CHAPTER 11

Conclusions & Future work

11.1 Conclusions

Based on the detailed field and laboratory investigations, following conclusions have been drawn:

1. The highest annual average concentration of $PM_{2.5}$ was measured (81 μg m^{-3}) in the year 2017, and the lowest average annual concentration was measured (66 μg m^{-3}) in the year 2016 in Singrauli coalfield. These values are slightly higher than NAAQS.

2. The annual concentration of PM_{10} was varying from 178 μg m^{-3} to 230 μg m^{-3}. The highest and lowest value observed for PM_{10} in 2017 was 351 μg m^{-3} and 28 μg m^{-3}, respectively. This concentration value is higher than the recommended permissible limit (60 μg m^{-3}) in Singrauli coalfield.
3. The twenty–four hours PM_{10} concentrations in the industrial cum–residential area ranged from 32 μg m^{-3} to 351 μg m^{-3}, and it is higher than the national ambient air quality standard of India of 100 μg m^{-3}.
4. The value of the air quality index varied from 30 to 332. This indicates degradation in air quality in the area. However, moderate air quality (101-200) was observed for 47% of the total of two consecutive years (2016 & 2017) in the area.
5. The toxic metal concentrations (As, Pb, Ni) in particulate matter is well within the permissible limit.
6. The study area's enrichment factors indicate a high–value arsenic, lead, cadmium, cobalt, chromium, copper, mercury, nickel, selenium, and zinc. The enrichment factor confirmed an anthropogenic origin. The other elements (Ca, Mn, Na, Mg, K)

have lower than five enrichment factors due to concentration in a geological material, possibly due to the suspension of particles in the atmosphere.

7. The activity concentration ratios of $^{234}U/^{238}U$ range from 1.3 to 2.2 (1.8 ± 0.8) in PM_{10} and almost the same concentration observed in $PM_{2.5}$, and SPM [0.1 to 1.7 (1.4 ± 0.7), and 1.1 to 2.0 (1.3 ± 0.8)]. Hence, there is no risk of radioactive radiation.
8. The lifetime cancer risk value is 2.9E–04 due to particulate matter which is several orders lower than established by UNSCEAR. Hence, there may be no risk of cancer in the study area.
9. The principal component analysis result showed that the coal combustion contribution is ~30%, traffic–related emission ~25%, soil dust ~13%, biomass burning ~9%, and resuspended road dust ~7%. The remaining percentage (~16%) is unknown sources of the total particulate matter.
10. The primary role of coal combustion and traffic–related emission was also supported by statistical analysis (principal component analysis). The elements extracted in principal components significantly contributed by coal combustion and traffic–related emission.
11. The positive matrix factorization results showed that the contribution of the secondary inorganic aerosols (~15%), coal combustion and mining activity (~23%), traffic–related emission (~17%), resuspended road and soil dust (~16%), biomass burning (~12%), and mixed emission (~17%) are sources of particulate matter in the study area. Overall, it may be concluded that coal combustion, mining activity, and traffic–related emissions adversely affect nearby areas.
12. The laboratory experimental set up confirms encouraging findings. The effect of soap bubbles suppressing the $PM_{2.5}$, PM_{10}, and TSPM significantly.

13. Sodium palmitate effectively reduces TSPM at an experimental scale. The percentage of suppression in TSPM is ranging from 10 % to 35%.

11.2 Future work

Following investigation/study may be conducted in future:

1. Devices/dust arresters may be developed for point sources and non–point sources for controlling dust of finer sizes.
2. The ultrafine particles ($PM_{0.1}$) have a more deleterious effect as they can penetrate the alveolar region. Therefore, a study of ultra-fine particles should also be done to find their chemical characterization and exposure assessment.
3. Approaches should be made to determine the particulate matter's reactivity series to understand aerosol particles' formation.
4. For arrestation/suppression of dust, the polymer technology study should be conducted to suppress the dust on major dust producing sources.
5. The methods may be developed for source apportionment based on mineral clustering for industrial complex having mining operations.