RSC-NEERI symposium

On

Urban Air Pollution Chemistry

Date: 2 and 3rd December 2016

Venue: NEERI Nagpur

	DAY 1 (December 2)	
1:00 pm - 2 :00 pm	**Registration/Lunch**	
2:00 pm – 2:30 am	**Introductory Session**	
2:00 pm - 2:05 pm	Welcome	NEERI
2:05 pm - 2:25 pm	Director's Address	Rakesh Kumar
2:25 pm - 2:30 pm	About RSC	Rajesh Parishwad
2:30 pm – 4:30 pm	**Session 1:**	**Chair:**
2:30 pm – 2:50 pm	Measurement of vehicle emissions on a vehicle by vehicle basis	Francis Pope, University of Birmingham, UK
2:50 pm – 3:10 pm	Exposure to air pollutants and inequalities among different socio-economic groups during commuting in London	Prashant Kumar, University of Surrey, UK
3:10 pm - 3:30 pm	Source apportionment study in coal mining area	Dr K V George, CSIR-NEERI
3: 30 pm - 3:50 pm	A world avoided: Impacts of changes in anthropogenic emissions on the burden and impacts of air pollutants	Alex Archibald, University of Cambridge
3:50 pm – 4:10 pm	Long-term visibility trends in the UK and India	Ajit Singh, University of Birmingham ,
4:10 pm – 4:30 pm	Q & A	
4:30 pm – 5:30 pm	POSTER AND TEA	
	DAY 2 (December 3)	
10:00 am - 11:45pm	**Session 2:**	**Chair:**
10:00 am - 10:20 am	Modelling Urban Vehicle Emissions	Mukesh Khare, IIT Delhi, India
10:20 am - 10:40 am	Source Apportionment of fine aerosol in Mumbai City	Elizabeth Abba, Xavier University, India
10:40 am - 11:00 am	TBC	R B Biniwale, CSIR-NEERI
11: am – 11:15 am	Q & A	
11:15 am – 11:45 am	Tea & Poster Session	
11:45 am – 1:00 pm	**Session 2 continued**	
11:45 am – 12:05 pm	VOC monitoring and Photolysis rate analysis for India	Dr Neel Kamal, CSRI-NEERI
12:05 pm – 12:25 pm	Effect of PM2.5 on Atmospheric Visibility Impairment in Delhi City, India	Dr Isha Khanna, IIT Delhi
12:25 pm – 12:35 pm	Q & A	
12:35 pm – 2 pm	**Lunch**	
2:00 pm - 4:00 pm	**Session 3:**	
2:00 pm – 4:00 pm	**RSC Publishing workshop**	Rajesh Parishwad
4:00 pm – 4:15 pm	Closing Remarks	NEERI

Source Apportionment of fine aerosol in Mumbai City

Abba Elizabeth Joseph[1], Seema Unnikrishnan[2], Rakesh Kumar[3]

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Increasing ambient levels of fine particles due to anthropogenic activities are leading to adverse effects on human health and climate change. Indian subcontinent has witnessed high levels of air emission and its increasing concern. Air quality management in India is being studied with more rigor, in recent times due to immense pressure from public to clean the ambient air. Growing concern about fine particulates Indian Ministry of Environment and Forest has introduced new National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ as 60 µg/m^3 **(CPCB, 2009)**. Only Measurement of fine particulate levels does not help in understanding the source, but the determination of chemical composition of fine particles sheds light on the nature of pollution.

The estimation of $PM_{2.5}$ concentrations, chemical characterization and source apportionment for different land use pattern in Mumbai was the objective in the present study. The average outdoor $PM_{2.5}$ mass concentrations at Control, Kerb, and Residential and Industrial site were 69±20.97, 84±31.99, 89±33.52, 95±36.01 µg/m^3, respectively. Factor analysis was performed followed by application of Chemical Mass Balance (CMB) model using source profiles developed for India and organic marker profiles developed in the United States of America. Advantages of using speciation data viz. OC, EC, major ions and metals (with molecular marker) was helpful in identifying local sources like refineries, generators and kerosene combustion. Fine Particle Source Apportionment using Organic Marker indicated that major contributors to $PM_{2.5}$ mass were diesel exhaust, biomass burning, gasoline emissions secondary inorganic aerosol and road dust. The vehicular contribution (gasoline and diesel) were around 20-40%. The gasoline contribution is mainly attributed to vehicles but the diesel emissions may also be contributed from vehicles, industries, stationary generators, forklifts for material lifting, bakeries etc. The secondary inorganic aerosol formation contributes to 11-28% indicating as one of the major sources followed by vehicles. Biomass combustion contribution was about 6-24% could be due to area sources like bakeries, crematoria, open burning, garden waste, domestic etc. Moderate road dust contribution was observed except at control site. The fossil fuel (diesel, gasoline and coal) contributions (27% to 38%) exceeded biomass contribution (6-24%) in Mumbai city. This information can be used to prepare appropriate air shed management plans to protect human health and environment.

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Dr. Elizabeth Abba holds a Ph.D. in Environment Management from National Institute of Industrial Engineering, Mumbai. Dr. Elizabeth has ten years of research experience at National Environmental Engineering Research Institute, Mumbai Zonal Laboratory, and more than 3 years of teaching and consultancy experience in the area of Environmental Science. She was awarded the prestigious Fulbright Doctoral and Professional Research Scholarship during 2008-09 and spent 9-months at the Graduate School of Public Health at San Diego State University. Prior to joining Xavier University, Bhubaneswar, she taught courses in Environmental Science and Management to post graduate students at K.J Somaiya College of Science and Commerce,

Effect of $PM_{2.5}$ on Atmospheric Visibility Impairment in Delhi City, India

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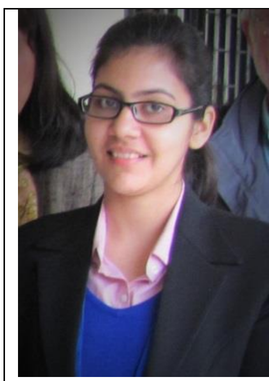
Visibility impairment has become a highly prevalent phenomenon in developing countries including India due to exponential growth and development in all sectors. It has resulted into increase in atmospheric pollutant concentrations which frequently violates the National Ambient Air Quality Standards (NAAQS), particularly the ambient PM2.5. Visibility impairment is primarily caused due to extinction of light by scattering and/or absorption by fine particles. Hence, it seems imperative to investigate causes of reduced visibility for effective implementation of emission reduction strategies. The objectives of this study are twofold, one, to assess the relationship between $PM_{2.5}$ and visibility; two, to assess the causes of visibility impairment by relating light extinction coefficients (b_{ext}) to $PM_{2.5}$ chemical composition. In the present study, the relationship between $PM_{2.5}$ and visibility has been analysed at a sampling site located at a kerbside along a National Highway in Delhi city, India. $PM_{2.5}$ has been sampled during summer and winter seasons in 12-hour cycles using standard $PM_{2.5}$ sampler. The mean $PM_{2.5}$ mass concentrations have been observed to be 293.1±36.7 $\mu g/m^3$ and 60.5±21.4 $\mu g/m^3$ during winter and summer seasons, respectively, exceeding the NAAQS of 60 $\mu g/m^3$. $PM_{2.5}$ and its chemical constituents show negative correlation with visibility during the summer and winter seasons. The exponential fits are obtained relating PM2.5 and visibility in both seasons. The results of apportionment of bext show that organic matter has been the largest contributor to b_{ext} in both the seasons (34% in summer, 32% in winter) which may be attributed to combustion sources. In summer season, it is followed by elemental carbon and ammonium sulfate. However, in winter, major contributions are from ammonium nitrate, elemental carbon and ammonium sulfate. Higher elemental carbon in both seasons may be attributed to traffic sources; while lower concentrations of nitrate during summer, may be attributed to volatility because of higher atmospheric temperatures.



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Isha Khanna, Senior Research Scholar at IIT Delhi, has completed M.Sc. (Environmental Studies) and B.Sc. (Hons.) (Biomedical Sciences) before joining PhD. She is currently working on evaluating the urban air quality in Delhi city and the major sources of pollutants for assessing the regulations required in policy framework with the help of chemical characterization of fine particulate matter ($PM_{2.5}$) and apportionment of the sources. She has authored three journal papers, one book chapter and two conference papers. Her research interests are mainly in area of monitoring and modelling of urban air quality, indoor air quality, and health risk assessment, etc.

Exposure to air pollutants and inequalities among different socio-economic groups during commuting in London

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Transport-related air pollution (TRAP) is harmful to human health. Exposures during commuting are expected to be especially high due to closeness to emission sources. An usual understanding is that the people on low income are often exposed to higher air pollutant concentrations. We tested this hypothesis for London with an aim to determine and compare the exposure to particulate matter (PM), Black Carbon (BC) and ultrafine particles (UFP; 0.02-1 µm) during commuting of inhabitants from 4 London areas with different levels of income deprivation (G1 to G4, from most to least deprived), different transport modes (car, underground and bus) and different day periods (morning and afternoon rush hour, midday non-rush hour). London areas were classified into 4 groups as per their Income Deprivation Index score (from the Index of Multiple Deprivation 2010). Origins were selected among one area of each group, located at the corresponding average commuting distance for its group (7.7km for G1, 9.4km for G2, 11.5km for G3, 12.2km for G4). The destination was in London financial district (with the highest employment density). Four different routes were covered by 3 different transport modes (car, underground, bus), 3 times a day in each mode, obtaining a total of 120 round trips. We simultaneously measured PM in different size bins (PM1, PM2.5, PM10), BC concentrations, UFP concentrations while tracking their spatial position. Regarding the time spent in commuting, the round trip of the bus required much more time (>110min) than the underground (always <110min) or the car (~110min). Generally, the highest concentration of all pollutants and transport modes was found during the morning. No clear trends were observed among income groups; however the lowest BC and UFP concentrations were reported for G2. The underground showed the highest concentrations of PM (especially the coarse fraction, PM2.5-10, and trains with openable windows) while having the lowest UFP concentration (similar in all type of trains). Cars had the lowest PM (especially PM2.5-10) due to the efficient removal of the car filters (windows were always close). Concentrations were generally higher in buses than in the car, especially for PM2.5-10. Trip duration emerged as an important factor than the income level when considering the total exposure. Further details of this work are available in: Rivas, I., Kumar, P., Hagen-Zanker, A., 2016. Exposure to air pollutants during commuting in London: are there inequalities among different socio-economic groups? Environmental International (under review).

Acknowledgements: This work has been carried out by the 'Air Pollution Group' at the University of Surrey under the framework of the ESRC-NWO-FAPESP funded project, ASTRID (Accessibility, Social justice and Transport emission Impacts of transit-oriented Development; ES/N011481/1).

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Dr. Prashant Kumar is a Reader (a UK rank between Associate Professor and Full Professor) at the Department of Civil and Environmental Engineering at the University of Surrey (UK). He obtained his Ph.D. from the University of Cambridge (UK) and holds a master degree in Environmental Engineering and Management from the Indian Institute of Technology Delhi (India). He founded and lead a research group in the area of "air pollution and health" at Surrey. To date, he has secured over €3 million of funding for his research from the UK and International funding bodies such as the EPSRC, NERC, ESRC, UKIERI, QNRF, H2020, and UGPN. He has authored over 110 journal articles, receiving ~2300 citations with an H-index of 25 and i_{10}-index of 52. Prashant is currently a Surrey PI on a number of international consortium projects such as the H2020 funded 'iSCAPE: Improving the Smart Control of Air Pollution in Europe', QNRF funded 'EMf4ME: Emission models for fugitive particulate matter towards an online emission inventory for the Middle East Area' and UK-India NERC funded 'ASAP-Delhi: An Integrated Study of Air Pollutant Sources in the Delhi National Capital Region'. He is CoI on an ESRC-FAPESP-NWO funded project 'ASTRID: Accessibility, Social justice and Transport emission Impacts of transit-oriented Development', with a focus on air pollution exposure assessment of different socioeconomic groups. He is serving editorial board of 8 journals, including Science of the Total Environment. Further details of his research can be seen on his web page.

Estimation of local and regional contribution of O_3 and NO_2 in Delhi

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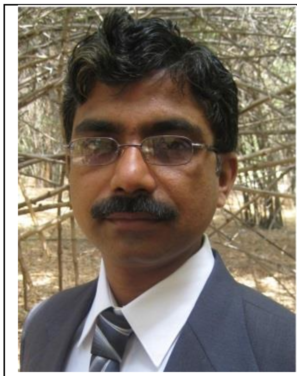
This paper aims to study the applicability of Clapp and Jenkin (C-J) model for NOx (NO_2+NO) and Ox (NOx+O_3) analysis for Delhi, India. C-J model was successfully applied for UK urban area, helped in identifying episode and non-episode days in terms of high O_3 levels; and differentiate between local and regional contribution of Ox pollution. The model application in Indian tropical climate puts a challenge on account of different conversion rate of NOx to O_3 due to high solar insolation owing to its geographic location i.e., India close to equator compared to UK. The regional contribution is determined using the intercept of linear regression model. In case of Delhi, regional contribution of Ox is found to be 39 ppb and can also be assumed as leftover O_3 from previous night.



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George Varghese did B.E. (Civil), M.E. (Environmental Engineering) and Ph.D. (IIT Delhi). He joined National Environmental Engineering Research Institute (NEERI), Nagpur in 1991 and worked on various environmental components. Application of source dispersion modelling using CALPUFF, receptor modelling using CMB and air quality monitoring and meteorological data analysis, are some of the major activities. Currently his interest is WRF-Chem and satellite data (AOD) analysis and atmospheric photochemistry for air quality assessment.
Studies for cleaning of UCIL, Bhopal premises, decontamination of groundwater at H-Acid affected area in Bichhri, Udaipur, EIA for Chemical Industry, TPP, Cement Plant, Refinery and Fertilizer plant coal based TPP were some of the previous activities.
Presently Dr. George is working as senior principal scientist at CSIR-NEERI, Nagpur.

Web: http://www.neeri.res.in/division/air-pollution-control-division/staff

Long-term visibility trends in the UK and India

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Many Asian countries, including India are undergoing rapid industrial development and urbanization, which can be alarming due to the significant influence it exerts upon future air quality. At present, India is facing extreme and rapid changes in their air pollutants level, mainly fine and ultrafine particles level in different scenarios. In contrast, in the UK, after the 1956 Clean Air Act, air quality improved due to reduction in coal consumption in domestic and industrial uses (Williams, 2004). As a result, particulate pollution has decreased since 1960 with improved visible air (Ayres, 1997). However, visibility is still of high importance in both India and UK, where a poor visibility can disrupt transportation, public safety and tourism and can cause country economic loss. The present work investigates annual visibility using hourly data for selected stations Heathrow (UK) and Delhi (India) to compare the historical visibility trends between the UK and India. The present quantitative analysis also attempts to explain the influence of aerosol concentration and composition, and meteorology on long-term visibility. Annual visibility in Delhi (India) decreased rapidly at a rate of 0.11 ± 0.01 km $year^{-1}$ during 1980–2000, but was found to be stabilized after the year 2000 (Singh and Dey, 2012). The accelerated decline in visibility during 1980-2000, has been attributed to an increase in aerosol concentration due to rise in anthropogenic emission, which also leads to a reduction in surface reaching solar radiation (Wild et al., 2005). However, the stabilization in visibility in recent years is seen to be a possible consequence of adopting the major air quality policy of moving the regional transport sector from diesel/petrol to CNG which was implemented during the year 2001. In the contrast, a steady increasing trend of annual visibility was observed for Heathrow (UK) with the rate of 0.2 ± 0.018 km $year^{-1}$, which is clear indicative of air pollution reduction (Singh et al., 2016). It is found that, after 1956 Clean Air Act, air quality improved in the UK urban areas (Harrison et al., 2015). Overall, changes in fuel pattern and consumption have had a significant influence on the environment due to the adopted air quality policies. Both air quality policies adopted by UK and India were presented as very useful tools for the reduction of air pollutants and thus for visibility improvement. However, a reduction in mass concentration of pollutants like soot and water soluble particles may improve visibility (Singh and Dey, 2012). Fortunately, these specific aerosol components are anthropogenic and can be controlled by improved air pollution control policies.

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Ajit Singh is a Doctoral researcher at University of Birmingham. His research investigates the impact of atmospheric pollutants and meteorology on visibility and tropospheric chemistry. Ajit previously received his Master degree from Indian Institute of Technology, Delhi in the field of Atmospheric Sciences. Between his Masters and current PhD research he spent few months as a Junior Research Fellow and Project Scientist in IIT Delhi. In 2013 he started his PhD at the GEES, University of Birmingham. Here he received "Elite Doctoral Scholarship" for his PhD studies. He has also received many scholarships and awards during his undergraduate, masters and PhD level; such as Chetna Award, National Talent Award, MHRD scholarship, NTS Scholarship, EGU Support Grant, etc. For more information see: http://www.birmingham.ac.uk/schools/gees/people/dr-students/singh-ajit

A world avoided: Impacts of changes in anthropogenic emissions on the burden and impacts of air pollutants.

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Emissions from anthropogenic activities are known to have deleterious impacts on human and ecosystem health and as such a significant amount of time, effort and money has been spent developing legislation to minimise their effects. But to what end have these efforts been a success?

Here we use a state of the art coupled chemistry-climate model HadGEM2-ES, with extended tropospheric chemistry, to assess the impacts that changes in emissions from anthropogenic activity have had on the burden and impacts of air pollutants over the last three decades. We use HadGEM2-ES to assess an alternative trajectory in air pollutant emissions to that which we have seen. This alternative trajectory can be consider to reflect a world avoided. In this world avoided, the significant levels of air pollution legislation imposed over the last three decades are simulated to not have come into effect in the contiguous United States and Western Europe. By combining the results of simulations of the world avoided with a base case present day atmosphere our model runs demonstrate that as a result of air pollution legislation, over 500,000 lives a year have been saved owing to reduction in sulfate aerosol and up to 10,000 as a result of improvements in ozone and NO_2 pollution. These results highlight the important role of legislation in reducing air pollution related mortality in these areas of the globe and highlight a compelling case for developing regions to follow.

 **Dr Alexander Archibald** **Department of Chemistry** **University of Cambridge, UK** **Email: ata27@ch.cam.ac.uk**	Alexander Archibald received his education and professional training in Chemistry at the University of Bristol before starting at the University of Cambridge in 2009 as a National Centre for Atmospheric Science postdoctoral fellow. He is currently a University Lecturer in the Department of Chemistry and theme leader and deputy director of the NERC ACSIS project (http://www.ncas.ac.uk/acsis). His group is interested in understanding the interactions between atmospheric composition and climate; from deep time to the near future and across spatial scales spanning global to local. For more information see: http://www. ch.cam.ac.uk/person/ata27.

Modelling Urban Vehicle Emissions

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Air pollution is a growing problem because of the increasing urban population causing high densities of motor vehicle traffic, greater electric power generation needs and expanding industrial and commercial needs. The high density of emissions release from urban centres have such a significant magnitude that a healthy air quality cannot be achieved by natural regeneration and scavenging processes only. A major problem related to urban air pollution is the urban transport system and its interaction with the city, as motor vehicles produce different emission under different conditions of speed, acceleration and idle. Against this background it becomes quiet important to predict air pollution caused by vehicular sources in urban areas. Most practical dispersion models assume inert pollutants, emissions from traffic exhaust are chemically reactive. Their dynamics are further complicated by atmospheric turbulence, geometry of buildings, thermal stratification and chemical kinetics, etc. Reactive flue gases, including nitrogen oxides (NO_x) and volatile organic compounds (VOCs), are among the most important pollutants that would cause a series of public health problems. They are known to be precursor of tropospheric ozone (O_3) which is a greenhouse gas (GHG) and photochemical reactive pollutants. Tropospheric ozone is also a major component of photochemical smog which has been a point of concern lately in urban cities like New Delhi, India. The dispersion and transportation of these pollutants is not only dependent on chemical precursors but also on meteorological parameters such as relative humidity, temperature, solar radiation, atmospheric boundary layer and wind speed and its direction etc. In addition, there is strong need for improved understanding of the dynamics of chemically reactive pollutants in urban areas too. For this, the weather research and forecasting (WRF) model which is a mesoscale numerical weather prediction system is used for predicting the photo-chemically reactive pollutants like O_3, NO_x, SO_2, and VOCs. In this presentation an attempt has been made to describe various air quality models following in deterministic, stochastic and numerical modelling domains and their applications in Indian urban scenarios.

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Professor Mukesh Khare is the Fellow of Institution of Engineers India and Fellow of Wessex Institute of Great Britain. He is a Chartered Engineer and was born in Varanasi, India. He obtained his Ph.D. degree in Faculty of Engineering from Newcastle University, UK and has managed a range of environmental projects throughout his professional career. With a specialization in air quality modelling, Prof. Khare’s experience has covered research and development studies, teaching, consulting, modelling, editorial activities. In addition, Prof. Khare has authored more than 150 research publications primarily for peer reviewed journals and conference proceedings. He has two sons and lives and work in Indian Institute of Technology Delhi, India. For More information see http://civil.iitd.ac.in/index.php?lmenuid=faculty
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Prediction and Examination of seasonal variation of Ozone with Meteorological parameter through artificial Neural Network at Neeri Nagpur, India

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Abstract

In this paper, seasonal relations and predictions of the Ozone (O_3) coupled with NO_2 and meteorology during one year in the study area. The O_3 show higher concentration in monsoon (30.03µg/m^3) and summer (27.06µg/m^3) while lower concentration in post-monsoon (18.97µg/m^3) and winter (13.72 µg/m^3) respectively. In the monsoon season, O_3 shown positive and negative correlation with temperature (T) (r=0.41) and relative humidity (RH) (r=-0.43) and Post-monsoon O_3 shown a negative correlation in with both T and RH (r= -0.48 and -0.46) respectively. While in winter and summer season ozone showed appositive correlation (r=0.028, 0.014 and r=0.52, 0.42) in both T and RH respectively. A comparison between three types of ANN (multilayer perceptron trained (MLP) with back propagation, radial basis functions (RBF) and generalized regression neural network (GRNN)) for short prediction of ozone are conclusively demonstrated. On the basis of the model's performance, the MLP back propagation model correlations have strongest than other models during. Analysis of long-term O_3 concentration trends indicates an increasing trend during the summer season and decreasing trends during the winter season. Performance assessment parameters considered in the study show that MLP proves to the best fit model for all season for predicting the concentration of ozone.

Keyword: Ozone, Temperature, Relative humidity, Multilayer Perceptron, Radial Basis Function and Generalized Regression neural network

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Studies on Treatment of Hotel Food Waste for Production of Bio-ethanol Using Pervaporation Technology

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Abstract:

The development of alternatives to fossil fuels like Bio-fuel is becoming increasingly urgent with the depletion of resources of fossil fuels and the steadily worsening state of our atmosphere and natural environment. The usage of bio-fuels is one possibility to decrease greenhouse gas emissions in the nearer future. Bio-ethanol can be used in fuels for vehicles without any modifications of the engines in concentrations up to 5 per cent, and even 10 per cent in newer engines. Different possible raw materials for the production of bio-ethanol have been studied during the last few decades. Food waste from restaurants and hotels is an increasing environmental problem, particularly in tourist areas. Food waste can be defined as any edible waste from food production and consumption. Food waste generated in India is rich in carbohydrate, as high as 65% of total solids due to its high proportion of cooked rice and cereals. With the use of fermentation & pervaporation technology this waste can be converted in to useful byproduct like bio-ethanol. Thus, utilization of hotel & restaurant food waste for bio-ethanol production can positively influence both the energy and environmental sustainability.

Keywords: air pollution, fossil fuels, bio-fuels, Food waste, bio-ethanol, pervaporation technology.

Application of Clean Air Scorecard Tool to Aurangabad City

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Worldwide air pollution has emerged as one of the grave threats to public health. Several Indian cities as Delhi, Gwalior, Raipur, Patna, Varanasi, Agra, Kanpur etc exceed PM2.5 levels by almost 20 times than WHO's permissible limits resulting in approximately 660,000 deaths in India in 2013. Managing India's air pollution requires a comprehensive national action plan complete with targets along with strict measures for reducing emissions from major polluting sectors. However, our cities face insufficient information on air quality management as air pollution data is not easily available resulting in poor public awareness and insufficient measures to reduce air pollution.

The CAST (Clean Air Scorecard Tool) was developed by Clean Air Asia, a flagship initiative of ADB to improve air quality management in Asian cities. In 2010, CAST was introduced to several Asian countries, to accelerate air quality management initiatives. CAST is an objective and comprehensive tool that, instead of judging and ranking cities based on air pollution alone, looks at existing capacity, policies, and measures as these are better indicators for their future levels of air pollution and greenhouse gas emissions. Aurangabad city of Maharashtra state was chosen for CAST Application as it is 5^{th} populous city in the state with air pollution a significant cause of concern, the city being an industrial hub. The tool was applied during October-November, 2016 data was gathered from the cities based on the questions under the three indices of the tool. After evaluating and summing up the results from all three indices, the scorecard gave an overall band of DEVELOPING to Aurangabad city implying that despite poor score for air quality and health index the city received better scores for clean air management capacity and clean air policies and action.

Through the pilot run, Aurangabad has been able to identify concrete measures to reduce air pollution. This city, for example, has found out it should prioritize roadside monitoring and ambient monitoring of PM2.5 and conduct studies on air pollution impact on health and other sectors (agricultural, tourism, and economic) among others.

Pt–Cu Intermetallic Nanoparticles with Ordered Structure for Catalytic CO Oxidation Reaction

Khobragade, Rohini, Nagar, Chand Laxmi, Rayalu, Sadhana, Labhsetwar, Nitin and Govindachetty Saravanan *
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Catalytic removal of carbon monoxide (CO) through oxidation from flue gases plays a pivotal role for the treatments of exhaust for automobiles, thermal plants, etc.[1,2] Platinum group metals (PGM) have been utilized efficiently for the catalytic oxidation of CO due to their superior activity, long-term catalytic performance, stability against poisoning moieties, etc. Localized resources and continuous increasing cost of PGM, however, would limit their usage for the future exhaust treatments. Therefore, there is an urge to find alternatives to PGM.[3] Mixed oxide, spinels, perovskites, etc. are anticipated as the alternatives to PGM, however they pose certain limitations in terms of activity, long-term performance, poor stability, etc.[4,5] Considering the limitations of both PGM and non-PGM, achieving of superior catalytic performance with a little amount of PGM finds the best replacement to the current PGM for the future exhaust treatments. Intermetallic phase of PGM with transition metals is one among promising options due to the difference in interatomic distance, electronic structure, *d*-band center, bi-functional mechanism, etc. to realize the superior catalytic activity with a lower amount of PGM for exhaust treatments.

Platinum (Pt)-based intermetallic nanoparticles (NPs) using abundantly available element copper (Cu) with an average particle size of 4-5 nm on γ-Al_2O_3 support were prepared successfully to reduce the consumption of Pt for the removal of CO through catalytic oxidation reaction from flue gases.[6] Intermetallic Pt_3Cu, PtCu, $PtCu_3$ NPs with a Pt loading weight of 5 wt.% were prepared on the γ-Al_2O_3 support by a simple wet impregnation method followed by calcination in H_2 environment. Despite the higher synthesis temperature of these intermetallic NPs, they are not agglomerated and form highly ordered intermetallic structure. Although the Pt-loading weight of these intermetallic NPs is same, Pt_3Cu NPs showed the stable and enhanced catalytic activity compared to the other intermetallic PtCu and $PtCu_3$ NPs. Pt_3Cu NPs showed the onset- and the maximum conversion- temperature at 50 and 125 °C, respectively. The intermetallic phase between Pt and Cu of Pt_3Cu NPs was not decomposed after catalytic CO oxidation but for PtCu and $PtCu_3$ NPs. Unlike PtCu and $PtCu_3$ NPs, the Pt_3Cu NPs were not agglomerated and they were finely dispersed even after catalytic CO oxidation. The reported synthesis method for achieving of the ordered intermetallic Pt-Cu systems with smaller size can be extended to the other order intermetallic systems that can find the other catalytic- and optical- related applications.

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Supported Intermetallic Pt-Fe Catalysts for Indoor Air Treatment

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The so called 'Emission Cocktail' (carbon monoxide (CO), volatile organic compounds (VOCs), particulate matter (PM) etc.) present inside homes, office buildings, and other stagnant spaces (e.g., indoors of vehicles and spacecraft) can have serious ill effects on human health. According to WHO, 4.3 million people die prematurely every year due to the exposure to indoor air pollutants. Platinum group metals (PGM) are traditionally used to scrub air through catalytic oxidation of CO, VOCs and other air pollutants to innocuous products. Due to localized mineral deposits and high cost of PGM, it becomes necessary to explore other cost effective catalytic materials. Additionally, it is required that these alternative materials are catalytically efficient at low or near room temperatures. Some of the most potential materials in this run for substitutes are based on morphologically modified PGM, transition metal oxides and intermetallics. Intermetallics are stoichiometric compounds between two or more metal elements having their own specific crystal structures which lend them unique physical and chemical properties. For catalytic applications, intermetallics that are nano sized and stabilized on appropriate support are desirable due to their enhanced catalytic activity, high dispersion, stability, etc. Alumina-supported, stable intermetallic compounds synthesized using Pt with abundant cheap metals like iron (Fe) and copper (Cu) are one such cost effective and viable alternative to PGM only catalysts.

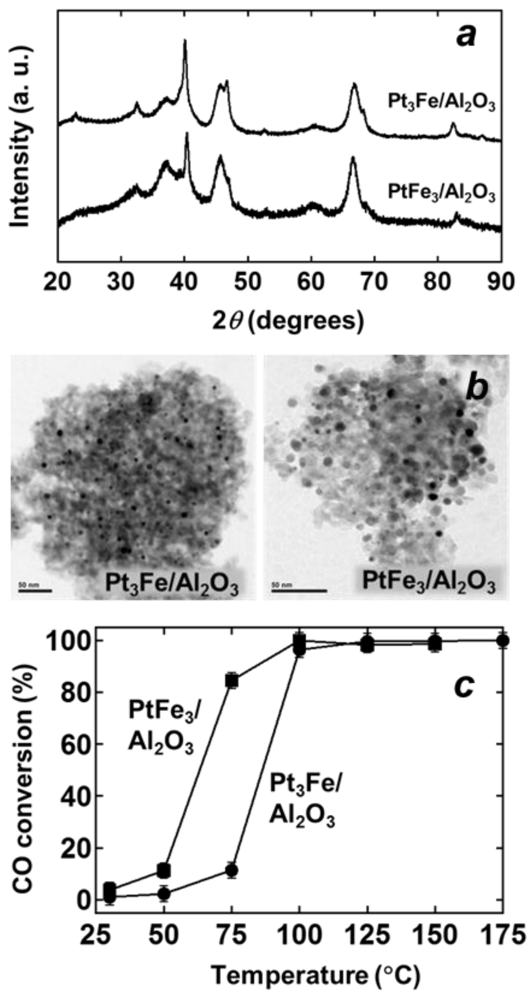

Figure 1: (*a*) X-ray diffraction profiles of Pt_3Fe/Al_2O_3 and $PtFe_3/Al_2O_3$. (*b*) TEM images of Pt_3Fe/Al_2O_3 and $PtFe_3/Al_2O_3$. (*c*) Comparison of catalytic CO oxidation performance of Pt_3Fe/Al_2O_3 and $PtFe_3/Al_2O_3$.

In this work, we synthesized and tested intermetallic Pt_3Fe and $PtFe_3$ on γ- Al_2O_3 with an average particle size in the order of ~ 5 nm for CO oxidation. These finely dispersed Pt-Fe systems on γ- Al_2O_3 showed good catalytic efficiency for CO oxidation when tested using state-of-the-art catalytic evaluation assembly (Figure 1). $PtFe_3/Al_2O_3$ showed superior catalytic activity with an onset temperature (~ 1% CO conversion) of 30 °C which is comparable to commercially available catalysts. This system was found to be exceptionally stable under repeat cycle evaluations. We are currently studying their efficiency for VOC abatement, which if found to be at par with PGM catalysts can make them a wholesome alternative to the same.

Keywords: Intermetallics, PtFe, Indoor air pollution, CO Oxidation, Al_2O_3 Support

Exceedance of SPM, RPM, SO_2 and NO_x for Six Cities of India

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Abstract:

Acute air pollution problem is being faced in urban agglomeration due to economic expansion, increase in population, increased industrial activities and exponential growth in automobiles. The air pollution from these sources is imposing threat to urban human health. The morbidity and mortality caused by air pollution result in long term reduction of productivity and ultimately in overall deterioration of economic condition. A comprehensive approach for designing policies and implementation of monitoring and management system is required to identify major sources of air pollution and subsequently restore air quality in major urban centers by corrective measures.

Due consideration has been given in this surveillance programme to the need of the country to have first-hand information on ambient air quality. The data may be useful to pinpoint major air pollution sources and implement control measures. CPCB presently monitors three pollutants at nearly 298 locations in India.

Four parameters namely RPM, SPM, NOx and SO_2 are regularly monitored at most locations mainly (Delhi, Kolkata, Chennai, Mumbai, Hyderabad and Nagpur). The data thus collected forms the base line data which has many applications and implications. Some obvious applications and APC NEERI's role in it are listed below.

1. long term study for pollutants will provided the methods and protocol of monitoring and analysis of new pollutants
2. long term study for pollutants will help Strengthening of air quality standards
3. long term study for pollutants will help Identification of sources of pollutants

Air Quality & Health Risk Assessment around Crematoria Emission Site Nagpur

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Abstract:

There are total 10 numbers of open pyre crematoria in Nagpur city spread in all the direction viz., Moksha dham Crematorium, Ambazari Crematorium, Gangabai Ghat Crematorium, etc

To study the status of ambient air quality and toxic gas emissions from and around the Crematoria, a detailed study of characterization was undertaken in source and immediate receptor of the crematoria. The source as well as ambient air quality monitoring was undertaken as per the CPCB norms using state of art samplers and health hazard quotient was estimated. A pilot reactive scrubber was installed and operated for 3 months in the crematoria and it was observed that its performance was more than 80% for particulates and gases. This has also improved the air quality in and around the pyre.

Mobile Emission Monitoring & Control Laboratory

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Abstract

Air Pollution is becoming a major area of health concern as many Indian cities are falling in the category of bad AQI Index (CPCB). The source emission control is necessary for efficient diagnostic study of air pollution in urban and rural areas. Emission monitoring and control in sources is hence needed in large scale. The development of a Mobile Emissions Monitoring and Control Laboratory capable of real time sampling, analysis and control of air pollution from sources through air pollution control studies in individual units is hence relevant and is developed by CSIR-NEERI, Nagpur. This unit is built in a chassis of Swaraj Mazda and is equipped with a number of innovative technologies that enhances the air monitoring capabilities. It is proposed to be deployed in and around Nagpur on special monitoring projects to provide instantaneous, onsite data directly relating to a multitude of air quality issues. CSIR- NEERI's first priority is to provide a more proactive approach to improving air quality of Nagpur and its nearby industrial areas by ensuring compliance to ambient air quality standards and identifying areas of concern before any serious problems arise.

Keywords: APC, Mobile emission