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Green Ionic Liquid as Corrosion Mitigator for Mild Steel in 0.5 M Sulfuric acid studied with Electrochemical analysis.

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Abstract:-

An Ionic liquid, 3-pentyl-1-ethyl-3-imidazolium bromide [PEIM]Br as a Green Corrosion mitigator with electrochemical studies is analyzed by NMR, IR and mass spectroscopy and electrochemical studies like galvanostatic polarization and impedance spectroscopy practiced by electrochemical analyzer by static polarization mitigation efficiency on mild steel in an acidic medium are 96% at 303 Kelvin temperature which is also indicated by impedance spectroscopy and these electrochemical studies performed very efficiently on mild steel. It concludes that mitigation efficiency of inhibitor decrease with decrease in concentration and with increase in temperature.

Introduction:-

The current investigation is concerned with the ionic liquids containing oxygen and nitrogen in this corrosion inhibitor. The inhibitors with phosphorous, nitrogen, oxygen, or sulfur atoms assist in the donation of electrons to the surface of the metal thereby forming a protective layer on the metal surface [1-6]. Some destructive effects of corrosion on metals are the weakening of mechanical properties of metals leading to damage or the total breakdown of the whole structures [7]. This corrosion can cause serious damage to the metal and degrade its properties. Corrosion inhibitors play a very important role to protect metals from corrosion.

These IL usually adsorb on the MS forming a protective layer by chemisorption or physical adsorption and block the active sites on the metal surface. Mostly inhibitors decrease the corrosion rate via block the active site of chemical reaction. Organic compound are protect the metal surfacein acidic medium which mostly contain delocalized electrons or those containing hetero atoms like nitrogen, phosphorus, oxygen, and Sulphur. As earlier reported some ionic liquids compounds are effective corrosion inhibitors in an acidic solution for mild steel. An appreciable interest has been developed recently among corrosion scientists for Ionic liquids (ILs) [8-9] as an alternative kind of corrosion inhibitors. These ILs have exceptional properties like discernable fume pressure, higher energy, non-poisonousness, climate well-disposed nature, and better selectivity. Being a future solvent existing in cation-anion sets the advantages of ILs for researchers has been upgraded exponentially. A simpler arrangement of micelles by ILs design after bringing down the interfacial strain underpins both, hydrophilic and lipophilic properties that become appropriate for adjusting the glue and firm powers for overly wet-capacity and absorptivity of such mixes as their function as consumption inhibitors (CIs) [11-12]. In this work, therefore, the mitigation effect of 3-pentyl-1-ethyl-3-imidazolium bromide [PEIM]Br bromide on mild steel in 0.5M sulphuric acid at varied temperatures and concentrations have been studied.

Electrochemical studies:-

Table 1: Galvanostatic data for alleviation efficiency esteem in with and without of mitigator [PEIM]Br on different conc. at 303K in 0.5M H_2SO_4.

Temp (K)	Conc (ppm)	b_a (mV/dec)	b_c (mV/dec)	-Ecorr (mV)	Icorr micro ampere μ A cm^{-2}	corrosion rate (mm/yr)	Polarization Resistance (ohm)	θ	I.E% *Φ*
303	0	166	66	389	2808.00	32.62	32.62	_	
303	800	55	28	478	27.56	0.321	295.9	.9901	99.01
303	600	58	28	480	41.47	0.481	200.5	.9852	98.52
303	400	77	42	481	96.00	1.112	124.2	.9658	96.58
303	200	82	49	485	145.18	1.681	92.34	.9482	94.82

The nature of Tafel polarization for mild steel corrosion mitigation in presence of [PEIM]Br is given in Fig.1. The changes in b_a and b_c curves show that anodic reaction is being effected up to a greater extent [13-14]. Also, the variation in E_{corr} value is 95 mV indicates that [PEIM]Br is an anodic type mitigator.

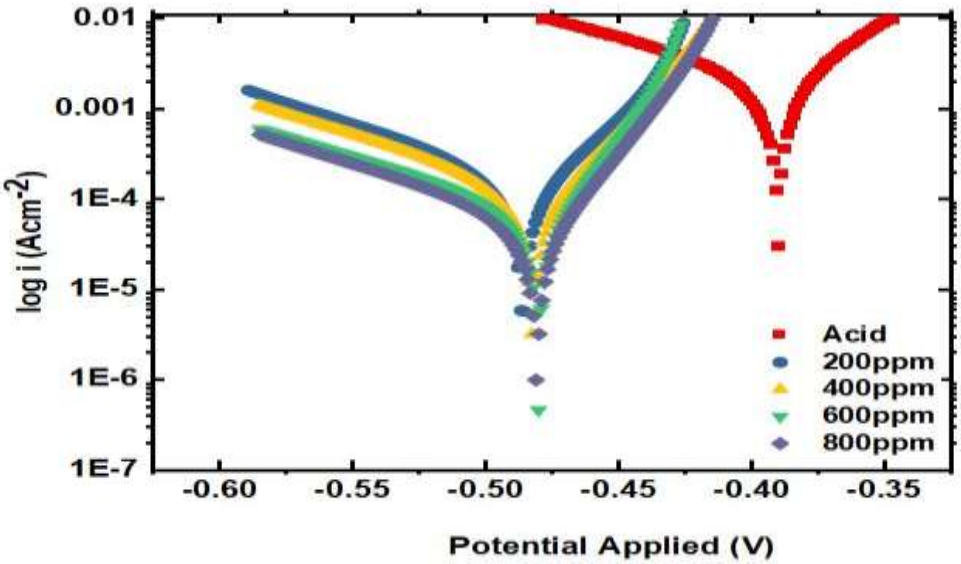

Fig 1: Fig 1: Tafel polarization for MS in acidic solution without and with various conc. of [PEIM]Br at 303 K

Corrosion mitigation in presence of [PEIM]Br is mainly due to suppression of anodic reaction at the metal solution interface [15-16]. Maximum mitigation efficiency (99.01 %) shown by [PEIM]Br is at its higher concentration i.e. 800 ppm and the efficiency decreases as the concentration of mitigator decreases to 200 ppm to a lower value (94.82).

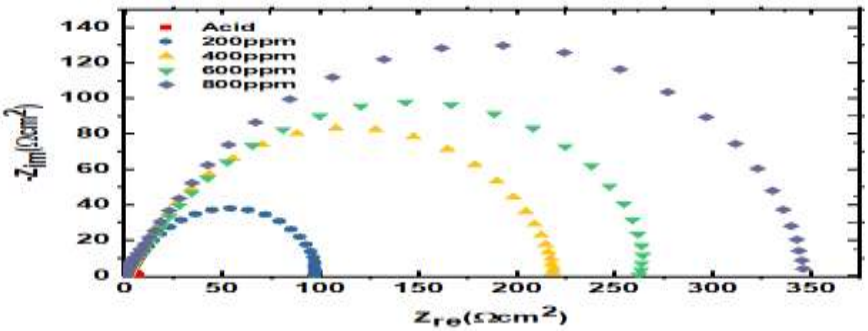

Fig 2: Nyquist plot for MS in 0.5M sulphuric acid medium without and with various conc. of [PEIM]Br at 303 K

The electrochemical impedance responses, shown in Fig 2, are single dejected capacitive loops which are increasing with the concentration of [PEIM]Br which shows that the addition of mitigator has improved the corrosion mitigation [17-18].

Table 2: EIS calculations and mitigation efficiency esteem in the with and without of mitigator [PEIM]Br on different focus at 303K in 0.5M H_2SO_4.

Conc.(ppm)	R_{CT} **(Ω cm^2)**	C_{dl} **(µF cm^{-2})**	**I.E %** **(Φ)**
0	5.921	100	-
200	95.44	59.34	93.79
400	218.31	45.61	97.28
600	263.78	39.75	97.75
800	346.19	38.13	98.28

Charge transfer resistance values (R_{ct}) in Table 2 are increasing with the concentration and it governs that the corroding system will be very slow and on the other hand C_{dl} value decreases on adding of mitigator which indicates that the width of double-layer capacitance has increased at metal solution interface and hence higher corrosion mitigation [19-20].

Conclusion:

Electrochemical studies have shown that [PEIM]Br is a very effective inhibitor showing a maximum mitigation efficiency of 99.01% which decreases with lowering the concentration of [PEIM]Br. The inhibitors behave as anodic mitigator in nature having a deviation in E_{corr} value as 95 mV. EIS studies reveal that there is a protective layer formation at the metal surface governed by rising R_{ct} values at higher concentrations in comparison to the blank acid solution.

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