GLOBAL ENVIRONMENTAL FACILITY (GEF/SGP)

Project to introduce new technologies
to the communities to minimize emission of green house gases
when burning firewood for cooking

Report on the Measuring of Emissions in Kitchens Prior to Improvement and After Improvement

Prepared by

Darshanamala Dissanayake

Project Engineer

Submitted by

Integrated Development Association (IDEA)

Galmaduwawatte Road

Kundasale

August 2008

Contents

Chapter	*page*
1. Introduction	1
2. Methodology	4
3. Results	6
4. Conclusions	12
5. References	13

Abbreviations

ARECOP	Asia Regional Cook stove programme
CO_2	Carbon Dioxide
GEF	Global Environmental facility
IDEA	Integrated Development Association
KIP	Kitchen Improvement Programme
LPG	Liquid Petroleum Gas
mg/m3	milligrams per meter cube
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter in the diameter less than 2.5 micrometers
ppm	parts per million
UCB	University of California Berkeley
UNDP	United Nations Development Programme
WHO	World Health Organization

Introduction

Today in the world, more than half of the population use solid fuels range from coal to dung, for their daily requirements and cooking is on the top most priorities. The situation of Sri Lanka is almost same instead we do not use solid fuels like dung and some of the crop residues. Also much of these fuels are burnt in unimproved stoves like three stone fires or traditional stoves leading to high level of indoor air pollution.

In simply air pollution is the presence of gases or the trace gases anything other than acceptable levels creating discomfort to any kind of a living being. Both the levels and the source of pollution may be different from place to place and time to time. Indoor air pollution and out door air pollution is two different phenomena of air pollution. The sources may be not only the industries and vehicles, but also the carpets, curtains, pets and etc in our houses. Since an average people would spend 90% of his or her time in indoors and indoors are 2 to 10 times more hazard than outdoors; indoor air pollution must be taken into consideration.

According to the estimations of the world health organization (WHO), 1.5 million people die prematurely each year from the exposure to indoor air smoke and it is ranked in the fourth in the list of serious threats in less developing countries after malnutrition, unsafe sex and unsafe water [1]. Women and children face the greatest risks because the majority of these deaths are children below 5 years of age and women. The reason is that the women spent most of her time in kitchens who accompanied her children with her and therefore inhaling polluted air is unavoidable. Also there are other health problems associated with the kitchen smoke even though they are not lethal. These consequences include acute lower respiratory tract infections and pneumonia. Prolonged exposures can cause chronic bronchitis, chronic obstructive pulmonary disease, asthma, upper airway cancers, cardiovascular disease, pulmonary arterial hypertension, cataracts, low birth weight, and prenatal mortality (stillbirths and deaths during the first week of life) [2]. This means that not only people would die from the indoor air pollution but also they became lifelong patents who have to suffer for a long.

With the social background, knowledge and awareness and also with the affordability, people tend to use cleaner fuels which are on the top of the energy ladder. LPG and electricity are two common examples. Not like in the past, today even the biomass is not free. Even though it is free for some people, it takes time to collect, chop

and dry the firewood. On the other hand inefficient use of fuels increases the fuel usage which automatically increases the cost and the time spending on it. This again increases the burden on women because collection of firewood is another extensive task laden on her back.

In the global scenario green house effect and global worming is highly conversational issue today. Even though biomass is a renewable source of energy, fuel combustion is a major cause for global warming where as emission of carbon dioxide which is a green house gas is unavoidable. In the same time we cannot stop green house gas emission by stop burning of firewood because the degradation of biomass would emit methane which is 21 times more dangerous green house gas than carbon dioxide. But with the effective use of firewood can lead to use lesser amount of firewood and there by reducing the number trees cut down. That is, it reduces the emission of CO_2 and in the same time existing trees will absorb the CO_2 present in the atmosphere for the photosynthesis process.

The Project background

Even in a small scale thousands of people would lead to a healthier life if their exposure to lethal levels of smoke are reduced. The most effective way to reduce smoke in the home is to switch to cleaner fuels including LPG, bio gas, electricity and solar which are on the top of the energy ladder. But there are several limitations and barriers for it.

The cost of crude oil is sky scraping today. Therefore petroleum products are not affordable for the majority of people of the country. Even it is affordable, they are non renewable sources which would be fully extracted with in next 50-60 years of time. When considering the electrical power, about 60% of it is generated in thermal power plants by diesel burning. Then the hope for electricity is also a miracle after few years. Although solar and biogas are renewable sources of energies they are not well popularized because of their high capital investments, inconvenience, lack of technical expertise and also the ever reluctant mindsets of people to try out new things. Therefore the only hope is biomass which is renewable, affordable, and convenient which would not require high level of expertise.

Cooking with biomass is not a very big task whereas woman can place three stones on the ground, the pot above it and lit up the fire and cook. This is simple but it consumes more firewood, more time and emits more harmful pollutants. In the same time woman can use an improved stove and cook under a chimney while consuming less amount of firewood, time and with low harmful pollutants. From this project IDEA introduces new affordable, convenient and simple technologies to the people to use biomass in an effective and efficient way which would reduce both biomass usage and harmful emissions. This has a big economical impact because it will save both the money they spent on fuels and the bills paid to doctors. On the other hand firewood saving will save the time spent on collection of firewood. This is a big social impact because the housewives can use that time for other income generation activity or to rest.

Carbon dioxide emissions will be reduced with the reduction of fuel use. Therefore switching from unimproved stove to improved stove will automatically reduce the green house gas emissions and the contribution to global warming.

In a rural kitchen woman walks more than 4km per day while she is cooking. This is because none planned arrangement of the kitchen setting. Also most of the kitchens are not clean and hygienic. The kitchen improvement programme is one major outcome under the project which has a big impact on the above problems. The basic idea is to provide ventilation, improved stove and also planed arrangement of accessories. With this task women are encouraged to use their spare time (both available and also the time saved by cooking in an improved kitchen) on income generation activities and there by upgrade the living standards of them.

The other main idea of the project is to measure the indoor air quality. Although there are several parameters to be checked, depending on the available resources we selected two main parameters which are directly affecting the health. They are carbon dioxide and respirable particulate matter less than 2.5 μm in its diameter. For this we purchased four UCB PM monitors and two HOBO CO loggers. The funds were provided by the GEF/SGP where as the equipments were purchased by ARECOP from the University of California, Berkley; on behalf of IDEA. Also training on how to use those equipments was provided by ARECOP in Vietnam.

Methodology

Phase 1

1 Two basic components mainly affecting to the indoor air quality were selected. They are

type of the cook stove – whether improved or traditional and

chimney – whether available or not.

2 From the above components four different kitchen combinations were identified as improved stove and a chimney (K1), improved stove without a chimney (K2), unimproved stove and a chimney (K3) and unimproved stove without chimney (K4).

3 For each combination a group of households were selected and exposure levels were measured for a period of 24 hours for each house. The selected pollutants were carbon monoxide (CO) and particulate matter less than 2.5µm diameter ($PM_{2.5}$).

4 The averages of each parameter were calculated and check whether there is a change in the indoor air quality with the different combination. If there is a change in the indoor air quality the best possible combination was selected for the kitchen improvement programme.

Phase 2

1. A group of needy people with unimproved kitchens were Identified which can be modified and improved the status.

2. Obtained the baseline data of exposure levels, firewood consumption, time, ease of cooking and etc of the selected kitchens.

3. Kitchens were improved by providing an improved stove, chimney, ventilation and other necessary accessories.

4. The exposure levels of the kitchens were measured and check whether there is an improvement of the quality of the life.

UCB Particulate Matter Monitor and HOBO CO Logger

Fixing the Measuring Equipment in a Kitchen

Results

Results obtained in the phase 1

Table 1: Exposure levels of the K1 type kitchens

Household number	CO exposure level (ppm)	$PM_{2.5}$ Exposure level (mg/m^3)
1	0.200	0.083
2	0.200	0.056
3	0.200	0.079
4	0.240	0.079
5	0.300	0.087
Average	0.228	0.077

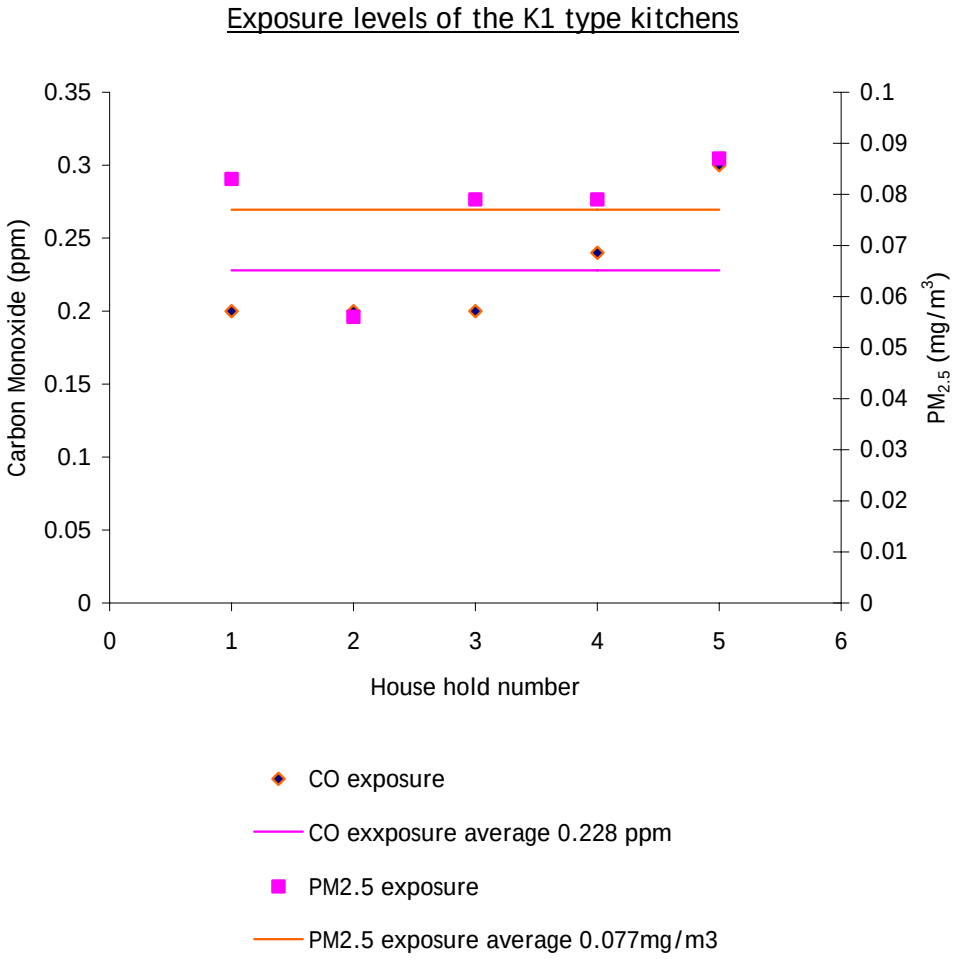


Table 2: Exposure levels of the K2 type kitchens

Household number	CO exposure level (ppm)	$PM_{2.5}$ Exposure level (mg/m^3)
1	0.22	7.43
2	5.4	0.230
3	1.5	1.284
4	5.9	0.352
5	1.52	0.073
Average	2.908	1.874

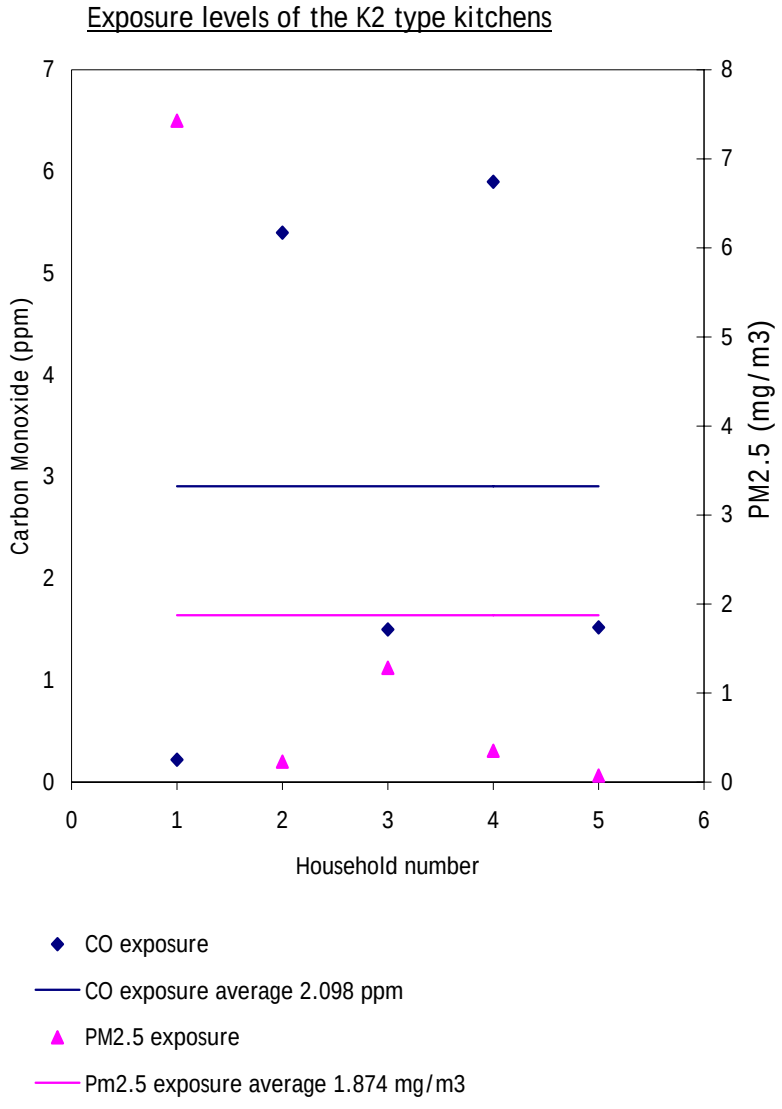


Table 3: Exposure levels of the K3 type kitchens

Household number	CO exposure level (ppm)	$PM_{2.5}$ Exposure level (mg/m^3)
1	1.7	4.33
2	1.26	0.246
3	0.3	0.059
4	1.1	0.216
5	1.3	4.34
Average	1.132	1.838

Exposure levels of the K3 type kitchens

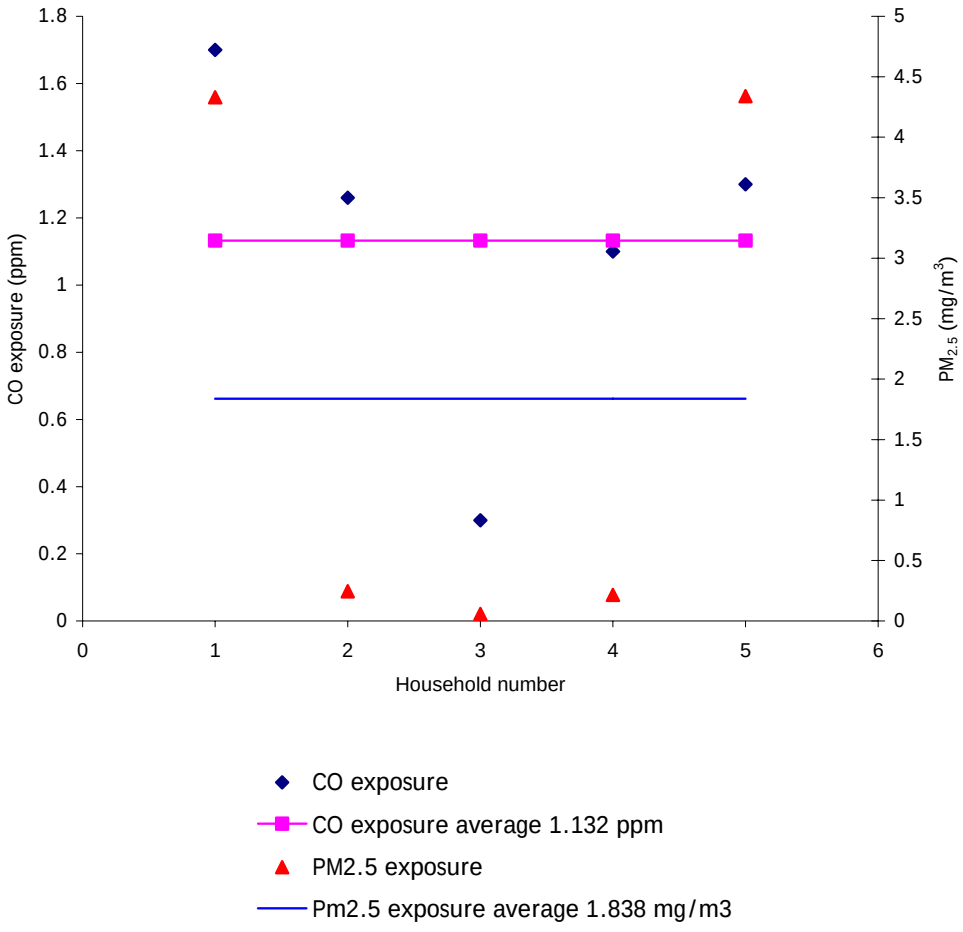
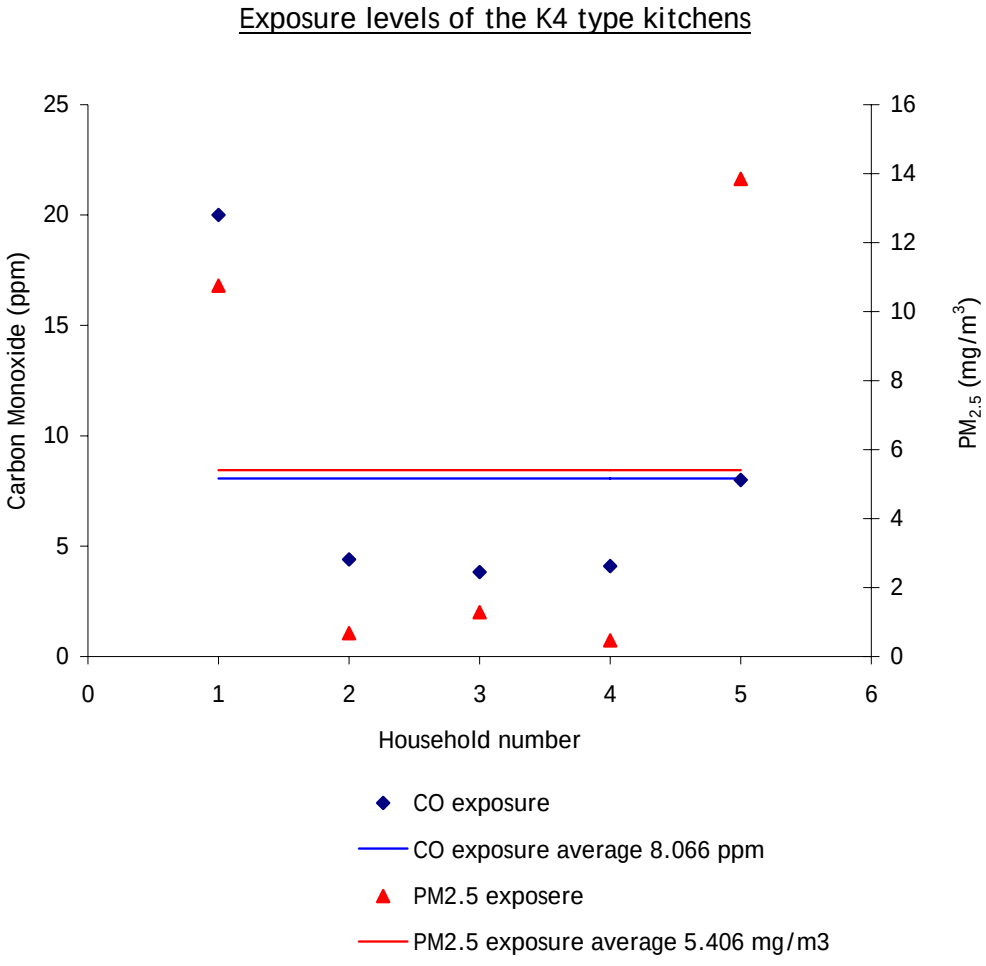
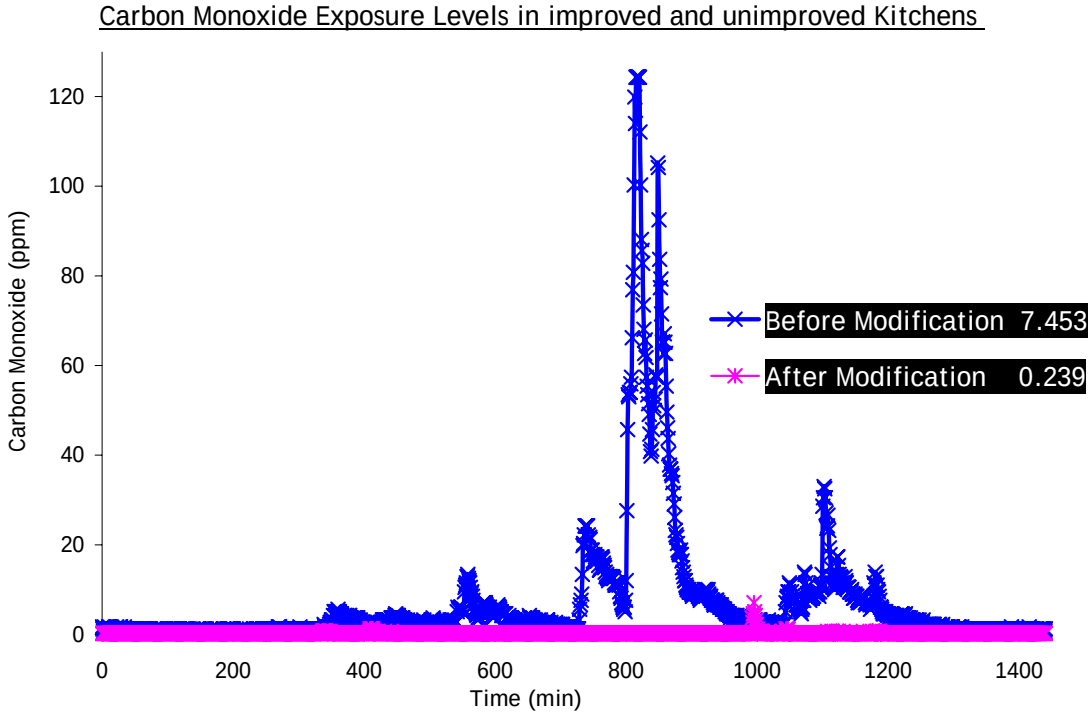


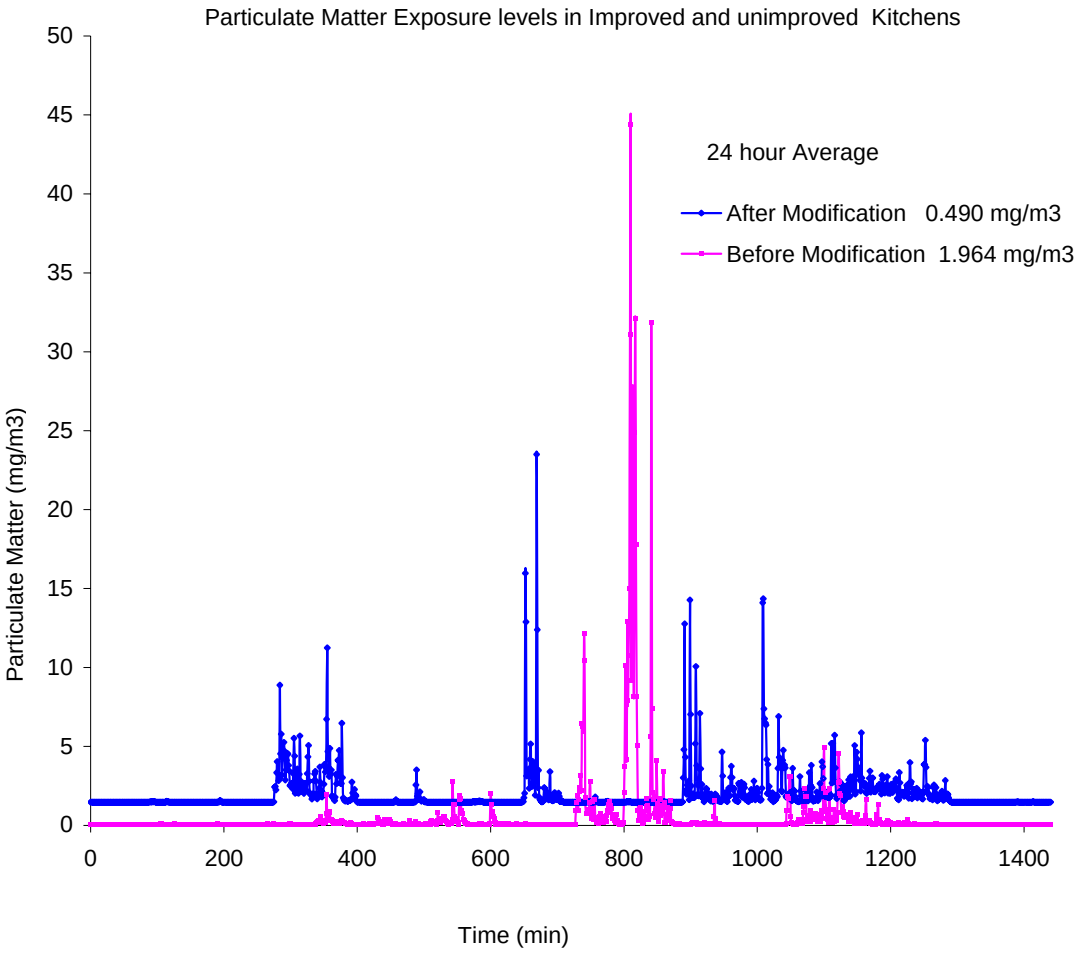
Table 4: Exposure levels of the K4 type kitchens

Household number	CO exposure level (ppm)	$PM_{2.5}$ Exposure level (mg/m^3)
1	20.000	10.750
2	4.400	0.678
3	3.830	1.284
4	4.100	0.468
5	8.000	13.850
Average	8.066	5.406



Results obtained in phase 2




Particulate Matter Exposure levels in Improved and unimproved Kitchens
24 hour Average
After Modification 0.490 mg/m3
Before Modification 1.964 mg/m3
Particulate Matter (mg/m3)
Time (min)
0
5
10
15
20
25
30
35
40
45
50
0
200
400
600
800
1000
1200
1400

References

1. www.PCIAonline.org
2. www.medscape.com/viewarticle/572069