ABSTRACT

In the present investigation, five essential oils from natural products namely Jasminum Grandiflorum (JG), Jasminum Sambac (JA), Oleum Palmarosae (OP), Ocimum Basilicum (OB) and Vetiveria Zizanioides (VZ) have been chosen as Vapour phase Corrosion Inhibitor (VCI) to study the corrosion inhibition properties of the these oils on mild steel and copper. These essential oils were procured from a perfume manufacturing company. They were systematically characterized by Fourier Transform Infrared (FTIR) spectroscopy and Gas Chromatographic (GC) analysis. The corrosion rate, surface coverage and inhibition efficiency of the VCI were determined by various weight loss methods such as VIA test, F12 Cyclic corrosion test, Salt spray test, Long duration protection test, Stevenson chamber test and electrochemical methods such as Potentiodynamic polarization and A.C Impedance methods. The suitability of the oils in packaging was studied by Razor Blade test. The application of the oils in protecting electrical and electronic components was studied by visual observation method.

All the VCI used for the present study protect both mild steel and copper metals from corrosion. The vapour pressure of the oils was determined by weight loss method and is around 4.1 to 6.7 x 10^{-3} mm Hg. This is really high to vaporize and condense after reaching the metal surface, thereby inhibit the corrosion process. In FTIR, the spectral band at around 1023-1287 cm^{-1} is due to C-O stretchings. The absorption bands at 696 $cm^{-1}$and 1371 cm^{-1}

correspond to C-C stretchings and C-N stretching vibrations respectively. The results of gas chromatographic analysis offered the information regarding the presence of alcoholic, nitrogen and carbon-carbon double bond compounds in the chosen essential oils.

The results of VIA test under different concentrations of VCI indicate that the optimum concentration required to protect the metal specimens is 4%. The inhibition efficiency of all the oils is found to be increased with increase in concentration of VCI. F12 Cyclic corrosion test established the protecting ability of these oils in severe corrosive environment. Hydrogen sulphide and sulphur dioxide tests indicated the protecting ability of the VCI in highly polluted atmosphere. Since these oils are not affected by SO_2 and H_2S, they have a potential to be used as VCI in industrial atmosphere. As evidenced by the long term protection test using VIA methods, these VCI are long lasting even after 60 days of exposure. Stevenson chamber tests reveal that the efficiency of these oils decreases with increase in number of days of exposure. Razor Blade test established that the inhibition efficiency of VCI retained in impregnated papers, thin film, pouches and emitter for metals upto 90 days of exposure. It is noteworthy that the corrosion rate increased with increase in the time of exposure.

Potentiodynamic polarization studies indicated that E_{corr} and I_{corr} values are lower for VCI protected specimen than blank. As the concentration of electrolyte increases, the corrosivity also increases, resulting in increased corrosion current. Tafel curves indicate that the polarization takes place on both direction but cathodic polarization is more predominant than anodic polarization and the inhibitors behave as mixed type. A.C Impedance studies reveal that the R_{ct} values decrease with increase in the concentration of the electrolyte. The R_{ct} values of VCI paper protected specimen are higher than that of blank and the inhibition is due to adsorption of inhibitor molecules on metal surface. This was further confirmed from Tempkin adsorption isotherms. Salt spray test indicated that the oils are efficient to protect the metals in 3.5% sodium chloride environment.

The comparison of inhibition efficiency values of individual constituents with the respective oil under identical experimental conditions shows that the individual constituents are less efficient than the oils. This observation indicated that the constituents are not solely responsible for inhibition. In otherwords, the constituents present in the oil have synergestic effect towards inhibition and boost the inhibition efficiency values. The higher negative values of free energy of adsorption indicate the spontaneity of adsorption process in the experimental conditions used. The chemisorption of the VCI was observed from ΔG_{ads} values. The molecular structure of the important constituents present in the oil indicate that the adsorption of inhibitor molecule on metal surface may take place through oxygen or nitrogen or both oxygen and nitrogen atom and π - electrons present in the compounds. Antibacterial and antifungal studies revealed that all the essential oils under study function against bacterial and fungal infections. Since the zone of inhibition against most of the micro organisms was maximum, the essential oils are considered to be more effective against bacterial strains.

Surface morphology was studied using scanning electron microscope. The SEM photograph differentiated clearly the corroded surface and VCI protected surface. These results are in reasonable concordance with weight loss method, polarization studies and impedance spectroscopy data. The test results of the oils in electrical and electronic components in sea water environment indicate that these oils are very effective in protecting electronic and electrical components. It is noted that 1ml of 4% VCI concentration is enough to protect the components of various metals for a period of two months.

The test conducted in the present work indicates that all the chosen essential oils inhibit the corrosion of both mild steel and copper. The inhibition efficiency of the oils is found to be more in rain water and least in sulphur dioxide (SO_2) environment. The mechanism of inhibition is through adsorption. The VZ oil has highest inhibition efficiency and OB oil has least inhibition efficiency among the studied oils. The order of inhibition efficiency is VZ > OP > JG > JA > OB.

The inhibition efficiency of VCI under various environments follow the order Rain water > NaCl > HCl > Sea water > H_2S > SO_2.

It may be concluded that these essential oils can used as VCI to protect electrical and electronic components packaging under corrosive environment environments.