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Air Pollution Studies and Determination of Smoke Particles Size on Siryab Road, Quetta, Pakistan

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Abstract: Quetta is like a cup shaped valley with an (lat. 30° 11'N long. 66° 57'E) is elevated at 1799 m above sea level and covered from all dry mountains [1]. Air pollution survey has been conducted for various types of vehicular, traffic, plying on the Siryab road, by taking into consideration, the amount of smoke particles released by them into the atmosphere of the University of Balochistan. This enabled us to determine the points where major amount of these smoke particles is concentrated. They turn out to be the crossing points where traffic was held up for short interval of times. Also a preliminary attempt has been made to determine the sizes of these smoke particles and after drawing their graph to relate them to the various types of theoretical averages.

Key words: Air pollution · smoke particles · traffic

INTRODUCTION

Balochistan is located at the eastern edge of the Iranian plateau and in the difficult to define border region between Southwest, Central and South Asia. It is geographically the largest of the four provinces at 347 and 190 km^2 and composes 42% of the total land area of Pakistan. The population density is very low due to the mountainous terrain and scarcity of water. The southern region is known as Makran. A region in the centre of the province is known as Kalat.

The Sulaiman Mountains dominate the northeast corner and the Bolan Pass is a natural route into Afghanistan towards Kandahar. Much of the province south of the Quetta region is sparse desert terrain with pockets of inhabitable towns mostly near rivers and streams.

The capital city is Quetta is located in the most densely populated district in the northeast of the province. Quetta is situated in a river valley near the border with Afghanistan, with a road to kandahar in the northwest.

At Gwadar on the coast the Pakistani government is currently undertaking a large project with Chinese help to build a large port. This is being done partially to provide the Pakistan Navy with another base and to reduce Pakistan's reliance on karachi and Port Muhammad Bin Qasim, which currently are the only major ports.

In such a harsh and barren environment, irrigation through channels, qanats, or seasonal flooding is an essential prerequisite for settlement. It thus developed early as an essential measure for the production of crops required by a growing population. The rising number of settlements from the beginning of settled life in the 6th millennium through the mid-third millennium BC witnesses the success of food production through farming and pastoralism. Pioneering archaeological fieldwork in this region was carried out by the great explorer Sir Aurel Stein, Hargreaves, W. Fairservis, B. de Cardi, J.M. Casal and G. Dales, the Deptartment of Archaeology and Museums, Karachi and a couple of other explorers.

Smoke is the term normally applied to the visible product of imperfect combustion. The smoke along with different gases is released by different vehicles and from various other sources, remains suspended in the air for some time because of their small sizes [2, 3]. They are easily spotted by the bombardment of air molecules. The main object of this investigation is to determine the various sizes of these smoke particles and to relate this with the air pollution of this area.

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Air pollution or atmospheric pollution is defined as the responses of undesirable substances mixed with air [3, 4]. These undesirable substances include gases, solid materials and tarry droplets. These aerosols, as they are some time referred to, are very injurious and produce much trouble. Out of these the largest particles escape from atmosphere thereby quickly causing damage and irritation [5]. It has also been estimated that in one square mile of a town, it is not uncommon for a ton of coal to be burnt every hour; on the average each ton of coal produces about 0.05 tons of pollution, which include sulphurdioxide and some solid materials [4]. If all this pollution is emitted to the atmospheres as usually as enough to cause serious pollution below rood level in 36 min [3]. Fortunately, most of the pollution spreads above road level and the clean air is continuously being brought in from out side the town and from above it. But if this natural ventilation were to fail it could be easily calculated than one should be gasping for breath in an hour or so and dead in 10-12 h.

The pollution materials are generally divided according to their properties in three groups:

- The reactive substances.
- the finest particles which remain suspended in the air for long time.
- relatively coarse particles which fall soon on the ground.

Much attention is given to SO_2 and smoke, not only because they are very important but also because they serve jointly as prototypes, i.e., any other pollution when released into the atmosphere will behave similarly to one or the other of them.

From Stock's Law of Flow of fluids, it can be shown that all particles more than 10 microns are easily suspended by the bombardment of air molecules [6]. These particles don't fall to the ground by their weight but are swept by the current of air. It may be noted that smoke particles do not remain permanently in the atmosphere. The average time for which they can be suspended is two days.

Scientists have developed processes for transforming coal into various smokeless fuels and have various methods for removing dust and SO_2 from gases. Air pollution can be removed in many different ways and each one of them involves the question of economics. So for very little problem of air pollution has been done in developing countries like Pakistan.

Experimental: The first phase of our project starts from the study of smoke concentration released from Buses, Trucks, Rickshaws, Wagons, Cars and Autocycles on Siryab road, Quetta. For this purpose different samples for fixed intervals were collected at different sites from all these vehicles by Bladder's method. This method was developed in the department of Physics, University of Balochistan, Quetta, Pakistan. Although this method is very simple but more accurate and precise. The apparatus consists of an ordinary rubber bladders and a glass tube open at both end. One end of the tube is quite large which is fitted into the silencers of the buses, etc. while the narrow other end is attached to the mouth of the bladder. Various samples of the smoke are thus collected for fixed interval of time. The time is usually controlled by stopwatch. After filling, the bladder is tightly closed. The smoke is allowed to settle for at least thirty hours. Then the air is exhausted out very carefully, so that no smoke particles are driven out. The bladder is rinsed for a large number of times with a suitable solvent and the washings are collected in the beaker. The samples in the beaker is then dried and weighed.

Since we have recorded the time taken for the collection of each sample. When the total time for which the transport is plying on the roads is known and the total number of Buses, Trucks, Rickshaws, Wagons, Cars and Autocycles going on these roads are determined, the total amount of smoke released by the transport can be calculated.

We determined the sizes of some smoke particles. The size determination was done by optical methods i.e. by using microscope provided with graduated circular micrometer. Other methods, which are used, for measurement of atmospheric pollution are as follows:

- Method of smoke filters.
- Method of self-changing smoke filters.
- Method of particle smoke filters.

$$D_n = \frac{\sum n_i D_i}{\sum n_i} = \frac{11730}{377} = 31.11405 \text{ m}\mu \quad (1)$$

$$D_{vs} = \frac{\sum n_i D_i^3}{\sum n_i D_i^2} = \frac{25735000}{500700} = 51.39804 \text{ m}\mu \quad (2)$$

$$D_w = \frac{\sum n_i D_i^4}{\sum n_i D_i^3} = \frac{1483470000}{25735000} = 57.64406 \text{ m}\mu \quad (3)$$

Which of these methods may be used, depend upon the economic condition of the country, selection of the site for the study and various other factors. Two other

Table 1: Shows the number of vehicles of various types passing at various studies points per hour

Sr. No.	Measuring point No. of types of vehicles	Crossing point at siryab pattack	Crossing point at overhead bridge	Crossing point at QDA office	Crossing point at University of Balochistan	Crossing point near forest research center	Crossing at point siryab chain
1.	Cars:	270	84	58	82	24	48
2.	Rickshaws:	170	14	6	10	10	6
3.	Auto Cycles:	70	74	16	30	12	20
4.	Buses:	72	126	86	33	6	81
5.	Wagons:	28	10	0	6	0	0
6.	Trucks:	6	6	1	5	5	1
	Total	616	314	167	166	57	156

Table 2: Shows the amount of smoke released from vehicles for five seconds

Sr. No.	Measuring point amount recovered per hour	Crossing point at siryab pattack	Crossing point at overhead bridge	Crossing point at QDA office	Crossing point at University of Balochistan	Crossing point near forest research center	Crossing at point siryab chain
1	Cars:	67.5675 g	21.0210 g	14.5145 g	20.5205 g	6.0060 g	12.0120 g
2.	Rickshaws:	366.9530 g	30.2197 g	12.9513 g	21.5855 g	21.5855 g	12.9513 g
3.	Auto Cycles:	8.2845 g	8.7579 g	1.8936 g	3.5505 g	1.4202 g	2.3670 g
4.	Buses:	85.8600 g	150.2550 g	102.5550 g	39.3525 g	7.1550 g	96.5925 g
5.	Wagons:	19.7470 g	7.0525 g	0.0000 g	4.2315 g	0.0000 g	0.0000 g
6.	Double Decker:	17.0544 g	17.0544 g	2.8424 g	14.2120 g	14.2120 g	2.8428 g
	Total weight	565.4650 g	234.3590 g	134.7560 g	103.4520 g	50.3787 g	126.7640 g

Table 3: Shows the various values from which these histograms have been drawn

Class Interval (mu)	Average diameter D_i	Frequency n_i	Precet frequency % n_i	D_i^3	$n_i D_i^3$	$\frac{n_i D_i^3 \times 100}{\sum n_i D_i^3}$
5-15	10	100	26.525	1000	100000	0.3885
15-25	20	73	19.363	8000	5840000	2.2692
25-35	30	60	15.951	27000	1620000	6294.0000
35-45	40	50	13.262	64000	3200000	12.434
45-55	50	45	11.936	125000	5625000	21.857
55-65	60	30	7.957	216000	6480000	25.179
65-75	70	12	3.183	343000	4116000	15.993
75-85	80	5	1.326	512000	2560000	9.947
	$5.665 \sum n_i - 377$	$\sum n_i D_i^3 = 25735000$				

methods i.e. (a) Deposit gauge method and (b) Petrie dish method are also being simultaneously tried.

From the data obtained, from these experimental measurements, various histograms showing the percentage frequency verses the diameter of these smoke partials are drawn. This is made possible with the help of optical photomicrographs of these samples at a reasonable high magnification. From these histogram various type of size average are calculated. The weight of the total material collected at various point gives us an idea of the total polluting material released in Siryab road, Quetta. The next phase of the project is to determine the same parameters for the whole of the Quetta area, which subsequently will be extended to the other industrial cities of Pakistan.

Table 1 shows the number of vehicles of various types passing at various studies points per hour.

Table 2 shows the amount of smoke released from these vehicles assuming that each vehicle spends five seconds in the vicinity of these points. This amount is per hour for each type of vehicles.

Figure 1 shows the histograms of a typical micrograph from a collected sample. Table 3 shows the various values from which graph have been drawn. The graph shows the % of total weight and the % of total number in each size class as obtained from the theoretical equations given in column 7 and 4 of Table 3, respectively.

The various types of sizes are defined by the equations for various class intervals as shown in Table 4. The calculations are done for various location points and

Table 4: Shows the calculation of average from microscope particle contents

Class intervals (mill-microns)	Average diameter D_i	Frequency n_i	$D_i n_i$	$n_i D_i^2$	$n_i D_i^3$	$n_i D_i^4$
5-15	10	100	1000	10000	100000	1000000
15-25	20	73	1460	29200	584000	11680000
25-35	30	60	1800	54000	1620000	48600000
35-45	40	50	2000	80000	3200000	128000000
45-55	50	45	2250	112500	56250000	281250000
55-65	60	30	1800	108000	6480000	388800000
65-75	70	12	840	58800	4118000	288120000
75-85	80	5	400	32000	2560000	204800000
85-95	90	2	180	16200	1458000	131220000
		377	11730	500700	25735000	1483470000

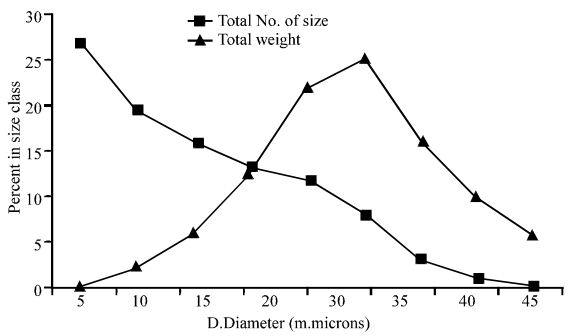

Fig. 1:

this histograms are accordingly prepared. Also the average amount of smoke released from the various types of vehicles when combined together gives us the total amount of the smoke particles released in the atmosphere of the University of Balochistan, Quetta, Pakistan, area by these vehicles.

- Average mount of smoke release from a Truck in one second = .5648 g sec^{-1} .
- Average amount of smoke released from a Rickshaw = 0.4371 g sec^{-1}.
- Average amount of smoke released from a Bus = 0.2385 g sec^{-1}.
- Average amount of smoke released from an Autocycle= 0.0236 g sec^{-1}.
- Average amount of smoke released from a Wagon = 0.14105 g sec^{-1}.
- Average amount of smoke released from a Car = 0.05005 g sec^{-1}.

- Total amount of smoke released from all these vehicles =1.44928 g sec^{-1} or 5219.20 g h^{-1}.
- Total area of Siryab Road, Quetta = 2.427×10^6 m^2.
- Total amount of smoke released per square meter per hour = 2.15047×10^{-3} g M^{-2}.

The data shows the amount of smoke released from the types of vehicles, varies from vehicles to vehicle. It also depends on the conditions and model of the vehicle. This is being greatest for the trucks or buses and decreases in the following order, Truck > Rickshaw> Bus >Wagon > Car > Auto-Cycle. Similarly, the highest concentration of smoke particles varies from point to point. Concentration being greatest on crossings and bus stops where traffic is held up for a short interval of time.

The order of decreasing concentration of smoke particles being crossing point near Siryab Pattack, Overhead Bridge, QDA Office, University of Balochistan, Forest Research Center and Siryab Chain. The histogram of Fig. 1 shows the distribution of these sizes. It has been found that the particles in smoke area of the range of 5-95 mm in size.

Further studies of these various factors are continuing and their conclusions will be reported in subsequent publication.

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