In many industries, the need to use constructional materials safely, but cost-effectively, is a primary consideration. Frequently, physical requirements can be satisfied easily, but corrosion effects seriously complicate the selection of suitable materials. Generally, increased corrosion-resistance can only be obtained at increased cost. However, the actual material-related costs incurred in a project will depend on the corrosivity of the environment concerned, the required design life, the physical requirements of the material, and the readily available stocks. The costs and problems associated with corrosion-resistant materials mean that, in many cases, the use of corrosion inhibitors is a practical and economic alternative. Industrial use of corrosion inhibitors is, therefore, now broad based and extensive.

Presently much effort is being provided on preventing metals from corrosion by use of corrosion inhibitors. Most of the inhibitors that are synthesized in laboratories show an efficiency up to 99 percent. But their use on industrial level is taken carefully because of their toxic nature. This resulted in the deviation of attention towards the synthesis of eco-friendly inhibitors. Plant extracts and oils are also found to be non-toxic, highly efficient, renewable and cheap. But less effort has been given towards the identification, that which compound is active in the extract. It is pertinent to mention that there occurs an increase in the inhibition efficiency of one component in the presence of another in the mixture, i.e. synergetic effect. It has been found that plant extracts and oils show inhibition efficiency up to 98 percent. So, it is certain that plant extracts and oils emerge out to be an effective type of inhibitors to corrosion and can be successfully used on industrial level.

Plants are a goldmine of novel chemicals. The inhibitor appears to operate through its adsorption over the metal surface and through the ability to slow down the metal dissolution and hydrogen gas evolution.

The corrosion inhibition prospective of DV/MS/CA extracts on mild steel acid corrosion are examined by weight loss method, electrochemical method, and surface analytical methods. All these methods confirm the inhibitive potential of the investigated inhibitors. The results pertaining to the current study is discussed in detail in chapter IV.
SALIENT FEATURES

The salient features pertaining to the present study entitled “Experimental and Theoretical investigation of flavonoid based plants-stem and leaves of Dodonaea viscosa, Mundulea sericea and Cassia alata on mild steel corrosion in acid media” are summarized below:

- The investigated inhibitors, performed in an effective manner to minimize the corrosion of mild steel in both acidic media.

- Phytochemical screening of constituents present in stem and leaves of Dodonaea viscosa, Mundulea sericea and Cassia alata are quite in good agreement with literature survey. Characterisations of DV/MS/CA are effectively carried out using GC-MS, FT-IR and UV.

- Analysis of Potentiodynamic polarization results reveal that the $E_{corr}$ for all the examined inhibitor system in both the acid media do not change appreciably with the addition of the inhibitors and thus affect the anodic dissolution as well as cathodic hydrogen evolution reactions and act as mixed type inhibitors.

- $I_{corr}$ values decreases significantly in the presence of inhibitors showing that all the inhibitors are effective in controlling corrosion.

- Tafel constants $b_a$ and $b_c$ for the studied systems and polarization curves of mildsteel in the presence of current inhibitors infer that all the studied inhibitors behave like mixed type inhibitor.

- $R_p$ values increases with increase in inhibitor concentration indicating a better corrosion protective ability of the inhibitors under study.

- Results pertaining to EIS techniques highlight that the Nyquist plots contain depressed semi-circles with the centre under the real axis, whose size increase with the increase in DV/MS/CA extracts concentration, indicating a charge transfer process mainly controls the corrosion of mild steel. The impedance of inhibited substrate increases with increasing DV/MS/CA extracts concentration and consequently the inhibition efficiency increases.

- The impedance parameters for the corrosion of mild steel in acid media without and with addition of various concentrations of DV/MS/CA extracts reveal increase in $R_{ct}$ values with increasing concentrations of inhibitors. This behaviour reveals the adsorption of DV/MS/CA extracts on mild steel. $R_{ct}$ values increase but $C_{dl}$ values...
tend to decrease. The decrease in $C_d$ values might be due to adsorption of the DV/MS/CA extracts on mild steel surface.

- Analysis of results of the mass loss measurement infer that the inhibition efficiency increased with increasing concentration of DVLE, DVSE, MSLE, MSSE, CALE and CASE respectively in 1 M HCl and 0.5 M H$_2$SO$_4$ solution. All the investigated inhibitors afford a maximum IE in the range of 85-90% in both acid media.

- Immersion studies results reveal that as the time of immersion increases from $\frac{1}{2}$ h to 6 h the inhibition efficiency increases, thereby indicating the enhanced stability of the adsorbed constituents of the extract on mild steel surface, at longer periods of immersion. All the investigated inhibitors afford a maximum IE in the range of 85-94% in both acid media. These results infer that inhibitor efficiencies of DV/MS/CA extract increases continuously with time of immersion. It is obvious that the studied inhibitors are promising inhibitors in 1 M HCl and 0.5 M H$_2$SO$_4$ at various time of immersion, at all concentration at room temperature.

- All the investigated inhibitors used in the current study reveal that inhibition efficiency increases with increase in particular temperature and then decreases at higher temperatures. Maximum IE for all investigated inhibitors are found to be around 93% in HCl and 89% in 0.5M H$_2$SO$_4$. This may be due to the adsorption of the inhibitor up to particular temperature and then desorption of the inhibitor at higher temperature.

- From temperature studies, the activation parameters of the investigated inhibitors for the corrosion process ($E_a$, $\Delta H^\circ_a$ and $\Delta S^\circ_a$) are calculated. In the present investigation, $E_a$ values are found to be greater than those calculated in the presence of the inhibitors. The higher values of $E_a$ in the inhibited solution can be correlated with the increased thickness of the double layer, which enhances the activation energy of the corrosion process.

- The positive value of the enthalpy of activation ($\Delta H^\circ_a$) reflects the endothermic nature of the mild steel dissolution process meaning that dissolution of mild steel is difficult.

- The positive values of entropy of activation ($\Delta S^\circ_a$) in the presence of all studied inhibitors in 0.5 M H$_2$SO$_4$ implies that the activation complex in the rate determining step represents as association rather than a dissociation step, meaning that an increase in disorderliness takes place on going from reactants to the activation
complex. The negative values of entropy of activation ($\Delta S_{a°}$) in the presence of all studied inhibitors in 1 M HCl implies the inhibitor molecules, freely moving in the bulk solution are adsorbed in an orderly fashion onto the mild steel surface.

- All the studied inhibitors furnish a large negative value of free energy of adsorption. In the present study, the calculated values of $\Delta G_{ads}$ obtained for mild steel corrosion in the presence of DV/MS/CA extracts in both the acid media ranges between -11 kJ/mol and -19 kJ/mol, mole indicating that the adsorption of the inhibitors on the surface of the mild steel obeys comprehensive adsorption.

- The values of $\Delta H_{ads}$ are found to be positive for the current inhibitors and indicate endothermic nature of the reaction. The negative values of entropy of adsorption ($\Delta S_{ads}$) in the presence of all the studied inhibitors are attributed to the adsorption process which is accompanied by an increase in order of the system due to the adsorption of the studied inhibitor on the metal surface.

- It is observed that the inhibition efficiency furnished by the studied plant extracts is higher than that the inhibition efficiency given by the flavonoid extracts by mass loss and electrochemical measurements.

- UV spectroscopic study implies the formation of insoluble Fe-Complex on the mild steel surface. FT-IR spectroscopic studies reveal that the phytochemical constituent of the plant extracts are adsorbed on the surface resulting in the characteristic adsorption bands of the functional group in the plant extract.

- The morphology of the specimen surface has been analysed using SEM, EDX, XRD and 3D Optical Profiler. The results reveal that in the absence of inhibitor a corroded rough and coarse uneven surface developed. However in the presence of the inhibitors the rate of corrosion is suppressed as can be seen from the smooth surface of the specimen.

- A synergistic study carried out using the mixture of stem and leaves of DV/MS/CA highlights the importance of phytochemical constituents present and their role in inhibition.

- Quantum chemical studies carried out using HyperChem 7.0 for the selected phytochemical constituents commonly present DV/MS/CA confirms the probable adsorption centers through which the Fe atom is linked to form Fe-complexes.
SCOPE FOR FURTHER STUDY

- The investigated inhibitors may be tested as corrosion inhibitor in other metals – carbon steel, copper, brass and zinc etc.,

- Corrosion inhibition studies may also be carried out using the investigated inhibitors in phosphoric acid medium, nitric acid medium, in alkaline and neutral medium.

- Quantum chemical parameters such as molecular polarizability, molecular volume, molecular surface area, Mulliken charges of the atom etc. may also be arrived at using the software latest Gaussian and Hyperchem versions.

- Gasometric techniques, cyclic voltametry studies may also be conducted using the investigated inhibitors.

- Resources are plenty. Efforts may be taken to analyze various fence plants as corrosion studies.

- Alkaloids/tannins/Terpenoids can be extracted from plant parts by simple procedures and comparison of inhibitor efficiencies may be done with plant extracts.

- Apply mathematical equations to find out the theoretical investigation of corrosion inhibition studies.

- The DV/MS/CA extracts under investigation may be tried as corrosion inhibitors in electroplating industries.

- Create knowledge to the industrial people to make use of deciduous leaves and flowers as corrosion inhibitor in their own industrial environment.