INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Corrosion inhibition of steel in acidic media using bio-waste extract: Experimental and theoretical consideration**

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SHORT ABSTRACT

This thesis discusses chemical processes, types, economic effects, and remedies of corrosion as background studies. The thesis focuses on finding green corrosion inhibitors from various bio-wastes, such as solid waste from tea factories (food-industrial waste), purple rice bran (agro-byproduct), banana flower bract, and onion peel (kitchen waste). The corrosion inhibition efficiency was determined in acidic media (HCl and H_2SO_4) on boiler-quality steel. The main objectives were (a) Extraction and characterization of green corrosion inhibitors, (b) Electrochemical kinetic study of inhibitors using potentiodynamic polarization on boiler quality study in acidic media to find out their corrosion rate and corrosion current, (c) Study on inhibition mechanism using electrochemical impedance spectroscopy, (d) Adsorption kinetics to find the type of adsorption, (e) Theoretical studies of inhibitory molecules identified in the extract. The entire work of this thesis has been divided into four significant chapters as follows:

(a) Corrosion inhibition by extract of solid waste from tea factory (industrial waste)

This chapter discusses the findings and analysis related to the utilization characterize the solid tea waste extract (STWE) as an inhibitor. After incorporating 500 mg L^{-1} of tea waste extract, the maximum

inhibitory efficacy in terms of charge transfer resistance was determined to be 90% in 1 (M) HCl on boiler quality (BQ) steel. The corrosion current (i_{corr}) and charge-transfer resistance $(R_{ct})$was found to be the minimum, 25.29 μA $cm^{2,}$ and 923.40 Ωcm^2, respectively, at 500 mg L^{-1} of STWE. A protective barrier on the metal electrolyte interface was formed by the adsorption of the phenolic compounds present in the STWE, which was confirmed by the FESEM, EDX, and AFM studies. Among the identified compounds, caffeine had a lower energy gap (Δ*E*) of 4.976 eV.

(b) Corrosion inhibition by extract of purple rice bran (agro by-product)

This chapter discusses the effectiveness of purple rice bran extract (PRBE), an agricultural by-product rich in antioxidants, at inhibiting corrosion. The characterization PRBE of PRBE indicated two key contributing compounds such as cyaniding-3-glucoside (C3G) and peonidin-3-glucoside (P3G). The corrosion inhibitory efficiencies of PRBE on BQ steel were 91.13% and 87.43%, respectively in 1 (M) HCl and 0.5 (M) H_2SO_4 in the presence of 200 mg L^{-1}. Langmuir isotherm was determined to be the best-fitting model, indicating both physical and chemical spontaneous adsorption of PRBE on the BQ surface. The quantum chemical parameters indicated P3G as a better inhibitory molecule.

(c) Corrosion inhibition by extract of banana flower bract (kitchen waste)

This chapter describes the corrosion inhibition efficacy of kitchen waste, banana flower bract extract on BQ steel in HCl and H_2SO_4 acidic environments. By using the gravimetric method, potentiodynamic polarization method, and electrochemical impedance spectroscopy method at room temperature (25 ± 2° C). After adding a maximum concentration of 200 mg L^{-1}, the studies showed that banana bract extract (BBE) had maximum inhibitory efficiencies of 90.84 % (1 M HCl) and 90.61% (0.5 M H_2SO_4). The value of K_{ads} and $\Delta G°_{ads}$ has supported thermodynamic favorability and mixed-type of adsorption. According to the density functional theory study, P3G has a smaller energy gap than C3G, which helps better adsorption and has a more significant inhibitory impact.

(d) Corrosion inhibition by extract of onion peel (kitchen waste)

The results of corrosion inhibition of boiler grade (BQ) steel by onion waste extract are addressed in this chapter. The extract from onion peel was characterized using LC-MS, and quercetin was found as the main contributory compound. From the electrochemical impedance spectroscopy studies, the maximum inhibition efficiencies of 91.30% and 90.71 % were found at 200 mg L^{-1} in 1 (M) HCl and 0.5 (M) H_2SO_4, respectively. According to FESEM, EDX, and AFM experiments, the formation of a protective layer on the BQ steel by OPE greatly reduced the rate of corrosion. Quantum chemistry calculations found that quercetin had a lower energy gap in the aqueous phase than in the gaseous phase, resulting in more effective inhibitory action.

In summary, this Ph.D. thesis affirms that inexpensive, environmentally beneficial Bio-waste extracts can replace traditional, expensive, and harmful inhibitors because of their exceptional effectiveness in preventing steel corrosion in acidic conditions. The collected data are expected to be used as the basis for future studies into creating or discovering a new corrosion inhibitor that is both commercially and environmentally feasible.