the values were average (1.8), maximum (3.2), and minimum (1.0) of CO % and average (1523), maximum (2840) and minimum (870) HC ppm respectively. (Table 4.9)

The vintage wise comparison of the vehicles from the three batches clearly revealed that there is correlation in the age of the vehicle and emission level of CO and HC from the vehicles. The average values in CO and HC showed decline in years (Table 4.10 and Table 4.11). the same trend was notices in the maximum and minimum values in both the parameters, accept in case of minimum value in HC which was increased in the last batch.

Table 4.10 Vintage Wise Trend of CO % Emission of Two Wheeler Vehicles from 1981 To 2007

	Vintage		
CO % value	**1981-1990**	**1991-2000**	**2001-2007**
Average	4.0	2.7	1.8
Maximum	6.5	5.7	3.2
Minimum	2.8	1.0	1.0

Table 4.11 Vintage Wise Trend of HC ppm Emission of Two Wheeler Vehicles from 1981 to 2007

	Vintage		
HC ppm value	**1981-1990**	**1991-2000**	**2001-2007**
Average	3699	2043	1523
Maximum	5890	4760	2840
Minimum	2340	560	870

It is evident from these results that there is clear positive trend in the exhaust emissions from the three vintage two wheeler groups studied. This is perhaps due to better maintenance facility and availability of unleaded petrol and the additives used in fuel to reduce emissions like Speed (HP), Power (Indian Oil) etc. The decreasing values for both the pollutants are also attributed to newer technologies used in the manufacture of vehicles these days.

Table 4.12 Increasing Trend of Vehicles in Last Twenty Years in Kolhapur District

Vehicle Category	1987	1997	2007
Motor Cycle	14910	56715	296603
Scooters	19637	50825	54980
Mopeds	22924	39547	43998
Cars	5521	9363	33687
Jeep	1653	5410	15707
Station Vaughan	16	599	91
Taxi	153	260	626
Auto Rickshaw	5413	8391	12006
Stage Carrier (ST or KMT)	591	929	922
Contract Carrier	23	207	540
School Buses	6	11	41
Private Public Carrier	5	14	83
Ambulance	33	65	184
Trucks & Lorry	6361	7269	9799
Tankers	.....	.....	626
Delivery Van(Goods Carrier)	.....	.....	1179
Four wheeler	.....	2333	5870
Three Wheeler	.....	802	4931
Tractor	5101	9897	14702
Trailer	4079	10832	15770
Other	40	67	49
Total	**86466**	**203536**	**512394**

(Panditrao, 2007)

The total number of motorcycles, scooters and mopeds in the district in 1987 was 57,471 which grow to 3,95,581 by 2007 i.e. 14.52% growth (Table 4.12). Table 4.12 reflect the tremendous growth in the

Figure 4.1: Vintage wise trend of CO % from two wheelers in Kolhapur (1981 to 2007)

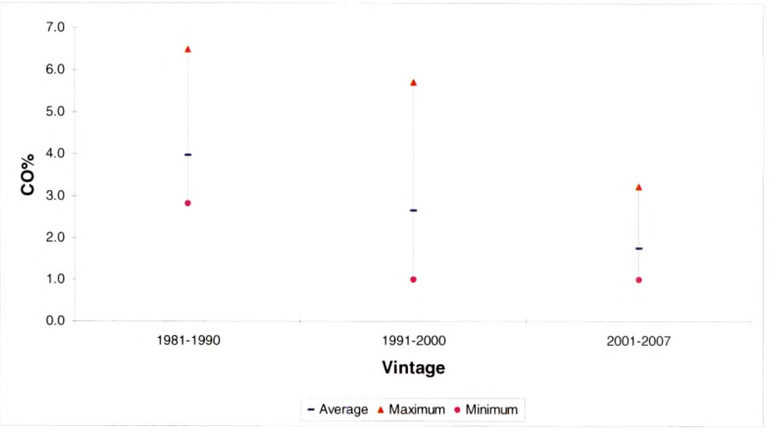


Figure 4.2: Vintage wise trend of HC ppm from two wheelers in Kolhapur (1981 to 2007)

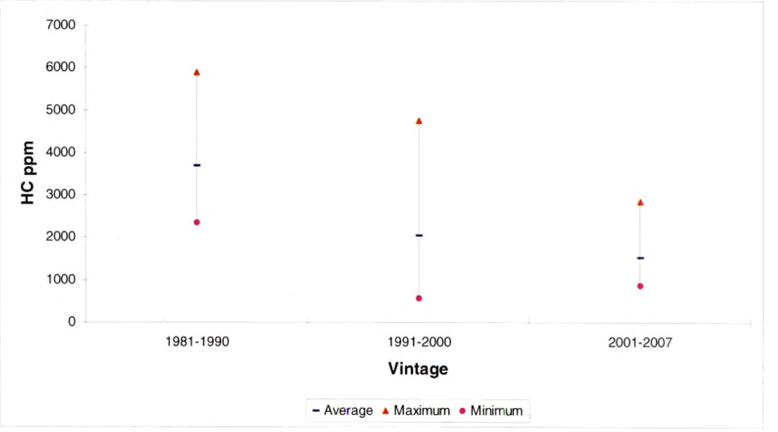


Figure 4.3: Vintage wise trend of average exhaust CO % for two wheelers

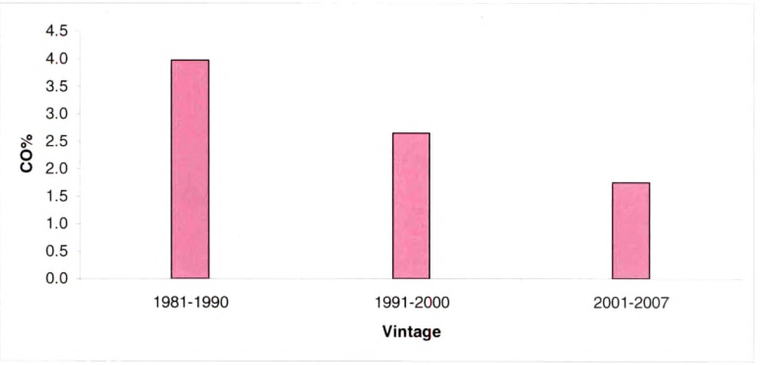


Figure 4.4: Vintage wise trend of average exhaust HC ppm for two wheelers

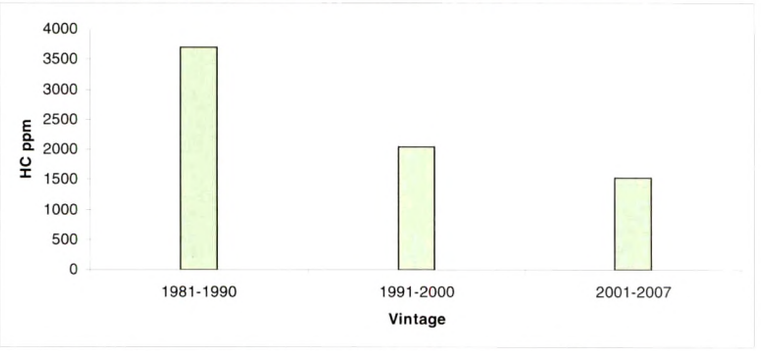
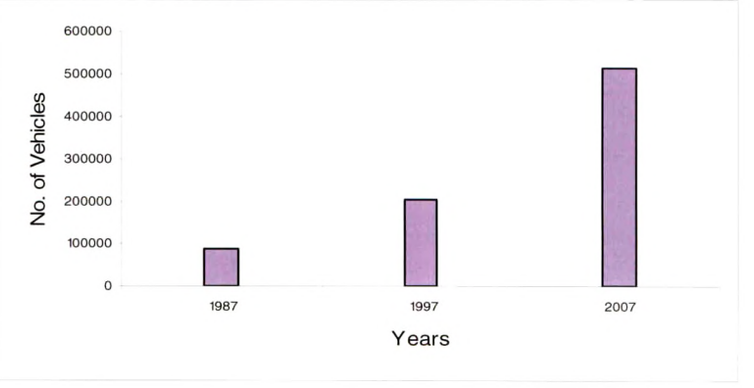


Figure 4.5: Increasing number of vehicles in Kolhapur District in last twenty years (1987-2007)



number of vehicles from 1987 to 2007. From the fig 4.5 it is clear that tremendous growing trend in no of vehicles in Kolhapur district, which are more than 21000 new vehicles per year.

If this trend continues there will be further stress on the already scanty infrastructure of roads, parking places leading to serious problems in urban transportation. This is leading to crowding as well very slow movement of the vehicles on the roads causing excess fuel consumption and tremendous increase in air pollution leading to road accidents and health of the citizens. This situation demands urgent and serious efforts on the part of experts, policy makers and administrators to try to curb pollution due to vehicular exhausts in the city through integrated traffic management and pollution control measures.

The unburned and partially burned oil comes through the exhaust and is responsible for smoke and SPM emission. The studies indicate that 2-stroke engines exhaust contains almost 15-25% of unburned fuel (Pundir, 2001). In actual practice, the 2 stroke vehicles require 2% concentration of 2 T oil i.e., 20 ml in a litre of petrol and even a modest 1% increase of oil, may lead to 15% increase in SPM besides visible smoke (CPCB, 1999).

Congestion engenders a double effect. First the time cost of a vehicle per kilometre rises rapidly with increased congestion. This is because the addition of a vehicle to an already crowed network increases travel time foe many other passengers. Since the average speed has reduced to levels that are far below the optimal operating vehicle speed, this leads to increase in rate of emissions per kilometre- thus the two effects are inter related (Johansson, 1997).

Krawack (1993) states that a reduction from 40 km/h to 20 km/h doubles the emissions of CO and volatile organic compounds (VOCs) for a car fitted with a catalytic converter. Since VOCs and CO are 250% higher under congested conditions than during free- flowing traffic, poor air quality is the consequence.

According to Sengupta (2001), Member Secretary, CPCB, MoEF, GOI, The vehicular pollution problem in India are attributed to high vehicle density in urban centres, older vehicles predominant in vehicle vintage, inadequate inspection and maintenance facilities, predominance of two stroke two wheelers, adulteration of fuel and fuel products, improper traffic management system and road conditions, high level of pollution at traffic intersections, absence of effective mass rapid transport system and intra city railway networks, and high population exodus to the urban centres.

4.5 Survey Analysis

Under these studies three surveys were conducted namely PUC Centres, Mechanics and two wheeler owners to get the actual feed back of the vehicular related air pollution status from Kolhapur as well as the implementation of the pollution acts at the grass root level. The observations of the field investigations are given bellow.

a) PUC Centres

In use vehicle emission control, the PUC provision is very important. Pollution Under Control (PUC) under rule 115 (7) of Central Motor Vehicle Rules (CMVR), 1989, motor vehicles are required to carry PUC certificate to be given by an agency authorised for this purpose by State Government. Measurement of emissions from petrol vehicle is done by gas analyser and in case of diesel vehicle emission is measured by

smoke meters. There is list of approved vendors and models of PUC equipment which is compiled and circulated by ARAI, Pune (Plate-II, d).

However, there are reports of serious limitations in implementation of the present PUC system. The limitations of PUC implementation in general are as follows

- Test procedures and norms have not changed since introduction
- PUC centre operators are not trained
- Equipments are not well maintained or calibrated
- Proper test procedure are not followed
- No well defined criteria are followed for authorising/registering PUC centre.
- No periodic auditing of PUC centre is done
- There is lack of centralised agency for coordination
- The number of vehicles undergone PUC test is very small due to absence of control mechanism to identify vehicles escaping PUC
- There is no analysis of data collected is done
- Existing system is prone to tampering and is being misused
- Proper extension pipes, specially for 2 and 3 wheeler vehicles are not used
- There are chances of leakages in the system leading to low readings

There are 40 stationery PUC and 17 mobile PUC centres in Kolhapur city authorized by R.T.O. Kolhapur. Out of which 15 PUC centres i.e. 10 stationary and 5 mobile were randomly selected during the present study for the procedures followed by PUC centres and their testing was carefully observed. The PUC centres studied were as follows:

Stationary PUC Centres

1. Standare auto services, Nagala Park, Kolhapur.

2. Purva enterprises, Shahupuri, Kolhapur.
3. India automobiles, Pune-Benglore road, Kolhapur.
4. Sai auto services, Dabholkar corner, Kolhapur.
5. Mirje associates, Bagal chowk, Kolhapur.
6. Nilesh auto PUC center, Rajarampuri, Kolhapur.
7. Hemkiran diesels, Rajaram road, Kolhapur.
8. Amar auto PUC center, Appaj complex, Kolhapur.
9. Konduskar PUC centre, Rajarampuri, Kolhapur.
10. Sun PUC center, Mukta-Sainik Vasahat, Kolhapur.

Mobile PUC Centres

1. M/s Punkaj motors, Kavala naka, Kolhapur.
2. Sahakar auto services, Shahupuri, Kolhapur.
3. Sunita mobile PUC center, Rajopadhyae nagar, Kolhapur.
4. M/s Prajwal enterprises, Shivaji peth, Kolhapur.
5. Bhosale PUC Centre, Mukta-sainik vasahat, Kolhapur.

To understand the accuracy of detecting the CO and HC values from vehicular exhaust, a same vehicle was tested at five different randomly selected PUC centres under similar conditions for comparison of the results. The results of the experiment are given in the table 4.13. It was evident as expected that there was no consistency in the results from the five PUC centres, for tests of the same vehicle on the same day visited immediately after one another.

Table 4.13 Exhaust emission values for CO and HC for the same vehicle recorded from the PUC centres in Kolhapur city

Model	Name of Vehicle	Vehicle no.	PUC Centre	CO %	HC ppm
2001	Hero Honda CD 100	MH 09 Y 8278	1	2.0	1480
			2	2.8	2270
			3	2.2	1950
			4	1.8	1240
			5	2.4	1990

The personal observations of the working of the 15 PUC centres were as follows.

- Instruments in many PUC centres were not in working conditions, and still PUC certificates were issued within the prescribed pollution limits.
- PUC centres, those having working instruments, had no calibration of instrument done periodically.
- It could not be ascertained from some of the centres whether they were authorized or whether their license was valid or renewed.
- In most cases the person handling the instrument not necessary had any technical background or knowledge of PUC procedure.
- The main purpose of most of the PUC centre seemed to be to issue the certificate and make money. The vehicle owners also did not much bother about this and acquired the certificate just as the RTO compliance. People also did not have much faith in this test certificate, as it was available for a specific amount at times on some centres even without testing the vehicle.
- The customers were not aware that the proper PUC would help them detect the better performance or malfunctioning of their vehicle leading to timely maintenance. This in turn improve fuel average, save money and most important reduce air pollution in the city and improve health for all.

b) Mechanic Survey

Questionnaire survey of two and four wheeler mechanics from the city limits was conducted to get their feed back on the topic of the present

investigations. A total of 25 auto mechanics were randomly selected and personally interviewed. The findings of this study are given below.

The mechanics belonged to four age groups A) 15-25 yr = 19%, B) 26-35 yr = 45%, C) 36-45 yr = 22% and D) 46-55 yr = 14%. According to a majority (58%) of vehicle needs maintenance or check-up every 2 months, where some (34%) felt that it could be done ones a four months where very few (8%) were of the opinion that it should be done ones a six months to keep the vehicle in good condition. The general observation was most vehicle owners do not visit mechanic unless there is some mechanical problem with the vehicle and majority of them are much careless about the routine maintenance of their vehicles.

According to large majority (86%) of the mechanics damage in carburettor setting, accumulation of dust particle in spark plug, quality of fuel, and damage of Nozzle. are the main causes of excess emissions from exhaust. Most (92%) mechanics felt that following components are related to good vehicle mileage like Carburettor, Piston Nozzle pump, Oil sill, Sparkplug, Quality of Petrol, Proper maintenance and driving skills. A large majority (94%) said that, there was a positive role of regular maintenance in fuel i.e. petroleum saving. About 52% felt that vehicles in the city are not properly looked after. Similarly 91% mentioned that, there is a positive role of Catalytic Converter to minimise air pollution. Good road conditions, according to almost all (97%), are useful to minimise vehicle damage and improve vehicle performance. It is interesting to note that almost 87% felt that it was necessary to develop public awareness about air pollution due to vehicles. Most (94%) were of the opinion that public participation alone will help to minimise vehicular air pollution in Kolhapur.

Plate-V

a) One of the major cause of air pollution in city is due to traffic congestion

b) Is this the only future ?

c) Two Wheeler Owners Survey

Questionnaire survey of two wheeler owners was conducted to get their feed back about the topic under study. A total of 103 individuals randomly selected in the city were personally interviewed. While responding to the availability of the parking facility at the residence, for the owned vehicles. It was reported by the respondents that ground floor or under the stairs (38%), common parking (36%) and road (26%) was used for parking place. For most, parking facility at working place was also not much easy. As basement (22%), common parking place (41%) and road (37%) was the only option, which eventually blocked already narrow roads. About 97% people were not satisfied with the road conditions in the Kolhapur city. Almost 99% felt that there is urgent need to widen as well as repair roads in the city. Though 54% people were not happy with the city vehicular traffic management, 58% felt that there was no necessity to make the traffic rules more stringent.

A large number of (74%) respondents mentioned that, bad road condition was mainly responsible for the traffic congestion. Around 79% mentioned that, there is disturbance on the road traffic due to KMT bus stops, which are not located at the right spot and add to the congestion. Almost every respondent (97%) reported that there is disturbance to vehicular traffic due to unauthorised auto rickshaw (Vadap) stops which are scattered all over. Though about 59% were of the opinion that, there was no problem for traffic due to hawkers, the personal observations were not in conformity with this at some prominent places. However, many respondents (53%) mentioned that the problem for traffic congestion was due to encroachment by the shop owners. As most of the roads in the city do not have footpath facility, it makes life of the pedestrians, particularly old and children very difficult and risky. Around 63% of the respondents mentioned that there was immediate need to have footpaths in their area (Plate-V, a, b).