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Assessment of pH and Electrical Conductivity of the Hyderabad Urban Road Dust, India

[1]S. Sharon and [2]R.S.N. Sastry
1 & 2 Department of Applied Geochemistry, University College of Science, Osmania University, Hyderabad-500007;

Abstract

The road dust of Hyderabad causes more health hazards living along the highways. Urban road dusts are generated from different sources in developing cities. In the present investigation the given assessment of pH and EC of road dust sediments of two major road lines of Hyderabad city. The impact of road dust sediments on inhabitants is of present investigations in developing cities of the world is a prerequisite for maintaining a healthy environment for inhabitants. Hence the pH and EC measurements have been carried out from Hyderabad city of Telangana State, India. The urban road dust on the highway, the busy traffic-oriented roads, first road line (inner ring road) L.B. Nagar to Uppal X Road (lower pH 8.2, higher pH 10.66, lower EC 1400 µS/c, higher 2600µS/ cm). Second road line Ramoji film City to L.B. Nagar (NH-65) urban road dust sediments show alkalinity with lower pH (8.01) to higher pH (10.13) and lower EC (1100µS/ cm), to higher (2500µS/ cm). This investigation show the alkaline to moderately alkaline nature of urban road sediments along Uppal X Road to L.B. Nagar and L.B. Nagar to Ramoji Film City Roadways. The pH values (8.62 to 10.66) resulted more than the normal pH values of local soil (7.3 to 8.5).

Keywords: Hyderabad**,** pH & EC, Urban road dust and Alkaline

1. Introduction

Road dust (RD) is one of the most important sources of particles in the atmosphere, especially in industrial areas and cities (Dmitry Vlasov, et al. 2022). Re-suspended road dust (RD), enriched with toxic elements, polycyclic aromatic hydrocarbons (PAHs), black carbon, etc., is one of the most important sources of coarse, fine, and ultrafine particles in the atmosphere, which is especially true for industrial sites and cities with a high density of road network and large areas sealed under road pavement (Emerjian, et al. 2021). According to Heikki Tervahattu et al (2006), road dust forms an important component of airborne particulate matter in urban areas. In many winter cities the use of anti-skid aggregates and studded tires enhance the generation of mineral particles. The abrasion particles dominate the PM10 during springtime when the material deposited in snow is re-suspended.

Hyderabad is one of the fast-developing cities in India with huge traffic, and anthropogenic activities on the roadside contributing to urban road dust. The transport facilities are enhanced by laying inner and outer ring roads around the city given increasing geographical expansion and population growth.

Road transportation development for transporting men and materials is a prerequisite for the growth of the economy and plays a key role in increasing social divergence in all nations. Comparatively road transport is cheaper and convenient and hence, road projects improve the economic and societal well-being of people. A good road network can decrease travel time, reduce the costs of transport, and increase income and standard of living; thus, the merits of road transport are indisputable. Road transportation activities may contribute to unhealthy conditions and cause environmental quality depletion. Urban road dust is a complex mixture of particles of both natural and anthropogenic origins. The natural former is losing the benefits from soil, plant, and animal kingdoms (e.g., mold spores, animal dander, pollen, pollen fragments) and the atmosphere. Dust can physically injure plants through sandblasting, resulting in tissue damage, or indirectly alter soil pH, leaf temperature, and photosynthetic rate (Lewis, et al. 2017; Shah, et al. 2017). Urban road dust is a mixture of anthropogenic and natural-origin particles. It is primarily derived from plant, animal, soil, and atmospheric deposition. The anthropogenic activities disrupt the natural balance in the urban area environment. This imbalance is caused by automobile emanations, demolition and construction activities (Majumdar, et al. 2021).

Urban road dust has a good relation with wind-sweeping action on ground-level conditions and the movement of vehicles on the road (Jendritzki, et al. 1999; Countess, et al.2001). Dust particles in air with a diameter of <1 µm to 100 µm depend on their origin surrounding condition and physical characteristics (Ghosh, 2014). Based on the PM_{10}/TSP (total suspended particulates) ratios estimation in the Asia urban area air quality present 20% of road dust resuspension (Shah and Nagpal, 1996), in Barcelona (Spain) city 17% (Amato, et al. 2009) in Kanpur (India) it is 25-50% (Sai Bhaskar and Sharma, 2008). Which are very fine or micro particle ($PM_{2.5}$) dusts on the road effecting the respiratory system, and oncological and cardiovascular diseases (Tager, 2005; Shi, et al. 2011; Ali, et al. 2017; Li, et al. 2018; Men, et al. 2018; Mug Damani, 2022).

Dust particles append again and again with the air motion and meteorological wind speed direction and these particles assemble with toxic metals (lead, cadmium, mercury, chromium etc.) and metalloids such as arsenic, tellurium etc. (Tian, et al. 2018), organic matter such as coal, petroleum, methane, kerosene, etc. and aromatic hydrocarbons such as methylbenzene, naphthalene, phenanthrene, etc.(Chow, et al. 1996; Verica, et al. 2003; Denier van de Gon, 2013; Amato, et al. 2014; Kosheleva, et al. 201 8). The fine or micro dust particles are from soot or diesel and slightly coarser particles from road dust and soil (Rai, et al. 2010; Wang and Qin,, 2007; Al-Khash man, 2007; Ladonin and Plyaskina 2009; Acosta, et al. 2011; Yisa, et al. 2011; Hu, et al. 2011; Sutherland, et al. 2012). The diagram (Fig 1) shows road dust particle deposition and overview process (flows).

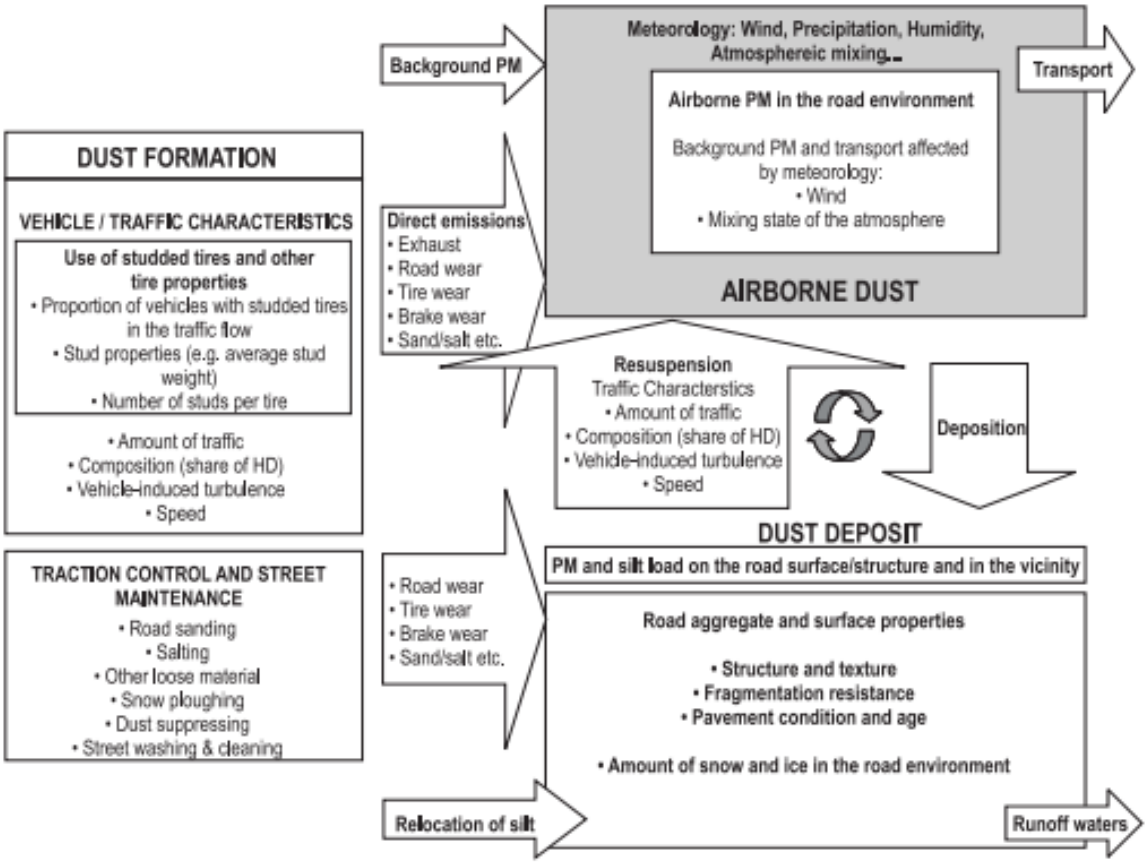

Fig-1 Material flows of road dust particles, with the main factors affecting the source strength (partially based on Gustafsson, 2003).

The road dust was dominated by sand and silt size particles (the share of PM_{10} particles varies from 2.3% to 39%) and had alkaline pH (6.4–8.1), high EC (33–712 μS/cm) and C org (0.17–6.7%). Road dust is alkalinized by detergents and particles formed by abrasion of roadways and blown out from construction sites (Nikolay, et al., 2019). The pH values ranged from 6.8 to 12.0 (with an average of 9.0), which were higher than the pH of the local soil (8.3)2 in bus stop dusts from Qing yang, NW China (Hongwu & Xin Wei Lu, 2018) The pH of the roadside soil dust of the studied sites in Nigeria ranged from 7.5-8.0 and Kuwait showing pH of 7.4 to 8.1 closer to the neutral value suggesting that urban soil is most neutral to the high content of carbonate, ash and cinder of anthropogenic origin (Lu and Bai, 2010).

The dust has an alkaline reaction, the pH value varies from 7.4 to 10.2. The alkaline reaction is caused by the entry of micro-particles of carbonate construction dust, as well as the redistribution of pollutants emitted by vehicles. Acidifying gaseous compounds, mainly nitrogen oxides, migrate off the roadway while alkalizing dust particles (construction carbonate dust, deicing mixtures) remain on the road (Dmitriy Moskovchenko, 2022).

2. Sampling Method and Laboratory Analysis

In India Hyderabad is one of the fast-developing city in all sectors such as construction, pharmaceutical, manufacturing, and road connectivity to other major cities and states, etc. The present investigations deals with pH and EC of the Hyderabad L.B. Nagar - Uppal X Road (road- 1) and Ramoji Film City - L.B. Nagar (road- 2) urban road dust. The road urban road dust samples were collected from 31 locations (Fig 2).

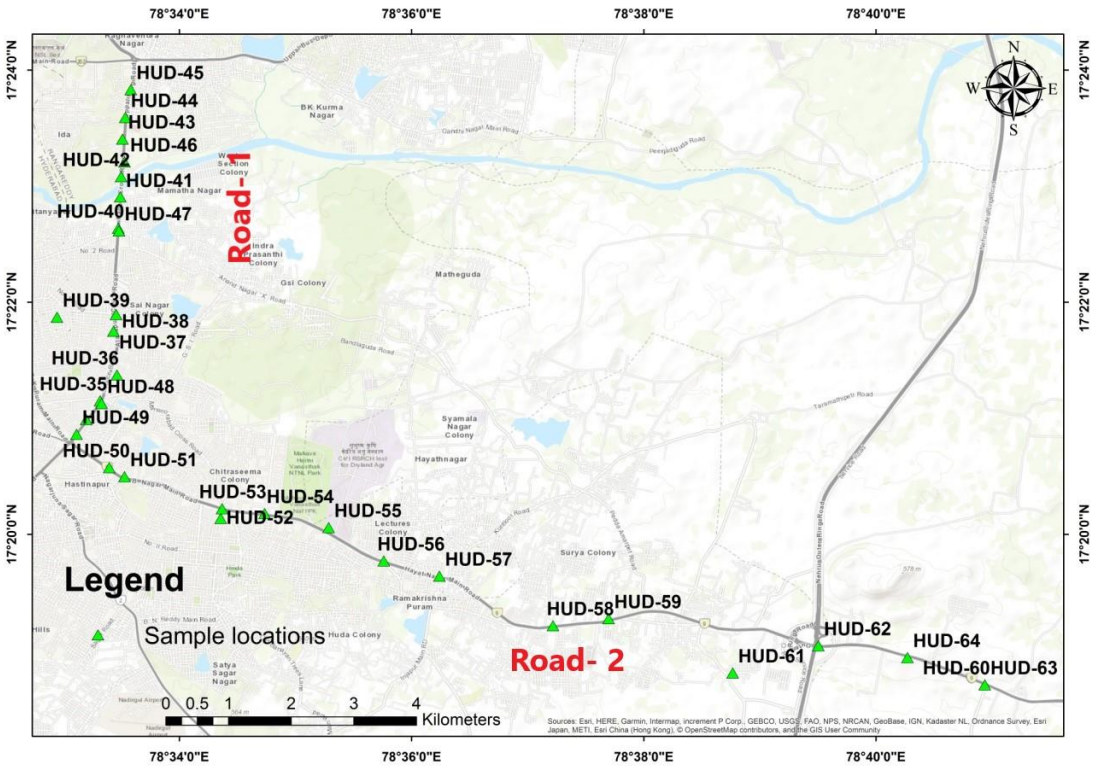

Fig. 2 Road dust sample collection location map road 1 (L.B. Nagar - Uppal X Road) and Road 2 (Ramoji Film City - L.B. Nagar) in Hyderabad

The urban road dust sample locations have been selected along the city roads, islands and sampling method adopted as follows. The required materials are plastic gloves, plastic trays, two-inch brushes, and self-locking plastic bags. The maximum dust accumulation places were selected. With the use of plastic gloves and two inches of brush road dust was gathered along the road divider and island of four roads. Thus, the dust accumulated was brought into a plastic tray and the contents were transferred to the self-locked plastic bags.

The sample numbers were marked by the marker pen on the plastic bag. Further GPS (global position system) locations and description of the road dust sample (Tables 1 and 2) were noted on the site in a field notebook. Winter and summer seasons make sediments dry and these seasons are the best seasons for collecting the samples because of accumulations of sediment by the wind-blowing action after the rainy days. The dust gusts accumulated by the natural air, vehicle speed etc., creating unhealthy conditions causing breathing, skin allergy, and visibility problems for the citizens of urban areas. Samples of 200-300 gm each was collected from road surfaces within 1 x 1 quadrates using plastic gloves, a plastic tray, and two inches of plastic brush and placed into self-locking plastic bags. The sample numbers were written on the plastic bag in order to avoid contamination and misplacements of samples.

The pH ranges from 0 to 14, with 7 as neutral. If pH is less than 7 it indicates acidity, whereas as pH is greater than 7 it indicates a basic (alkaline) nature. In the present studies, 1gm of sieved – (minus) 80 mesh size road dust samples were taken in 100 ml beaker and added 100 ml distilled water, stirred thoroughly, and kept them for 10 to 15 minutes and the pH and EC measurements were determined on Specific Ion Meter (Orion make). Determination of pH and Electrical Conductivity was done with the help of a digital portal analyzer kit (Systronics model-365), India (Gardner, et. al., 1991; Cross ref. Nagunayak et. al, 2022).

Table- 1 Sample Collection Road- 1 (Uppal X Road – L.B. Nagar)

S. No	Sample no	Location/ Place of Collection	Longitude	Latitude	Date of Collection
1	HUD-34	RTC Colony L.B Nagar x Road	N 17.3498	E-078.5533	20-11-2020
2	HUD-35	Disha Children Hospital L.B Nagar	N 17.3525	E-078.5553	20-11-2020
3	HUD-36	Mansoorabad Signal	N 17.3562	E-078.5577	20-11-2020
4	HUD-37	Nakshatra Hospital L.B Nagar	N 17.3625	E-078.5572	20-11-2020
5	HUD-38	Sai Nagar Colony Nagole	N 17.3649	E-078.5576	20-11-2020
6	HUD-39	Vasavi Colony L.B Nagar	N 17.3645	E-078.5491	20-11-2020
7	HUD-40	Kothapet Inner Ring Road	N 17.3773	E-078.5579	20-11-2020
8	HUD-41	Mamtha Nagar Nagole Signal	N 17.3818	E-078.5582	20-11-2020
9	HUD-42	Uppal Metro Depot Nr Shilparamam	N 17.3847	E-078.5583	20-11-2020
10	HUD-43	Nagole Metro Station	N 17.3901	E-078.5585	20-11-2020
11	HUD-44	Survey Colony Inner ring road Uppal	N 17.3932	E-078.5589	20-11-2020
12	HUD-45	Rajnagar colony Uppal x road	N 17.3972	E-078.5597	20-11-2020
13	HUD-46	Uppal Kalan Inner ring road petrol bunk	N 17.3868	E-078.5588	20-11-2020
14	HUD-47	Supraja Hospital Nagole Inner Ring Road	N 17.3769	E-078.5580	20-11-2020
15	HUD-48	Kamineni Hospital L.B Nagar	N 17.3521	E-078.5555	20-11-2020
16	HUD-49	L.B Nagar X Road Signal	N 17.3477	E-078.5519	20-11-2020

Table- 2 Sample Collection Road- 2 (Uppal - L.B. Nagar – Ramoji Film City)

S. No	Sample no	Location/ Place of Collection	Longitude	Latitude	Date of Collection
1	HUD-50	Chandrapuri Colony L.B Nagar	N 17.3429	E-078.5566	20-11-2020
2	HUD-51	Rainbow Children Hospital LB Nagar	N 17.3416	E-078.5588	20-11-2020
3	HUD-52	Mansoorabad Traffic Signal	N 17.3356	E-078.5726	20-11-2020
4	HUD-53	Chitra Seema Nagar Mansoorabad	N 17.3370	E-078.5728	20-11-2020
5	HUD-54	Auto Nagar Petrol Bunk	N 17.3363	E-078.5789	20-11-2020
6	HUD-55	CRID Research Institute Auto Nagar	N 17.3343	E-078.5881	20-11-2020
7	HUD-56	Lecturers Colony Hayat Nagar	N 17.3295	E-078.5960	20-11-2020
8	HUD-57	Hope & Deed School & Junior College	N 17.3273	E-078.6040	20-11-2020
9	HUD-58	Rajasthan Marble World Hayath Nagar	N 17.3202	E-078.6203	20-11-2020
10	HUD-59	Word & Deed ITA & Multispecialty Hospital	N 17.3212	E-078.6283	20-11-2020
11	HUD-60	Abdullapuramet Signal	N 17.3117	E-078.6823	20-11-2020
12	HUD-61	Padda Amberpet Signal	N 17.3134	E-078.6461	20-11-2020
13	HUD-62	Nehru Ring Road Padda Amberpet Village	N 17.3173	E-078.6584	20-11-2020
14	HUD-63	Ramoji Film City	N 17.3117	E-078.6823	20-11-2020
15	HUD-64	Ramoji Film city Petrol Bunk	N 17.3156	E-078.6712	20-11-2020

3. Results and Discussion

Road transport is essential but the pollutants from vehicles degrade the soil structure, vegetation of the surrounding area (Chaturvedi, 2013) and living organisms (Prajapati and Tripathi, 2008). The chemistry of the dust also plays a key role in the colour of the dust and its effects on the temperature of in leaf (Chaston and Doley, 2006). Plants are more affected by dust with their chemical composition, quantity of dust load, variable pH levels particulate size consequently impacting vegetation. Leaves have highly sensitive chlorophyll when the dust pH is increased, the function of chlorophyll may cease (Farmer, 1993). If the pH of dust is ≥ 9 plant tissues may be inflicted and they will get serious injuries (Vardak, et al. 1995). If dust has an alkaline nature with MgO it degrades epicuticular waxes coating on plants' leaves and fruits organism (Bermadinger, 1988) and it reduces the function of plants' ability to get minerals from the soils (Raaja Subramanian, et al. 2011). The most affected function of leaves are respiration function of the plants.

Through the dermal, Inhalation, and ingestion pathways of carcinogenic and non-carcinogenic elements enter into children's and adults' bodies (Jiang et al. 2016 and Han et al. 2017). Due to the traffic movements road dust raised up and down frequently and this dust contain some trace elements. Some of the trace elements (As, Ba, Co, Cr, Cu, Ni, Pb, Zn, Zr, Nb, Rb, Sc, Sr, Th, V, and Y) contact through inhalation, ingestion or dermal contact (Victoria, et al. 2014) and these cause some diseases like skin and eye infections, asthma, cancer, hearing and visual impairment, high blood pressure, headaches, cardiovascular disorder, lung granulomas and some other (Ray, 2016; Okereafor, et al. 2020).

3.1. ROAD- 1 (Uppal X Road – L.B. Nagar)

The present investigation gives an assessment of pH and EC of two main road lines of Hyderabad metropolitan city is an important parameter of inhabitant health issues. The pH concentration of Hyderabad Road dust (roads 1 and 2) was recorded with the highest pH and EC concentrations with an average pH value 9 of 0.57875 (µs/cm) (EC) and the highest values are recorded in roads 1and 0.66 (µs/cm) (Table 3 and 4) and road two with average pH value 9.29933 with the highest value of 10.13 (Table 5 and 6). At the same time, EC also recorded the highest values at road one (2600 µs/cm) and road two (2500 µs/cm) and the average values of 1893.75 and 1780 µs/cm.

A total of 16 samples were collected from road one and their pH, EC, and statistical parameters are followed in the below table. The maximum values of pH and EC were found at the RTC colony and Disha Children Hospital at L.B. Nagar X Road. Road one is a part of the inner ring road. This road has huge traffic conditions as well as flyovers, underpass constructions, and building constructions going on during the sampling time. On this road, we found three high pH and EC values (RTC Colony10.64: 2200 µs/cm; Disha Children Hospital 10.66: 2400 µs/cm and L.B Nagar X Road Signal10.54: 2000 µs/cm). These locations are very near to the flyover and underpass construction. The pH of the road one sampling results generally show a decreasing (Fig 3) nature from Uppal to LB Nagar areas. The Uppal and LB Nagar areas are showing higher pH values with positive spikes in addition to two high positive spikes and one with relatively low. EC values of road one (Fig 4) show high values with four positive spikes including the Uppal and LB Nagar areas. The EC values generally follow pH values from Uppal to LB Nagar areas.

Table- 3. pH and EC on Road- 1 (Uppal X Road – L.B. Nagar) Hyderabad

S. No	Sample no	Location/ Place of Collection	pH value	EC µs/cm
1	HUD-34	RTC Colony, L.B Nagar x Road	10.64	2200
2	HUD-35	Disha Children Hospital, L.B Nagar	10.66	2400
3	HUD-36	Mansoorabad Signal	9.02	1700
4	HUD-37	Nakshatra Hospital, L.B Nagar	9.05	1800
5	HUD-38	Sai Nagar Colony, Nagole	9.07	1900
6	HUD-39	Vasavi Colony, L.B Nagar	10.02	2400
7	HUD-40	Kothapet Inner Ring Road	10.57	2000
8	HUD-41	Mamtha Nagar, Nagole Signal	10.05	2600
9	HUD-42	Uppal Metro Depot Near Shilparamam	8.97	1600
10	HUD-43	Nagole Metro Station	9.25	1500
11	HUD-44	Survey Colony, Inner ring road Uppal	9.76	1700
12	HUD-45	Rajnagar colony, Uppal x road	9.09	1800
13	HUD-46	Uppal Kalan Inner ring road petrol bunk	8.97	1600
14	HUD-47	Supraja Hospital, Nagole Inner Ring Road	8.62	1400
15	HUD-48	Kamineni Hospital, L.B Nagar	8.98	1700
16	HUD-49	L.B Nagar X Road Signal	10.54	2000

A total of 15 samples were collected from Road two and their pH, EC, and statistical parameters are given below table. The maximum values of pH and EC were found at Chandrapuri Colony L.B. Nagar. Road two is National Highway 65 has huge traffic conditions

Table. 4 statistical parameters of road- 1(Uppal X Road – L.B. Nagar) Hyderabad

pH	**Max**	**Min**	**Mean**	**Median**	**Mode**	**St.Dv**
pH	10.66	8.62	9.57875	9.17	8.97	0.72425
EC	**Max**	**Min**	**Mean**	**Median**	**Mode**	**St.Dv**
EC	2600	1400	1893.75	1800	1700	349.225

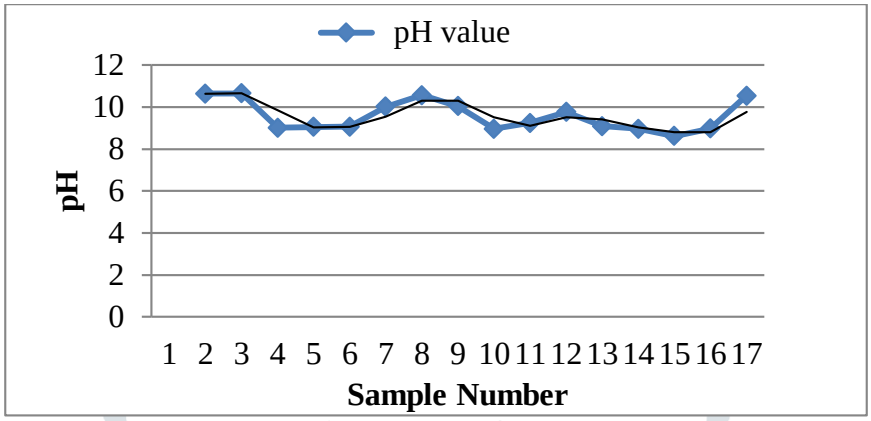

Figure 3. pH values of urban road dust on road one(Uppal X Road – L.B. Nagar) Hyderabad

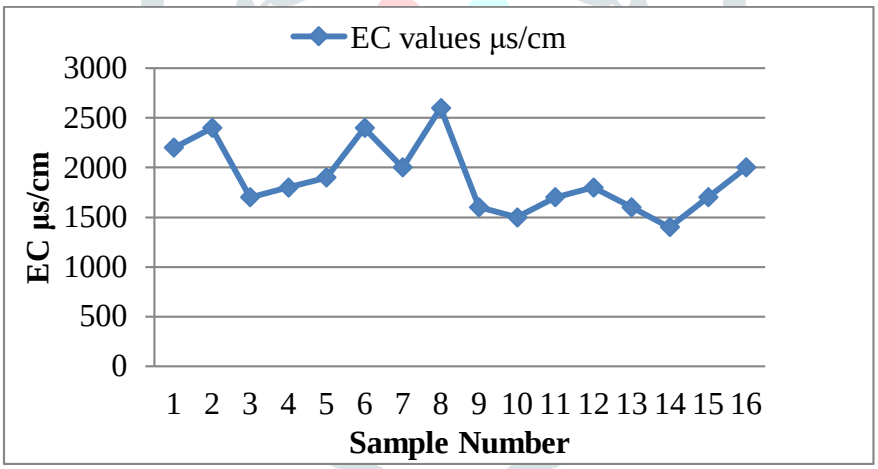

Figure 4. EC values of road one (Uppal X Roads – L.B. Nagar) Hyderabad

3.2. Road- 2 (Uppal – L.B. Nagar - Ramoji Film City)

The pH and EC values have been determined for the urban dust samples collected on road -2 (Uppal – L.B. Nagar - Ramoji Film City) are tabulated in table – 5.

Table- 5 Sample Collection Road- 2 (Uppal - L.B. Nagar – Ramoji Film City)

S. No	Sample no	Location/ Place of Collection	pH value	EC values µs/cm
1	HUD-50	Chandrapuri Colony L.B. Nagar	10.13	2300
2	HUD-51	Rainbow Children Hospital L.B. Nagar	9.54	1500
3	HUD-52	Mansoorabad Traffic Signal	9.25	1400
4	HUD-53	Chitra Seema Nagar Mansoorabad	9.92	2200
5	HUD-54	Auto Nagar Petrol Bunk	9.75	1800
6	HUD-55	CRID Research Institute Auto Nagar	9.71	1700
7	HUD-56	Lecturers Colony Hayat Nagar	9.53	1300
8	HUD-57	Hope & Deed School & Junior College	9.75	1800

9	HUD-58	Rajasthan Marble World Hayat Nagar	8.62	1400
10	HUD-59	Word & Deed ITA & Multispecialty Hospital	8.98	1500
11	HUD-60	Abdullapuramet Signal	8.95	1900
12	HUD-61	Padda amberpet Signal	8.01	1100
13	HUD-62	Nehru ring road Padda amberpet village	9.13	2200
14	HUD-63	Ramoji film city	9.15	2100
15	HUD-64	Ramoji film city petrol bunk	9.07	2500

pH

The graphical representation of pH values (Fig 5) on road two (LB Nagar to Ramoji Film City) shows a clear decreasing trend from road one (Uppal to LB Nagar). Similarly, EC values (Fig 6) show decreasing nature graphically on road two from Uppal to LB Nagar areas with 3 to 4 higher values with positive peaks.

Maximum pH is 10.66 at Disha Children Hospital (Road 1) compared to pH valued at 10.13 at Chandrapuri Colony LB Nagar (Road 2). The mean pH value is 9.57875 on road 1 is higher compared to the mean pH value of 9.29933 on road 2. The standard deviation of EC value of 0.54871 on road 2 is lower compared to the value of 0.72425 on road 1. The standard deviation on road 2 shows that the EC values are closer to the mean with less spread compared to the values on road 1.

EC

The EC value of 2600 at the Mamta Nagar Nagole signal on road 1 (Fig. 4)is higher compared to the value of 2500 at Ramoji Film City on road 2 (Fig. 6). The EC mean value of EC 1893 on road 2 is higher compared to mean value 1780 on road. The EC standard deviation value of 414.384 on road 2 is higher compared to the standard deviation value of 349.225 on road 1. The standard deviation shows that the EC values around the mean have less spread on road 2 compared to the EC values on road 1.

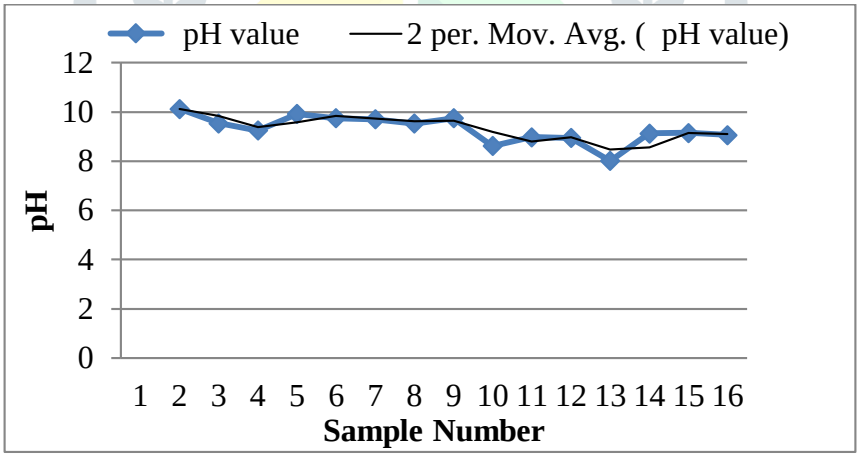

Figure 5. pH values of road two(Uppal – L.B. Nagar - Ramoji Film City) Hyderabad

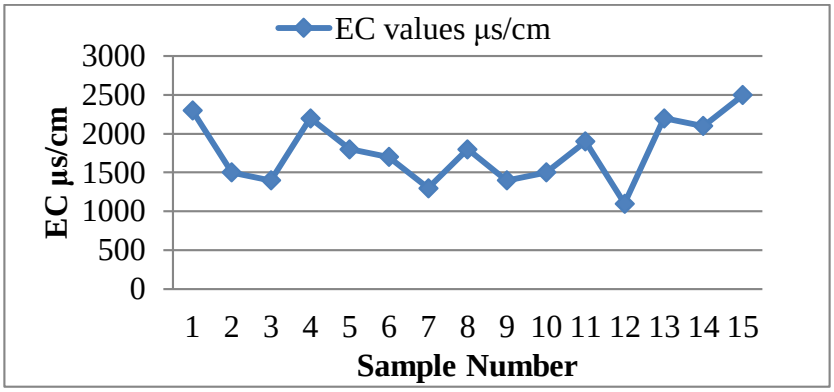

Figure 6. EC values of road two (Uppal – L.B. Nagar - Ramoji Film City) Hyderabad

Road 1 indicates alkaline to more moderately alkaline conditions compared to road 2 indicating alkaline to very less moderately alkaline in nature (Fig 9). Graphical representation of pH vs EC of road 1 and road 2 of urban road dust samples show normal positive correlation (Fig 7 and 8). It amply indicates the progressively moderate increase in pH and EC values on roads 1 and 2 and a similar trend.

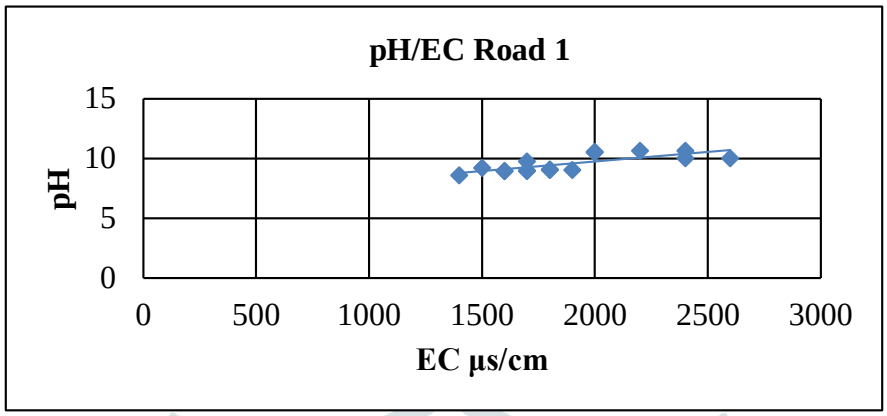

Figure 7. pH and EC correlation of road 1

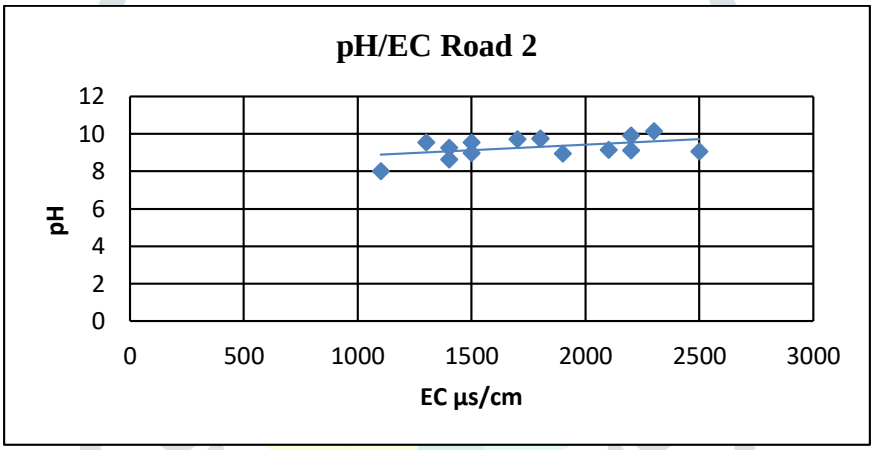

Figure 8. pH and EC correlation of road 2

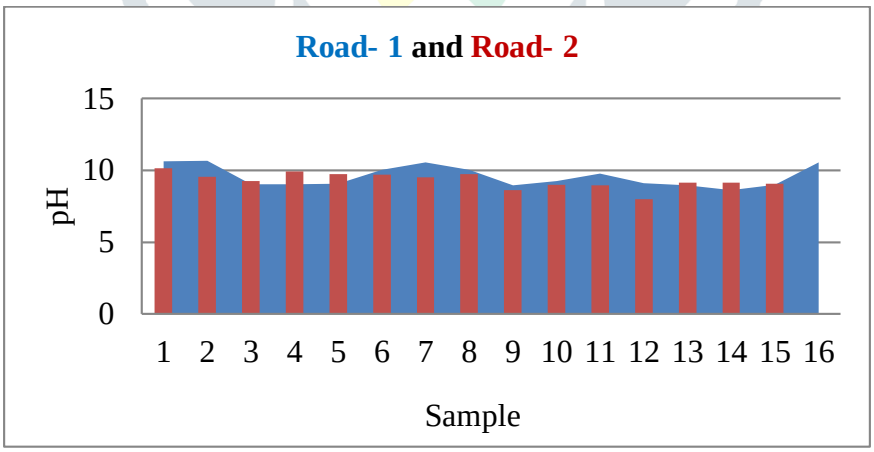

Figure 9. pH values of Road One and Road Two

Most of the samples show pH values of more than 9 (alkalinity), these conditions are due to the presence of calcium magnesium sodium carbonate and soluble salt (Zewd and Siban, 2021). Road dust affects human health, particularly in the breathing and cardiac system (Khan, et al. 2018). Alkalinity generated by the CaO source from the limestone, distillation sludge (Steinhauser, 2008), concrete crusher, and its aggregates (Renforth, 2011) and with Steelworks (Bobicki, et al. 2012; Eloneva, et al. 2010; Helena, et al. 2016).

To control the alkalinity in the road dust by maintaining the proper techniques while transporting CaO source goods, properly managing the waste during the construction, the introduction of cleaner alternate fuels (viz., CNG, LPG, Ethanol Blending), promotion of public transport system, mechanical sweeping of roads with water washes, carpeting of shoulders and green cover.

Earlier research on Hyderabad urban dust (Bombay highway: Salarjung Museum to Sanga Reddy Cross Roads) recorded an average value of pH is 9.50 (Nikhat Anjum and Sastry, 2018). Results of the Present study also evidently show the pH conditions of the Hyderabad Road dust. The lowest value of pH is 8.01 (average pH value is 9.45), even a single sample does not result from lower than 8 pH and it is akin to the Bombay highway road dust of Hyderabad.

4. Conclusions

In the Hyderabad urban road dust contains higher pH values at (10.66) indicating alkaline conditions and EC at Mamta Nagar, Nagole Signal 2600 µs/cm on road one can be attributed to commercial building activities, flyover, underpass constructions, demolition of old buildings, and , vehicular traffic movement and other activities along the L.B. Nagar to Uppal X Road. Similarly pH is valued at 10.13 at Chandrapuri Colony LB Nagar (Road 2). This is the prime reason for increasing the pH levels in road dust. The pH and EC indicate a normal positive correlation trend in both roads. The urban dust investigations show the conditions veers towards alkaline nature attributing to the presence of carbonate or insoluble organic compounds and hydroxide precipitation (Smith, et al. 1992).

As per earlier researchers, Hyderabad urban dust (Bombay highway: Salarjung Museum to Sanga Reddy Cross Roads) has an average pH value is >9 (Nikhat Anjum and Sastry, 2018). The pH values resulted from road 1, ranging from 8.62 to 10.66 (with an average of 9.58), and on road 2 ranging from 8.01 to 10.13 (with an average of 9.3), higher than the normal local soil pH (7.3 to 8.5, Sri Laxmi, et al. 2017). Most of the samples resulted slightly alkaline to alkaline nature. The alkaline nature was evidenced by construction and demolition activities prevalent in the city apart from vehicular traffic etc. The standard deviation on road 2 shows that the EC values are closer to the mean with less spread compared to the values on road 1.

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