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Monitoring Air Quality on Crop Residue Burning in Fields*

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Introduction

Burning is a chemical process through which a material rapidly reacts with the oxygen of the atmosphere. Burning involves ignition, flaming (burning and smoking with flame), and smoldering (burning cum smoking without flames). All these processes produce heat, light and smoke (a mixture of particulates and gases). These processes produce significant impact on local environment critically by altering Physics and Chemistry of the atmosphere.

Crop residue burning results in the emission of many a toxic pollutants. The list of major pollutants is given in Table 1, wherein the names of pollutants emitted, their source and their transport properties are listed. These emissions can travel long distances affecting thereby the entire region. In this list carbon dioxide and sulphur dioxide gases have not been listed since their yield is not critical. Due to these emissions the air quality of the region worsens, which results in nose and throat itching and burning, and irritation of the airway tract. These emissions change pH of fog and rainwater. They can also alter the thermic balance of the atmosphere, which can have impact on solar irradiation.

Pollutants produced on burning crop residues in open fields can have several other direct and indirect adverse effects as follows:

- Soil organic carbon lost in the burning done in the fields results in poor yield of next crop;
- Air pollutants produced have a severe impact on the health of the available crops in the area, affecting quality and quantity of the product;
- Blocks A and B ultraviolet rays and thus can cause chronic health problems;
- Can cause increase in the photogenic microorganisms in air and water. This helps to increase the production of larvae of mosquitoes, which are hosts to many deadly diseases;
- Haze is developed in the atmosphere, which spoils natural scenic beauty of the area, as also it has severe impact on health;
- The toxic biomass smoke gets absorbed in the eye lenses and causes oxidative damage resulting in cataract; and
- Emissions can have, though in lesser quantity than other pollutants, cancerous organic compounds like PAHs (mostly Benzopyrene, Formaldehyde, and Benzene).

Assessment

In crop residue burning, there is no stack, no vent or duct or exhaust pipe. Thus all emissions are fugitive. Smoke escapes in open field burning through unplanned exit passages in the downwind direction essentially uncontrolled. These fugitive emission loads, even from one field, can be quite large. Their assessment is needed in g/s.m^2 or kg/hr.m^2 or in g/operation.m^2.

To assess the quantity of pollutants escaping into the atmosphere, data is required of the velocity of escaping plume, the area of cross-section of the escaping plume, and the average concentration of pollutants in the escaping plume. Since velocity and concentration of the escaping plume may vary from point to point, gridding of the cross-sectional area is required and concentration of the major and critical pollutants may be measured at several points to work out the average emission load of each pollutant. Although emissions are continuous during the burning period but their concentration can vary depending upon the stage of burning. Based on these assessed emission loads, control management strategy can be worked out to reduce emissions and ultimately their impact.

For true assessment, samples need to be collected at the different stages of burning i.e., ignition, flaming and smoldering. Sample period is required to be decided based on the stage of the burning process. Sampling is required in the downwind direction on grid points depending upon the cross-sectional area of the smoke plume and the wind speed. Monitoring is necessary at two heights to adequately cover the entire cross-section of the plume (vertical) as shown in Fig.1.

Paper presented in the workshop on Agricultural Waste Burning held at PAU, Ludhiana on 29/07/2006

Table 1 LIST OF MAJOR POLLUTANTS EMITTED DURING CROP RESIDUE BURNING

Category	Pollutants	Source	Notes
Particulates	SPM (PM100)	Incomplete combustion of in organic material Veg. fragments ashes, soil, particles on burnt soot.	Course fraction do not travel long distance contain ashes and soil dust
	RPM(PM10) FPM PM 2.5	Condensation after combustion of gases and incomplete composition of orifice matter	Tpt. upto great distance have greater impact
Gases	CO	*Incomplete combustion of organic matter*	*Tpt up to great distance*
	NO_2 N_2O	Oxidation of N_2 in air at high temp	Reactive species concence deercase with distance
	O_3	Secondary Pollutant , form due to Nitrogen Oxide and Hydrocarbon	Tpt over great distance
	Formaldehyde	Due to incomplete combustion	Low concentration have great impact
	CH_4/Benzen	Ineaplete combusting organic material	Even low concentration cause serious damage
	PAHs	Incomplete combustion of organic matter Mostly Benzopyrene	Even low concentration cause serious damage

SELECTION OF MONITORING SITE

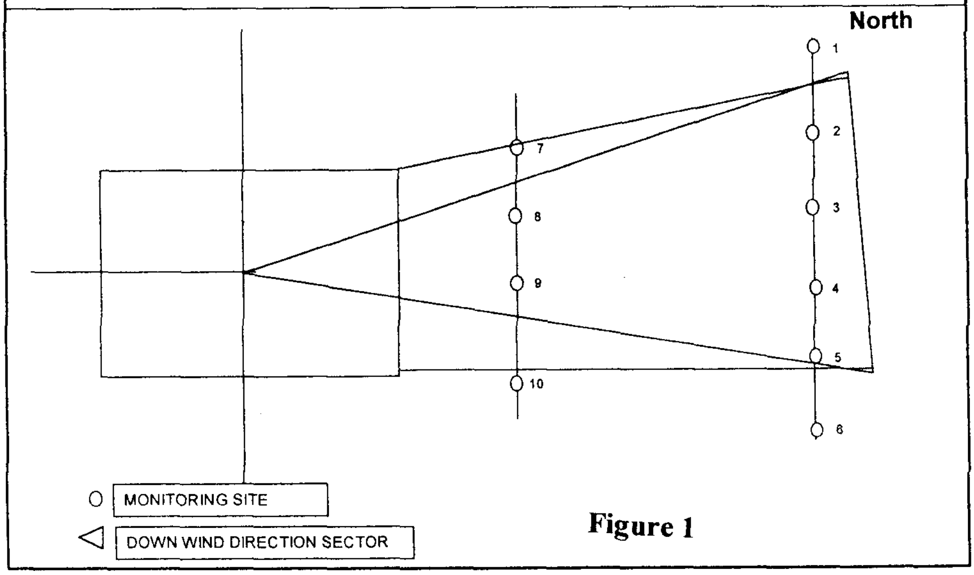

Figure 1

Assessment of Fugitive Escape

Location: **Sai Petrol Pump Okhla Industrial Area Phase-1, New Delhi -20**

Benzene

DATED 17 .12 .2004

Monitored at 3 locations at 0.5 m above the ground in the length of 85 meter.

	Site 1	Site 2	Site 3
Benzene	93µg/m³	127µg/m³	68µg/m³
Velocity	0.6m/sec.	0.8 m/sec	0.7 m/sec

Average Concentration = 96 µg/m³

Average Velocity = 0.7 m/sec

- **Area of cross section for release of emissions**
  = Length x Height
  = 85m x 3m
  = 255 m²
- **Volume of Air Passed** = 255 x 0.7 m/sc=178.5m³ /sec
  = 178.5 m³ /sec.
- **Fugitive Escape of Benzene** = 178.5 m³ / sec. x 96 µg/m³
  = 17136 µg/sec.
  = 17.14 mg/sec.
  = 61.70 gm/hr.

Figure 2

Assessment of Fugitive Escape

(A) Kitchen

Average Concentration of Pollution HC (as Benzene)
=3.45 PPM or 10.7 mg/m³

Size of Window = 0.30 x0.60 m

Measured Average Velocity = 2.0 m/s

Area of Cross-section=0.3 x 0.6 = 0.18 m²

Volume of Air Escaping Kitchen = 0.18m² x 2.0 m/s

Fugitive Escape =10.7 mg/m³ x 0.36 m³/sc
= 3.852 mg/ sec.
Or = 13867.2 mg/hr.
= 13.872 gm/hr.

Figure 3

- The list of instruments that would be required for assessment, are as follows:
- Profiler for fugitive emission monitoring;
- Respirable Dust Sampler and Fine Particulate Sampler;
- Digital CO Monitor;
- Digital Ozone Monitor;
- Thermoelectrically cooled Gases Monitor for NO_2 and N_2O;
- Total Hydrocarbon Analyser / Sampler;
- Ambient Digital Temperature Monitor (portable);
- Digital Wind Speed Monitor (portable);
- Auxiliary Power Generator System with adequate cable and exhaust system;
- Besides the above, one Weather Monitoring Station needs to be set up in the area for the continuous measurement of wind speed, wind direction, temperature, relative humidity, and solar radiation; and
- Online monitoring station also need to be set up in the area to understand short term impact of burning activities on air quality for quick management or control of the emissions like Particulates (PM10 and PM2.5), CO and Oxides of Nitrogen.
- A sample of the assessment of the fugitive escapes is given in Figs. 2 & 3 and the Flow Sheet is given in Fig.4.

Recommendations

- Detailed assessment needs to be done to work out emission loads in $gm/m^2.sec$;
- A study on impact of burning needs to be done on soils to know the physical and chemical changes taking place due to burning;
- Crop residue need not be burnt in fields. If these are composted, the manure so produced shall result in increase of crop yield on mixing with soil;
- Crop residue can be burnt for household cooking. This will result in significant energy saving; and
- Crop residue can also be used for paper and packing material manufacturing.