Reducing Emission From 3-Wheeler 2-Stroke Engine Taxis in Dhaka, Bangladesh

(Joint Energy Donors Meeting, May 7-8, 2001)

Presented by

M. Khaliquzzaman

Consultant, Environment Team

WB Dhaka Office


Royal

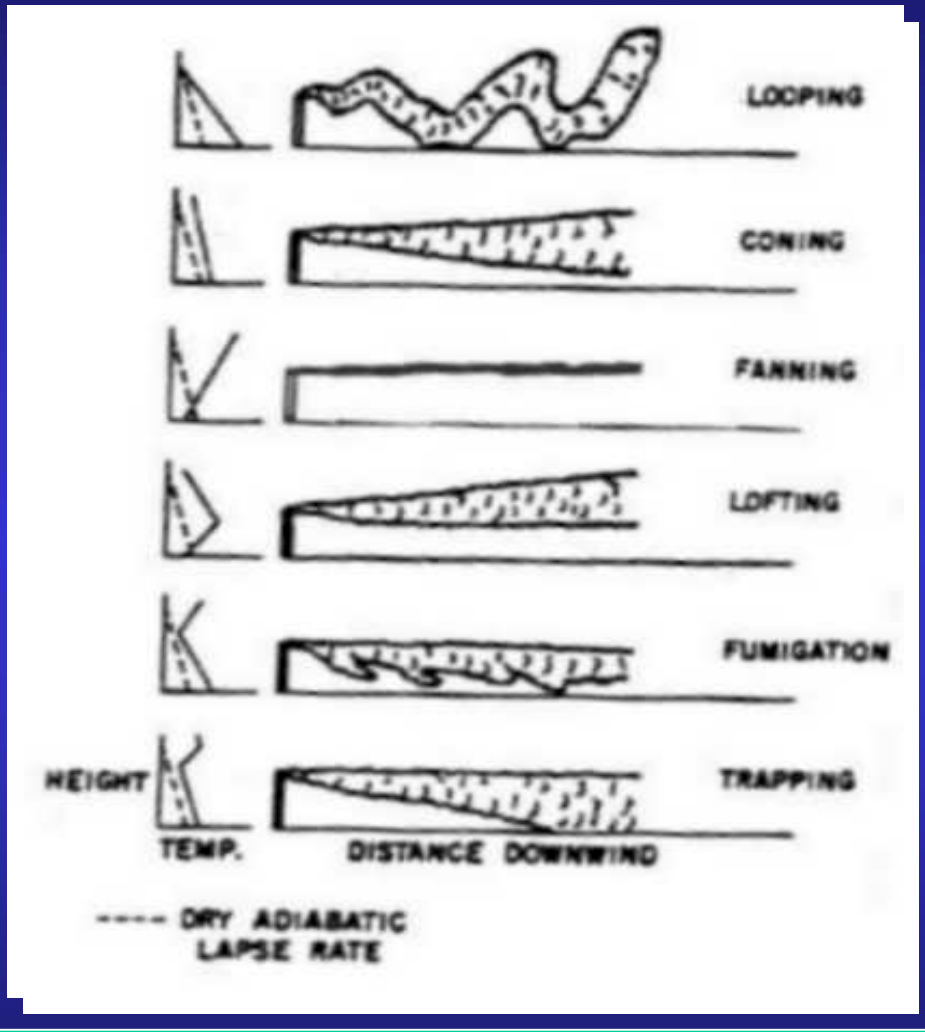
What is the most important pollutant?

- The most serious pollutant of concern in Dhaka is respirable and fine particulate matter, PM_{10} (particles with an aerodynamic diameter less than 10 microns) and $PM_{2.5}$ (particles with an aerodynamic diameter less than 2.5 microns).

Table . PM10 and PM2.5 Concentrations (µg/m³) in Dhaka

Size fraction	*Urban*	*Rural*	*USEPA*
PM10 (Avg.)	123±82	56±35	50
PM2.5(Avg.)	51±43	21±11	15
PM10 (LRF)	230±110		
PM2.5 (LRF)	88±47		

Inversion aggravates pollution during LRF



Effect of Adiabatic lapse rate on Plumes

Table: Dhaka Emissions(2000) in percentage for different types of vehicles

	Vehicle	km/ day	Number	CO	NOx	HC	PM-10
1	Cars/Taxis/ LDV	90	84,411	63%	12%	36%	14%
2	2 -Wheel	20	121,156	4%	0.4%	10%	2%
3	Baby Taxis	125	66,360	22%	3.5%	50%	40%
4	Buses/Mini buses	190	9,135	6%	47%	2%	25%
5	Trucks	130	15,600	5%	37%	2%	19%
	Total		296,662	100%	100%	100%	100%

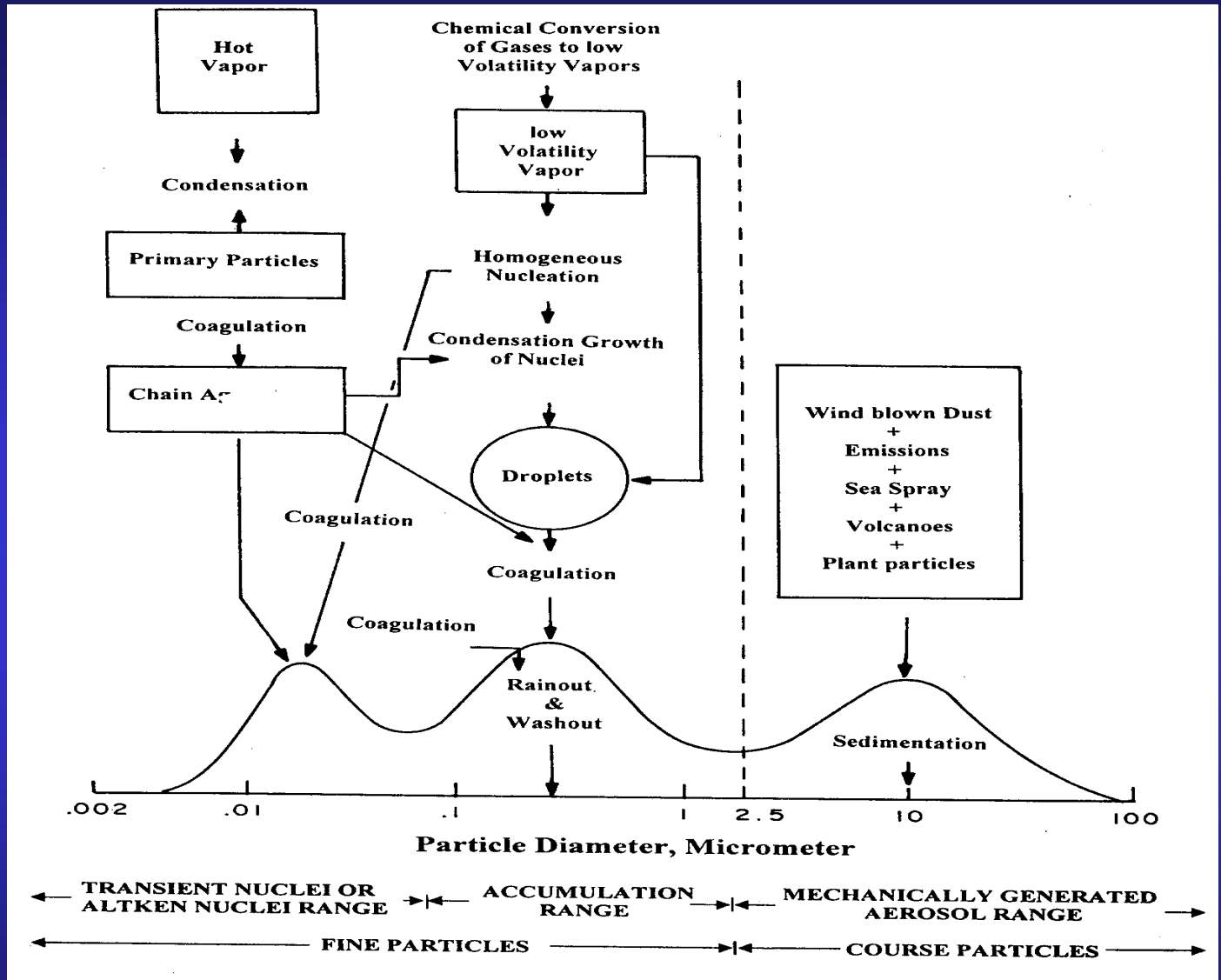


Figure 1.2 : Schematic diagram showing the size range, principle modes, main sources of mass of each mode, and the principle mechanisms by which particles are removed from the air [13].

Health Effects

- Death of infirm people
- PM10 Particles Aggravate Health Problems such as Asthma, Bronchitis and contribute to premature Mortality and Hospital Admissions
- PM2.5 Particles contribute mainly to premature Mortality and Hospital Admissions

Excess deaths/years due to air pollution

- ~6,000 in Dhaka City (approx.)

Health maintenance cost due to air pollution

- ~ US$12. Per capita per year (approx.)

PROGRAM DESCRIPTION/OBJECTIVES

- Quantifying the impact of the use of excess inferior quality lubricant on emissions from baby-taxis
- Training of mechanics servicing baby-taxis to improve emission perception
- Holding auto clinics to demonstrate the merit of changing their behavioral pattern with respect to the use of lube oil and vehicle maintenance

PROGRAM DESCRIPTION- Contd.

- Consensus-building within the downstream petroleum sector on a ban on the sale of straight mineral oil at gasoline stations
- Other awareness raising and dissemination activities to educate the drivers and the public on what affects vehicle emissions.

PROGRAM DESCRIPTION- Contd.

- **Create data base on:**
  - I& M Practices and level of expertise among mechanics for the work
  - Mechanical state of the in-use baby taxis
  - Health status of the drivers
  - Effect of improved lube oil and I&M on emission

Components

- **1. Mechanic Training - Held: 11th April to 26th April, 2000.**
- **2. Clinic - Held: 10th Oct. to 9th November, 2000**
- **3. Workshop on lubricant and gasoline quality - Held: 21st Nov., 2000.**

Program Coverage

- **Mechanic Training: Total number - 427**
- **Auto-Clinic: Total Number of Baby Taxis: 1000**
- **Workshop on lubricant and gasoline quality: Participants Number-93**

Mechanic Training:
11th April to 26th April, 2000.

- Distribution of training material
- Talks and posters
- Demo -1: Stripped down engines
- Demo-2 : Low emission from engines with 2T Lube (2 Baby Taxis)
- Collection of data on auto mechanics and maintenance practices.

Table . Mechanics Training Program

- **Air Pollution from two stroke engine vehicles:** 30 minutes
- **Preventive maintenance** : 60 minutes
- **Schedule of maintenance** 15 minutes
- **Advice for drivers :** 15 minutes
- **Collection of data** 10 minutes
- **Practical demonstration:** 45 minutes
- **Distribution of certificates:** 5 minutes

COMPONENTS OF AUTO-CLINIC

10th October to 9th November, 2000

- Engine check-up (Free of Charge)
- EMISSION MEASUREMENTS (Before and After maintenance)
- Demo-1: Posters
- Demo-2: Low Emission with 2T Lube
- Discussion and Statistics collection on the mechanical state of the baby taxis
- Medical check-up for drivers and supply of medication
- Info literature and sticker for drivers
- Compensation/Incentives/Stickers

AUTO CLINIC - I & M Inspection

- **Start the vehicle.**
- **Check CO and HC with the help of Horiba CO Analyzer before the repair.**
- **Observe smoke at the exhaust end with the help of *Wager Smoke Meter***

I &M Procedure (Cont.)

- Classify vehicles for Pass/Fail depending on emission values
- If the vehicle fails to pass emission test then carry out the Maintenance
- Repair / adjustment as per need of the vehicle.

Repair & Maintenance

- 1. Clean Air Filter
- 2. Clean Spark plug and adjust gap setting
- 3. Adjust carburetor air screw to specifications
- 4. Clean the carburetor jets and reset jet needle position
- 5. Clean and reset CB points if vehicle is 6 V
- 6. Decarbonise the Silencer assembly if needed,
- 7. Carry out any other minor repair if needed

I&M Final Check

- **Restart the vehicle &Check CO, HC and Smoke**
- **If the result is within the desired levels, affix the *"Dhaka Auto-Clinic 2000"* sticker**
- **If not OK, try a 2nd repair. If still not OK, then recommend need for major overhauling to the owner in writing**

Medical Check-up

- **General: Appearance, Height, Weight, Built**
- **Clinical: BP, Eye Sight**
- **Chest Examination**
- **Lung function test: Forced Vital capacity is measured with a Spirometer in units of ml (milli-litre). FVC is basically the volume of air exhaled after a deep breath in resting condition. Some more complex spirometers also measure FEV1(Forced Expiratory Volume in one second).**
- **Heart**
- **Diagnosis and treatment**

Table . Health and Work Related Parameters for Baby-Taxi Drivers

Parameter	*Value*	*Minimum*	*Maximum*
Age, years	32±8	18	75
No. of children	2.4±1.4	0	9
Experience, years	10±6	0	40
Drv.hrs. per day	12±2	4	18
Height, cm	163±6	140	192
Weight, kg	53±8	35	83
Sick days per mo.	7.0±2.7	0	20
BP (sys., mm Hg)	125±9	90	170
BP (dia., mm Hg)	71±5	60	100
Lung funct., ml	372±76	150	700

Table . Educational level of drivers

Years of Schooling	*Number*	*%*
None	664	67
0 - 5	165	17
5 - 8	100	10
8 - 10	31	3
10 - up	32	3

Table. Income and attitudes of Baby-Taxis Drivers

Parameter	*Value*
Avg. rental/day	Tk. 205.
Avg. income/month	Tk. 4205.
Pollution Awareness	>90%
Opposed to banning	>94%
Ownership Desire	> 96%
Can Offer Collateral	94%

Table. Emission Levels of Baby-Taxis

Parameter	*As received*	*Thai Std.*
% CO	1.1±1.4	4.5
ppm HC	3,420±1,950	10,000
% Opacity	40±24	30
No. of vehicles	988	

Table: Impact of Service

Parameter	*CO*	*HC*	*Smoke opacity*
Percentage of vehicles for which emissions decreased after service	**53**	**55**	**72**
Median decrease, relative %	**5**	**3**	**20**

Table . Correlation among Various Variables

Parameter	*CO*	*HC*	*Opacity*
CO	1.000		
Hydrocarbons	0.633	1.000	
Opacity	0.074	-0.020	1.000
Air filter choked	0.028	0.068	0.047
Lubricant, percent	0.017	0.020	0.137
Model year	0.030	0.060	0.005
Time lapsed since silencer serviced	0.074	0.085	0.108
Spark plug fouled	0.017	-0.055	0.165

Observations :Mechanics Training

- 427 mechanics for baby-taxis were trained in proper servicing and repair, and the impact of incorrect servicing and poor maintenance on emissions.
- With their newly gained emission perceptions, the trained Auto-mechanics are expected play important role in the area of emissions mitigation through providing service and advice to drivers and owners on lubricant use.

Observations :Mechanics Training (cont.)

- Most of them expressed interest in more training, and some were even prepared to pay for additional training.
- They spoke honestly, admitting that when they "replace" spark plugs, they use second-hand spark plugs from four-wheel vehicles, and so on.

Observations :Auto-clinic

- The drivers' perception of air pollution have changed dramatically in recent years, with over 90% of them saying today that their own vehicles were responsible for considerable air pollution.
- Many said that they or their family members were sick from air pollution.
- The average number of sick days per month among all drivers who answered this question was a staggering 7.
- Predictably, income was correlated with the number of days sick.

Observations :Auto-clinic (cont.)

- Towards the end many drivers showed up at the auto-clinic, queuing for hours. Police "harassment" appears to be one of the principal reasons. They feel it’s unfair that the government is singling them out while not saying much about buses and trucks.

- The drivers "tuned" their vehicles, even to the point of making them un-drivable, in order to pass emissions tests. Some showed up with no lubricant towards the end.

Observations :Auto-clinic (cont.)

- The drivers wanted to use proper 2T Lube but they could not buy it at the petrol stations. As selling straight run lube is a profitable business pump owners were not interested in selling 2T lube.
- Only 16% of them were literate, so that distributing pamphlets for education would not help. This also introduces potential problems in their ability to judge the quality of lubricant, since they are not in a position to read labels on lubricant containers.

Observations :Auto-clinic (cont.)

- The program was carried out by working closely with baby-taxi drivers' and owners' associations, we are beginning to have their buy-in and they don't go on strike when we try to do something about air pollution.

Observations :Auto-clinic (cont.)

- Perception among some government officials is that baby-taxis ought to be banned because three-wheelers are a symbol of underdevelopment, and they would much rather see all of them replaced by four-wheel taxis.
- The import duty structure on 3-wheelers (minimum of 72% duty) and four-wheel taxis (only 7.5% duty) supports this way of thinking. Both on the basis of emission and equity such taxes are not justified.

Observations :Workshop on lubricant and gasoline quality (21st Nov., 2000)

- Wide spread interest created among stakeholders.
- Government has promulgated a new lubricant regulation prohibiting sale of straight run mineral oil for use in 2T-engine vehicles and setting API TC/JASO FB as minimum standard from 1st January, 2001.
- Due to supply problem, the decision is yet to be implemented.

THE END

THANK YOU