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Microbial air quality on corrosion of mild steel: Preliminary field studies

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This paper describes the attempt made to find out the influence of airborne microbes on the atmospheric corrosion of mild steel at Madras city.

Key words: Atmospheric corrosion, airborne microbes, air pollutants

INTRODUCTION

Atmosphere is known to carry a variety of airborne microbes and viruses originating from human beings, animals, sea and soil [1]. Industrial operations like sewage treatment, animal rendering and fermentation processes also emit viable microbes into the air and are transported to great distances [2-4]. In an urban situation, sewage treatment plants, sanitary land fills and compost operations are considered [5] as potential sources of airborne infectious microorganisms. Urban atmosphere contains air pollutants in varying concentrations depending upon the area of activity. In addition to affecting human, animal or plant life, the air quality may increase markedly the corrosion of metals and maintenance cost of buildings, structures, etc.

The role of microbes on corrosion of metals is due to the metabolism associated with microbial growth and reproduction. The corrosive effect on metal can be attributed to direct chemical action of metabolic products and changes in oxygen potential, salt concntration and pH. There appears to be little work to show the effects of airborne microbes on atmospheric corrosion of mild steel. This study is an attempt made at Madras city in this direction.

MATERIALS AND METHODS

Sampling stations

Industrial, commercial and residential areas of the Madras city were chosen as sampling sites. The exposure (sampling) sites were located at 10-12 metres above ground. The residential and industrial sites were located at the same distance (0.50 km) from sea coast. The distance of commercial site was three times that of residential and industrial sites. Scope and methodology of experimental procedure were similar for all the three sites.

Determination of corrosion rate and analysis of rust for microbes

Method of exposure and determination of monthly corrosion rate (CR-mg/day) were carried out as per standard testing procedures [6]. Rust from the exposed panels was removed by swabbing and analysed. Standard procedures [7] were adopted for qualitative and quantitative enumeration of microbes.

Determination of salinity and air pollutants

Salinity measurements at each site were made by wet candle method [8] every month. Suspended particulate matter (SPM - $\mu g/m^3$) was determined gravimetrically, using high volume sampler. Oxides of nitrogen (NO_x - $\mu g/m^3$) were determined by the modified Jacob-Hoccheiser method. Sulfur dioxide (SO_2 - $\mu g/m^3$) was estimated colorimetrically by the modified West-Gaeke method [9,10].

Collection and enumeration of airborne microbes

All glass impinger technique was used for collection of airborne microbes along with monitoring of air pollutants. Enumeration of air borne microbes was carried out as described in standard testing procedures [11,12]. Individual counts of bacteria, fungi and actinomycetes were added together and expressed as total microbes or total microbial count/m^3 of air (Tc-No./m^3).

RESULTS AND DISCUSSION

Effect of air pollutants on corrosion

Results of field studies indicate good correlations between corrosion rate and SPM at residential site [13]. The corresponding regression equation is as follows:

$$CR = 18.5880\, e^{0.0086\ SPM} \ldots \qquad (1)$$

Microbial air quality and total count

In general, it was observed that the total microbial count at all the sites showed higher values from January to July than during the remaining period of August to Dcember. Peak value was found in June at all the three sites (Fig. 1) [14].

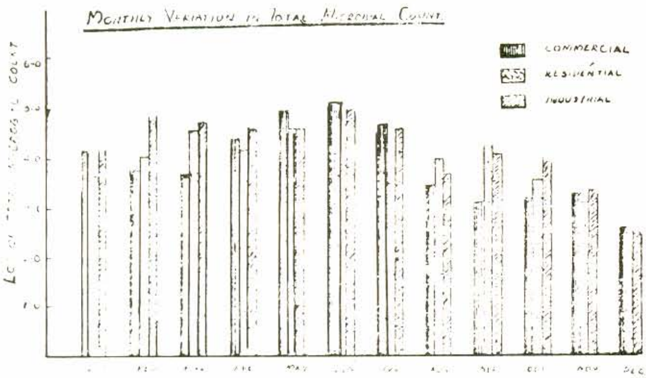

Fig. 1: Monthly variation in total microbial count

Effect of air pollutants on microbes

Correlations of total microbe count with suspended particulate matter gave positive correlations for all the sites, while the gaseous pollutant like SO_2 gave negative correlations [15]. The regression equations for the correlations of Tc with SPM are as follows:

$$\text{Residential} \quad Tc = 67.9361\, e^{0.0651\ SPM} \quad \cdots (2)$$

$$\text{Industrial} \quad Tc = 279.6703\, e^{0.0403\ SPM} \quad \cdots (3)$$

$$\text{Commercial} \quad Tc = 72.1640\, e^{0.0626\ SPM} \quad \cdots (4)$$

This indicates that microbes might be getting into the atmosphere when the wind velocities are high, that is, when the SPM concentrations in the atmosphere are high.

Effect of airborne microbes on corrosion

Solving these two equations (1) and (2), the value of corrosion contributed by total microbial count works out as

$$CR = 10.6463\, Tc^{0.1321} \cdots \quad (5)$$

Since positive correlations have been obtained between SPM and Tc at all sites and as no significant variation in occurrence of microbes has been observed in all the sites, the equation (5) was utilised for working out the value of corrosion contributed by Tc at all the sites. This is plotted in Fig. (2).

Analysis of rust

Analysis of rust showed a marked change in the qualitative medium with definite turbidity and lowering of pH from 5.2 to 3.2, which is positive evidence of growth of organisms; conspicuous characteristic colony was also observed. The resultant corrosion could be attributed to these organisms.

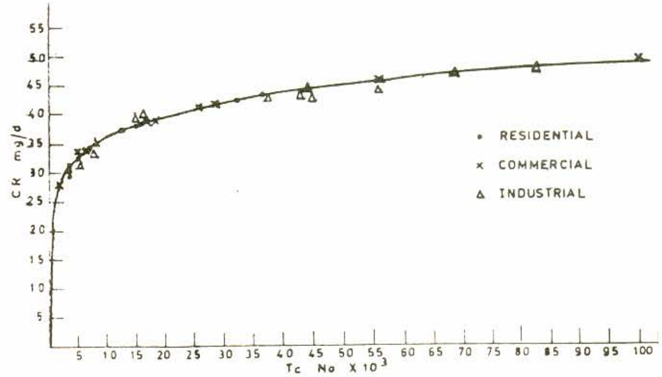

Fig. 2: Corrosion Vs T_C

CONCLUSION

(i) The total microbial counts obtained during January to July were high with peak counts in June. (ii) Analysis of rust showed qualitative evidence on presence of microbes. The air was shown to carry high microbe load, which indicates the contribution of microbes to corrosion of mild steel. (iii) This short term study provides only rough data on the effect of total microbial count on corrosion of mild steel; only long term studies extending over a period of 3-5 years will be able to provide more reliable information. (iv) Large number of samplings and controlled (in chamber) studies are needed to determine the specific mechanisms on the effect of microbes on open atmospheric corrosion.

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