



PARTICULATE MATTER EMISSION FROM LPG AND OTHER TYPES OF FUEL CONSUMPTION IN BANGALORE CITY

Habibulla¹, Prof. Sampat Kumar², Dr. C.S Bhaskar Dixit³

Abstract- Air pollution is the introduction of chemicals, particulate matter or biological material that causes adverse effect on human health and environment. Indoor air pollutants are the number of contaminants present inside the building by the source of smoke, fuel combustion, paints, etc. These pollutants release nitrogen oxide, particulate matters which harm the human health and surrounding environment. This is caused due to unsafe practice of utilization of sources. The present study has been undertaken to estimate the RSPM concentration in households using different types of fuels for cooking in Jayanagar, Bangalore. 15 locations were considered for the study out of which 10 locations for LPG use and 5 locations using other types of fuels. The study suggested that the concentration of these particles is very high in location where biomass is the main source of cooking. The indoor air quality concentrations were within limits for LPG. Thus, from the study we conclude that the occupants using other type of fuels have stronger effect on respiratory system as the RSPM concentration is high. The reason being incomplete combustion and improper ventilation provided inside the cooking area.

Keywords – Fuel, LPG, RSPM, PM2.5, Coal, Char coal, Wood, Firewood, Kerosene

1. INTRODUCTION

Approximately half of the world's population relies on biomass as source of fuels in most of the developing countries. Concentration of pollutants varies from home to home depending on the type of fuel used. We spend about 90% of our time indoors which leads to high risk to contaminants present indoor then outdoor pollutants ^{[1][2]}. Usually concentration of pollutants is higher indoor compared to outdoor pollution. In India there are about 0.24 billion households among them 0.1 billion still practice firewood, charcoal, coal, kerosene as source of household cooking. 41% of overall households still do not access LPG connections. Recent studies suggest that India has become the largest consumer of LPG in the world. Where in RSPM is the major source of air pollutant that has risen above the National Permissible Limit in most part of Bangalore. According to Indian scenario types of household fuels used contribute about LPG 28.8%, Wood 49%, Kerosene 2.9 %, Cow dung 8.9% and Coal or Charcoal about 1.5 %. As per the studies carried out the percentage distribution of PM2.5 compared to >PM11.2, PM11.2-2.5 and <PM 0.1 is firewood 56%, Coal 47%, Cow dung 82%, Kerosene 47% ^{[3][4]}.

2. MATERIALS AND METHODS

2.1 Study Area –

The present study was carried out in Bangalore, which is the capital of Indian State Karnataka. It is the third most populated city in India. Located in Southern India which is spread across an area of 709 km² and about 900 m above sea level. The present work mainly concentrated on household fuels used for cooking, according to the recent studies it is found that LPG is the main source of fuel in recent times therefore the concentration of Respirable Suspended Particulate Matter present indoor with use of LPG is considered for the study. Concentration of other type of household fuels was compared and average concentration is estimated. Bangalore is having 198 wards as per BBMP data which includes about 21, 01,831 households overall. Among 198 wards Jayanagar is considered for the study to estimate the concentration of particulate matter from household cooking. Jayanagar is the prime location in Bangalore, it comprises of 7 wards with 55,152 households where in 90% of population use LPG as the main source for cooking.

RSPM concentrations vary with different types of fuels used for household cooking. Among the four fuels considered cow dung gave maximum concentration where in LPG with lower concentration of RSPM. Figure 1 shows the concentration levels for four different types of fuels ^[5].

¹ PhD Scholar, Jain University, Bengaluru, India

² Prof & HOD, Department of Civil Engineering, BMS College of Engineering, Bengaluru, India

³ Professor, Centre for Disaster mitigation, Jain University, Bengaluru, India.

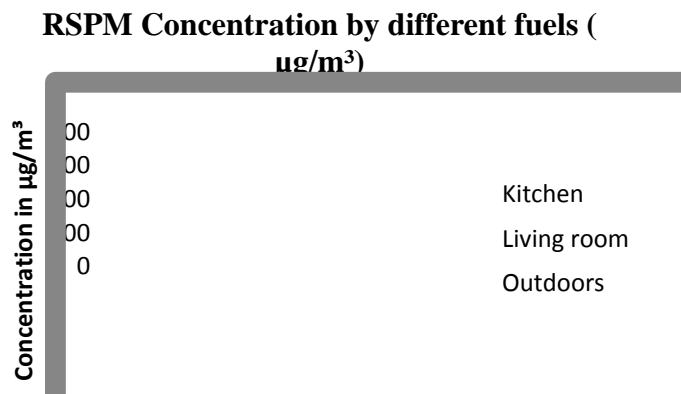


Figure 1. RSPM concentration by different fuels ($\mu\text{g}/\text{m}^3$)

The concentration of RSPM differs based on the kitchen configuration i.e. indoor variations with sufficient ventilation results in faster dispersion of particles then with kitchens with poor ventilation. Graphical representation of impact of kitchen design on RSPM concentration is shown below [5].

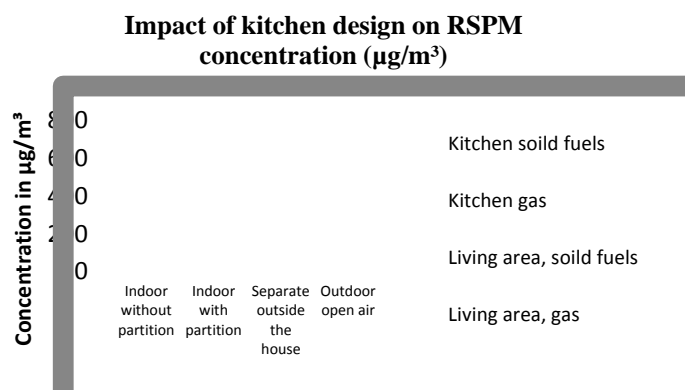


Figure 2. Impact of Kitchen design on RSPM concentration ($\mu\text{g}/\text{m}^3$)

2.2 Methodology –

Sampling was done considering 10 locations in Jayanagar. The study was carried out during two seasons i.e. during summer and winter and the samples were collected before and after cooking to compare the percentage of emission of pollutant and concentration variation of PM2.5 from the household activity. Personal Air Sampler was used to estimate the RSPM concentration.

This device accurately measures air quality. It has a built-in fan to quickly draw in ambient air to allow real time measurement. The time is fixed for sampling for about two to three hours. The initial concentration and final concentration is calculated using the following formula:

Concentration of Particulate Matter,

$$C = \frac{[\text{Final weight of filter paper}] - [\text{Initial weight}]}{\text{Volume of air sampled}}$$

$$V = \frac{[Q/1000] * T}{1000}$$

Where, T = time in hours

Q = flow rate in m^3/min [6][7]

LPG is considered as clear fuel as it does not produce detectable emission some gaseous pollutants like nitrogen oxide (NOx), CO and organic compounds produced are as small amount of SO2 and particulate matter [8].

Table -1 Experiment Result

Pollutants	Butane Emission factor (kg/m3)	Propane Emission factor (kg/m3)
	Commercial	Commercial
PM, filterable	23.96	23.96
PM, Condensable	71.89	59.91
PM, total	95.86	83.87

Total number of households in Jayanagar is estimated to be around 55152. Assuming 98% households using LPG as source of fuel and remaining 2 % occupant’s other fuels as source of cooking. Average weight of cylinder is 14.5 Kg hence considering 6, 48,588 LPG cylinders utilized by the residents per year consuming 9404.52 MT/Annum LPG.

3. RESULT AND DISCUSSION

As per the study carried out it was found that the emission of RSPM concentration with biomass fuels is higher compared to concentration of RSPM with the use of LPG. The reason behind the increase in concentration is low combustion temperature which leads to incomplete combustion and no proper ventilation provided for the particulates to disperse into the environment. The studies also suggest that the concentration of indoor pollutant during winter season may be much higher compared to summers where in sufficient ventilation is provided. According WHO the permissible limit for RSPM is $35\mu\text{g}/\text{m}^3$ [9].

3.1 RSPM Concentration During Summer –

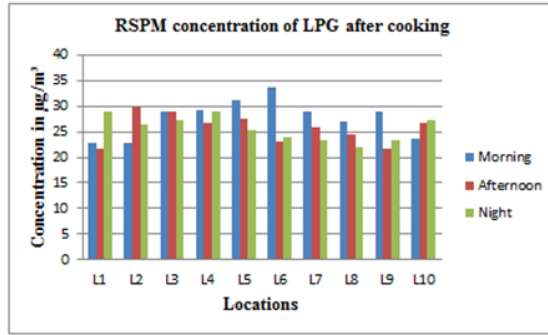
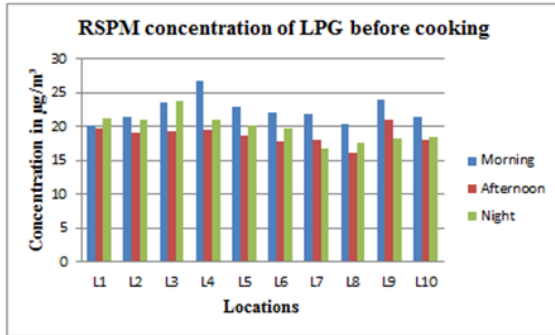


Figure 3. RSPM concentration of LPG before cooking

Figure 4. RSPM concentration of LPG after cooking

Figure 3 and 4 illustrates the concentration of RSPM during summer with LPG as source of cooking. The figure represents the concentrations during this season are well within the prescribed limits by WHO.

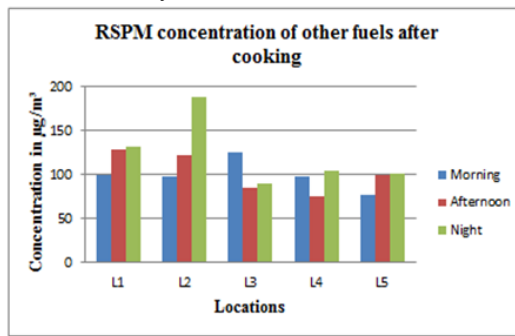
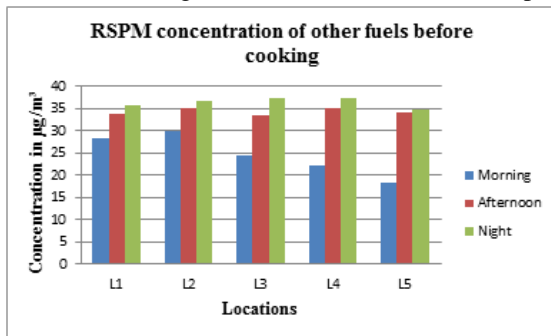


Figure 5. RSPM concentration of other fuels before cooking.

Figure 6. RSPM concentration of other fuels after cooking.

Figure 5 and 6 represents concentration variation with time. The concentration with use of other fuels is much higher compared to LPG. It also represents the concentration levels are higher than the prescribed limits. This is due to improper combustion of fuel.

3.2 RSPM Concentration During Winter –

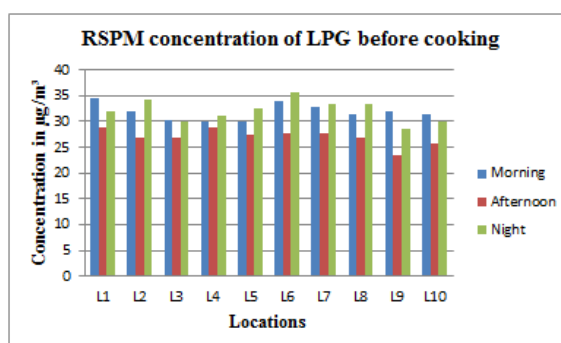
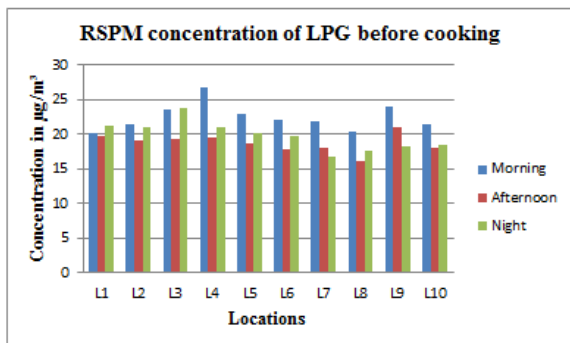


Figure 7. RSPM concentration of LPG before cooking

Figure 8. RSPM concentration of LPG after cooking

Figure 7 and 9 illustrates the concentration of LPG used in different locations of Jayanagar during winter season. The concentrations are within limits, but the concentration is little high as compared to summer due to improper ventilation during winters.

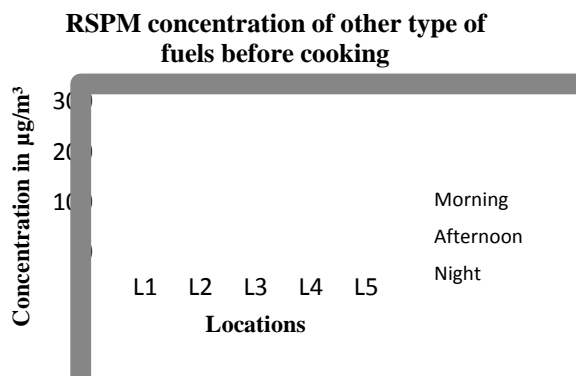


Figure 9. RSPM concentration of other type fuels before cooking

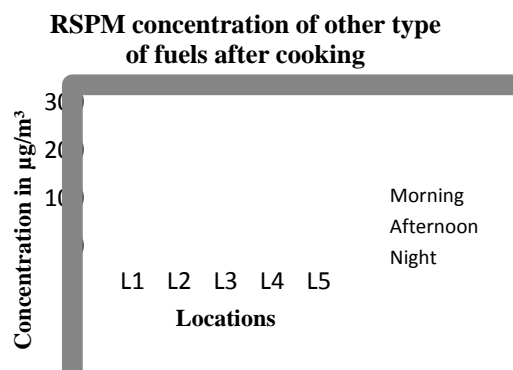


Figure 10. RSPM concentration of other type of fuels after cooking

Figure 9 and 10 illustrates the concentration level of particulate matter for other type of fuels. The graph represents higher variation in the concentration during winters as the reason of poor ventilation and improper combustion. The results are much higher during winter as compared to summer.

4. CONCLUSION

The present work was carried out to study the concentration variation of RSPM of household fuels. The following conclusions can be drawn from the present study and results carried on concentration level of RSPM:

1. The concentration levels during summer were within the limits for LPG and bit higher during winter due improper ventilation.
2. The concentration levels were higher for other type of fuels both during summer and winter.
3. The study showed that the concentration varies with type of fuel used.
4. It showed more concentration with biomass fuels compared to LPG.
5. From the study we can conclude about 98% population use modern way of cooking in the area choice for studies. It showed more concentration with biomass fuels compared to LPG.
6. Hence one can conclude that the concentration of RSPM is low indoor without having much effect on health.

5. REFERENCES

- [1] World Health Organization, 2015. WHO guidelines for indoor air quality: household fuel combustion. World Health Organization.
- [2] Balakrishnan, K., Mehta, S., Kumar, P., Ramaswamy, P., Sambandam, S., Kumar, K.S. and Smith, K.R., 2004. Indoor air pollution associated with household fuel use in India. An exposure assessment and modeling exercise in rural districts of Andhra Pradesh, India, p.114.
- [3] Priyanka Kulshreshtha, Mukesh Khare, "Indoor exploratory analysis of gaseous pollutants and Respirable particulate matter at residential homes of Delhi, India", Atmospheric Pollution Research 2 (2011) 337-350.
- [4] https://www.researchgate.net/figure/Percentage-distribution-of-particulate-matter-in-different-size-fractions-for-commonly_fig2_266679530.
- [5] Access of the Poor to Clean Household Fuels in India (cleancookstoves.org/resources_files/access-of-the-poor-to-clean.pdf).
- [6] Shilpa B S, K S Lokesh, "SEM Characterization Of Respirable Suspended Particulate Matter (RSPM) Emitted From Cow dung Cakes And Coal Fuels In Different Households", International Journal of Advance in Science Engineering and Technology, Vol – 4, Iss -3, Spl. Issue 2, 2016.
- [7] Shilpa B S, K S Lokesh, "Exposure Assessment And Morphological Study Of Respirable Suspended Particulate Matter (RSPM) Emitted From Household Fuels", International Journal of Science, Engineering and Technology, Vol 2, Issue 8, 2014.
- [8] Emission factor for LPG combustion.pdf, External Combustion Source, 07/08 pg.: 1.5-1 to 1.5-4.
- [9] Chafe, Z.A., Brauer, M., Klimont, Z., Van Dingenen, R., Mehta, S., Rao, S., Riahi, K., Dentener, F. and Smith, K.R., 2014. Household cooking with solid fuels contributes to ambient PM_{2.5} air pollution and the burden of disease. Environmental health perspectives, 122(12), p.1314.