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Effect of Yagya on the Gaseous Pollutants

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Abstract

'Yagya,' a Vedic procedure of burning some herbs in fire along with some rituals, is known for purification of atmospheric pollution through removal of foul odour, lowering of harmful gas levels and removal of harmful microbes. In this paper an attempt is made to study the effect of 'Yagya' on the gaseous pollutants like SO₂ and NO₂, in the atmosphere. For this purpose two experiments of Yagya were conducted in collaboration with the Envirotech Instruments Ltd. and Central Pollution Control Board, Delhi, at an interval of one year in the open air, in New Delhi. The air was sampled one day before the experiment for the background, on the day of experiment and then a day after the first experiment and till two days after the second experiment. The results of both the experiments show a decrease in the concentration of both the gases on the day of Yagya as well as the days after, in comparison with the background.

Introduction

Combustion is the dominant cause of gaseous air pollution. The various sources emit, to a large extent, the same pollutants, but only in varying proportions. In the design of cost effective abatement strategies [1], it is realized that the relations between emissions and resulting concentrations are by no means simple. The emitted gases eventually get dispersed in the atmosphere. This dispersion depends on meteorological parameters such as wind speed, humidity, temperature etc. Measurements and dispersion calculations [2] have shown that wind direction is also important in this respect.

During dispersion pollutants react chemically [3] and form intermediate and final products. In urban areas reactions between nitrogen oxides, organic compounds and ozone are of most importance. In most parts of the world, photochemical smog with the formation of ozone and other oxidants is observed with distinctly different patterns. Delhi experiences smog usually during winter. It has been reported that smog was the worst during the winter of 1998. Thereafter, however, due to the change in emission norms and other measures taken by the Government of India, it has not been so bad.

To study the effect of *Yagya*^d, a Vedic ritual, on the gaseous pollutants, on the atmospheric pollution, two experiments were conducted in Feb. 2004 and Feb. 2005. The procedure of *Yagya* [4], consists of burning of some herbs along with 'Ghee' and wood at specific intervals, while Mantras are also chanted. Thus there is combustion involved in the process which implies emission of gases like NO₂, CO₂ and Hydrocarbon compounds. However this is performed in such a way that combustion is almost full. [Needful precautions are taken while performing *Yagya* to ensure minimum emission of polluting gases. Pt. Shri Ram Sharma Acharya has brought these out in detail in the two encyclopedia volumes on *Yagya* [5,6].

Products of Combustion

Chemical reactions and Science of Yagya is an area that has not been scientifically explored. Some attempts have been made [7],[8],[9] by few individuals and organizations to find out the scientific basis of *Yagya* but the efforts are limited. At the outset, it can be said that the interpretation of the process of combustion in a *Yagya* is rather difficult in physical scientific terms due to the following reasons:

- i) The properties of substances which are used are vastly variable;
- ii) The conditions under which combustion takes place remain unspecified. The products of combustion depend on the following factors like –
 - *The nature of substances used and their proportions;
 - *Temperature attained;
 - *Controlled supply of air and
 - *Interaction amongst the various products formed.

As compared to the above conditions of combustion, the process of combustion [8] in a *Yagya* consists of the following:

Vaporization of wood

Besides complete combustion of cellulose material of wood, it is also subjected to vaporization. This happens due to the way *Samidhas*^e are arranged in the vessel or *kunda/agnikunda*^d, and the conditions of temperature and air supply which prevail in it.

Steam Volatilization of Odorous Substances

The temperature attained in the *Kunda* varies between 250°C and 600°C, while in actual flames it can go as high as 1200°C to 1300°C. The boiling points of volatile constituents get diffused over in the surrounding atmosphere. Also when cellulose and other carbohydrates undergo combustion, steam is formed in copious quantities by the combination of hydrogen of organic substances with oxygen. This is how substances like thymol, eugenol, pinene, terpinol etc., are carried over in the surroundings and the aroma of a *Yagya* can be smelt even at a considerable distance.

In addition to steam, smoke is also given out in copious quantities and solid particles existing in a highly divided state offer sufficient surface for mechanical diffusion. Thus smoke also functions in the form of colloidal particles for diffusion of volatile aromatic substances, depending of course on temperature and direction of wind.

Combustion of Fatty Substances

Fatty substances used in *Yagya* are mainly *ghee* and some other substances of vegetable origin. *Ghee* helps in rapid combustion of cellulose of wood and keeps the fire alight. Other fatty substances used are also combinations of fatty acids which volatilize easily. The combustion of glycerol gives acetone, pyruvic aldehyde and glyoxal etc. The hydrocarbons produced in the reactions again undergo slow combustion and as a result methyl and ethyl alcohols, formaldehyde, acetaldehyde, formic acid and acetic acids are formed.

Photo-Chemical process

The volatile substances diffused in the surrounding atmosphere are further subjected to photochemical reactions in the sunlight. This may be the reason why it has been recommended that *Yagya* should be performed in the presence of strong sunlight. These changes occur in ultra-violet and other short wavelength regions. Products of fumigation thus go photochemical decomposition, oxidation and reduction. To some extent even CO₂ is also reduced to formaldehyde as follows:



From environmental angle, reduction of CO₂ produced in *Yagya* as above and liberation of oxygen cannot be over emphasized.

Study of the Effect of Yagya on the Gaseous Pollutants

In order to study the effect of *Yagya* on the gaseous pollutants, two experiments were performed in the open air. Samples of air were collected and analyzed for gaseous pollutants SO₂ and NO₂ for both the experiments. The two experiments were performed at M.S. Apartments, K.G. Marg, New Delhi in the open air in January 2004 and February 2005, respectively. In both the experiments the objective was to see if there was any effect of performing *Yagya* in the open air on the gaseous pollutants. To the extent possible all the precautions mentioned above were taken so as to produce minimum of NO₂, HC and CO.

Experiment 1

The first experiment of *Yagya* was conducted in 2004 at M.S. Apartments, K.G. Marg, near India Gate in the open air. However the scale of experiment was small. Only five *Kundiya Yagya* were performed at the site and about 200 persons participated in it.

A high volume sampler was placed in the down wind direction. The samples were collected 8 hourly by the Envirotech Ltd. and were also analyzed by them. Background air was sampled on 31st, Jan, 2004, and thereafter sampling was done on the day of Havan, i.e. on 1.2.04 and one day after, i.e. on 2.2.04. On account of some logistic problem, the SPM samples could not be collected. Hence only SO₂ and NO₂ were monitored.

The day was slightly windy on the day of experiment and also on the day after.

The results of the gaseous experiment were as under:

Table 1: Results of the Gaseous Experiment of 2004 (micro-gm/ m³)

	NO ₂	% Change w.r.t Back Gr.	SO ₂	% Change w.r.t Back Gr.
31.1.04	56		11.0	
1.02.04	29.5	-47.3	1.5	-86.4
2.02.04	22.5	-59.8	0.0(BDL)	-100.0

Graphical representation of NO₂ and SO₂ results of this experiment is shown in Fig. 1:
Open Air Experiment - 2004

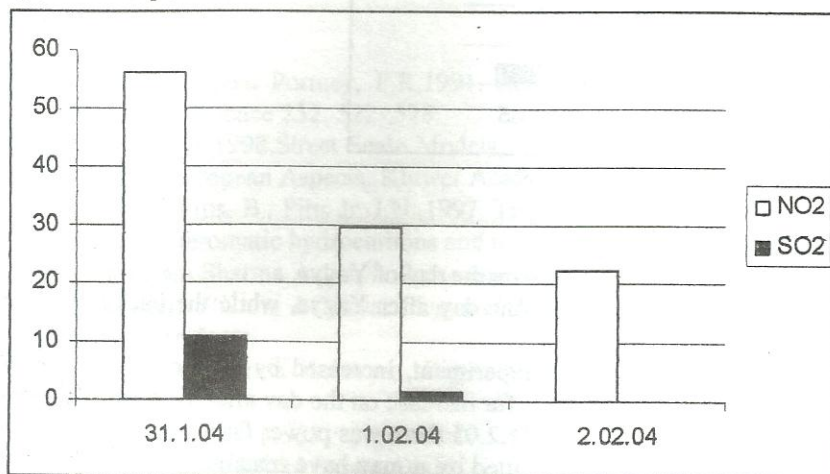


Fig. 1: Plot of the concentrations of NO₂ and SO₂ during the days of the experiment

From table 1 and its graphical representation in Fig. 1, it is seen that there was a drop in the concentration of NO₂ on the day of experiment as well as on the day after with respect to the background. The decrease in the concentration was 47 % on the day of experiment and about 60% on the day after Yagya.

The concentration of SO₂ dropped more significantly i.e. by 86% on the day of experiment w.r.t. the background and was below detection level on the day after.

Experiment 2

Another similar experiment was performed outdoors at the M.S. Apartments, K.G. Marg, New Delhi about one year later in February, 2005. The experiment was of the same magnitude as 2004 and was attended by approximately 200 persons. The same quality of wood and Havan Samigri was used. The samples were taken 8 hourly and a high volume sampler from Central Pollution Control Board (CPCB), Delhi, was used for the purpose. The sampler was placed in the down-wind direction. The samples were analyzed by CPCB. The results are tabulated in table 2.

Table 2: Results of the Gaseous Experiment conducted in 2005 (micro gm/ m³)

	NO ₂	% Change	SO ₂	% Change
19.2.05	74.5		8.4	
20.2.05	57.4	-23.0	5.6	-33.3
21.2.05	56.0	-24.8	12.8	52.4
22.2.05	75.2	0.9	5.0	-40.5

Note: % change has been worked out w.r.t. the background, i.e. as on 19.2.05

Open Air Experiment - 2005

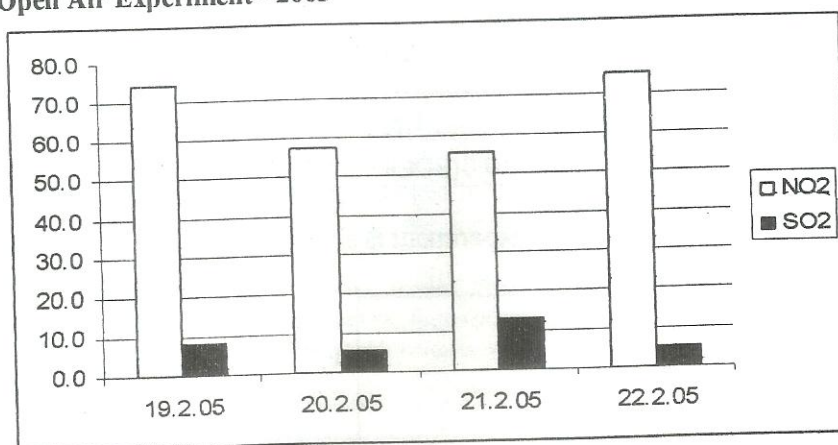


Fig. 2: Results of the open air gaseous experiment of 2005

From table 2 and its graphical depiction, it is seen:

* That there was 23% reduction in the concentration of NO₂ on the day of Yagya.

** There was about 25% reduction in NO₂ concentration one day after Yagya, while the background was restored two days after.

*** SO₂ concentration decreased by 33% on the day of experiment, increased by 52% one day after and showed a decrease of about 41% two days after. The reason for increase on the day after Yagya could be due to the fact that there was a generator installed nearby. On 21.2.05 there was power failure and the generator was switched on for about an hour and half. The fumes emitted by it may have remained in the atmosphere for long.

Precautions to be taken

It is clearly spelt in the 'Procedure of Yagya' that the following precautions should be taken while performing Yagya:

*The wood used should be dry and should preferably be one which produces least CO like Mango or Arani etc.

*The vessel (Kunda) should be of inverted pyramid shape with holes in the lower middle level for proper circulation of air.

*The wood should be arranged either in square or pyramid shape so that while burning there is proper circulation of air and wood gets burnt completely.

*'Ghee' should be used throughout to facilitate complete combustion of wood and herbs.

*'Ahuties' of herbs should only be offered to the fire when it is fully inflamed.

*'Ahuties' of herbs should be offered in the middle of the vessel and should not be disturbed. It is a well known fact that the temperature of any fire is the lowest at the base. NO₂ is produced when combustion takes place at high temperature. Since the wood is burning around the herbs, and herbs are put in the center, there is complete combustion in the presence of air though comparatively at low temperature. Thus NO₂ emissions are low.

*Water contained earthen pots are placed at some height around the place where Yagya is performed. Through the pores of the pot, most of the CO₂ emitted is absorbed as water bodies are known natural sink for CO₂.

Conclusion

From the above two experiments it can be concluded that open air Yagya when performed at a large scale is effective to some extent in the reduction of SO₂ and NO₂. The reduction of NO₂ is seen clearly in both the experiments, as there was no external disturbance, which disturbed the NO₂ concentrations other than the

experiment itself. In the second experiment, however, the concentration of SO₂ was disturbed on the 2nd day after the experiment due to emissions from the Generator which was in operation for some time near the sampler on account of power failure. Hence there was increase in SO₂ concentrations on the 2nd day after the experiment. However on the third day there was no power failure and a decrease of about 40% in the SO₂ concentrations was again seen compared to the background concentrations.

Notes

d: 'Yagya', a Vedic procedure of burning some herbs in fire along with some rituals is known for purification of atmospheric pollution through removal of foul odour, lowering of harmful gas levels and removal of harmful microbes.

e: 'Samidha' is the wood that is used to prepare fire for Yagya.

f: 'Kunda' is the inverted pyramid shaped vessel used for the fire and oblations in the Yagya.

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