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Corrosion treatment of industrial cooling water system by using *Brassica oleracca* (Cabbage) act as natural corrosion inhibitor

R. Sasi Kumar*, P. Govindaraj and T. Krishnaveni

Department of Chemistry, Saiva Bhanu Kshatriya College, Aruppukottai, Tamil Nadu, India

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ABSTRACT

The objective of the present work is to analysis the physico – chemical parameters and corrosion treatment of Industrial cooling water by using Brassica Oleracca (Cabbage). The Industrial cooling water is taken from dye Industry and the physico – chemical parameters like pH, alkalinity, hardness, total dissolved solids, chloride, ammonia, nitrite, nitrate and Iron was done by using standard procedures. Corrosion treatment was evaluated by metal weight loss method by using extract of Brassica Oleracca (Cabbage). The results revealed that the water sample is contaminated with some ionic pollutants which are responsible for corrosion for Iron pipe lines. Based on the corrosion treatment the weight loss measurement analysis showed excellent ability of Brassica Oleracca extract. The present study concluded that the cabbage extract a natural substance that is eco – friendly, economical and effective corrosion inhibition.

Keywords: Industrial cooling water system, Corrosion, Cabbage, Natural Inhibitor, WHO

INTRODUCTION

In general, cooling water system is generally used in commercial and industrial facilities to cool process machinery and the surrounding air inside the factory or industrial plant. In the cooling water system, water acts as a medium to transfer heat from liquid and the continuous circulating water absorbs heat and replaces it to create a cooler and fresher environment[1].

Two significant factors that need to be considered before choosing the right corrosion inhibitor for a particular material including for the industrial cooling water system is whether the compound is feasible in the sense of cost. Most effective corrosion inhibitors are synthetic chemicals which are costly, therefore, not economical to be used. The second factor is whether the compound is safe and eco – friendly. Synthetic compound is proven to be harmful to human and the environment, thus it is not a compatible choice. Other elements that contribute to the selection of corrosion inhibitors are like their accessibility. The question is whether the inhibitor could be found or produced easily. The significance of finding and identifying inhibitors which are safe, cheap, and easily accessible and does not emit dangerous substances and gaseous are acknowledged. That is why more and more research on plants, seeds and flower based inhibitors are being developed as naturally occurring substances contain the chemicals proven in being able to inhibit corrosion, they are cheap, easy to find, renewable and are safe to be used. Some examples of such natural inhibitors are henna, olive, natural honey and onion.

In essence, the compound responsible for the inhibitory action of the *Brassica Oleracca* is Quercetin, a conjugated and electron rich compound. The oxygen atom in Quercetin is electron rich and serves as a good adsorption site on the surface of the metal, thus preventing any further contact between the metal and ions present in water which can

cause corrosion. Quercetin found in *Brassica Oleracca* is a plant derived flavanoid. Flavanoid are also known as secondary metabolites are organic compound found in plants that are not directly involved in the normal growth, development, or reproduction of organisms. In *Brassica Oleracca*, the Quercetin can be found in the outermost ring. It has anti inflammatory and antioxidant properties thus make it suitable to be used in various fields, such as medical, engineering related research and food industries[2].

Brassica Oleracca is the species of plant that includes many common foods as cultivars, including cabbage, broccoli, cauliflower, kale, Brussels sprouts, and Chinese kale. In its uncultivated form it is known as wild cabbage. It is native to coastal southern and western Europe. Its tolerance of salt and lime and its intolerance of competition from other plants typically restrict its natural occurrence to limestone sea cliffs, like the chalk cliffs on both sides of the English Channel.

The aim of this study was to determine the inhibitory efficiency of *Brassica Oleracca* and the impact towards corrosion rate of metal iron. This metal is the main constituent that makes up the industrial chill wastewater system.

MATERIALS AND METHODS

Plant Material

The Plants of *Brassica Oleracca* were purchased from Local market, Aruppukottai, Virudhunagar District, Tamil Nadu. Initially, *Brassica Oleracca* was crushed and extracted in hot water for 20 min and that required concentration was prepared. This step was repeated using different quantity of cabbage (0.2 to 1.4 g/L) to produce various level of concentrated extract.

Industrial cooling water

The present study was carried out at the Sitco Industrial Park, Kappalur, Madurai. The region was selected due to its rapid industrial growth and numerous factories that are equipped with cooling towers. In addition, there are large amount of wastewater being discharged daily into the nearest lake ecosystem that no longer support the full biological diversities. Wastewater sample were taken from dye industrial plants that use cooling tower.

Chemicals and reagents

The chemicals, solvents and reagents used in the study were of standard analytical grade obtained from Modern Scientific Pvt Ltd., Madurai.

Physico - Chemical analysis

The water samples were collected using plastic bottle. This sample was taken to laboratory in SBK College, for physico chemical analysis. To analyze various parameters the standard procedures given in APHA (1998) was followed. pH meter (Systronicsdigital model 335) was used to determine the hydrogen ion concentration. Alkalinity was estimated by neutralizing with Standard HCl acid. Salinity and Total Dissolved Solids (TDS) were estimated using Systronics water analyzer. Total Hardness (TH) was determined titremerically, using standard EDTA. Fluoride was analyzed by SPANDS [2-(psulphophenylazo) 1,8-dihydroxynaphthalene- 3,6-disulphonic acid tri sodium salt),$C_{16}H_9N_2O_{11}S_3Na_3$] colorimetric method.

Experimental Preparation

Three containers with lid were filled with these concentrated liquid extract and the initially weighed metal sample was immersed in the liquid. After 72 hours, the metal sample was removed from the container and its weight was recorded. The water in the container was also tested for the presence of iron.

The inhibition efficiency (IE) was evaluated by weight loss techniques. The percentage inhibition efficiency (IE %) was calculated by subtracting the final weight of metal (after submersion in the inhibitor extract solution) with the initial weight (before submersion) and then divide by the final weight. The submersion period was 72 hours and the results were obtained from mean of three runs, each conducted with fresh wastewater solution. A control sample was also prepared with and without the inhibitor of different concentration.

$$IE\ (\%) = \left(\frac{W_2 - W_1}{W_2} \right) X\ 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots 1$$

W2 and W1 are the weight loss of the corroded iron in the presence and absence of the inhibitor, respectively[7].

RESULTS AND DISCUSSION

The results from this study were presented in two categories; water quality analysis of the industrial cooling water (cooling tower) and corrosion treatment using cabbage extract. The results were compared to the standard discharge limit stipulated in the WHO. The comparison was made between the wastewater from the cooling tower and specifications of Standard controls. For the corrosion treatment process, the performance was evaluated in terms of weight loss and surface analysis of the Iron[8].

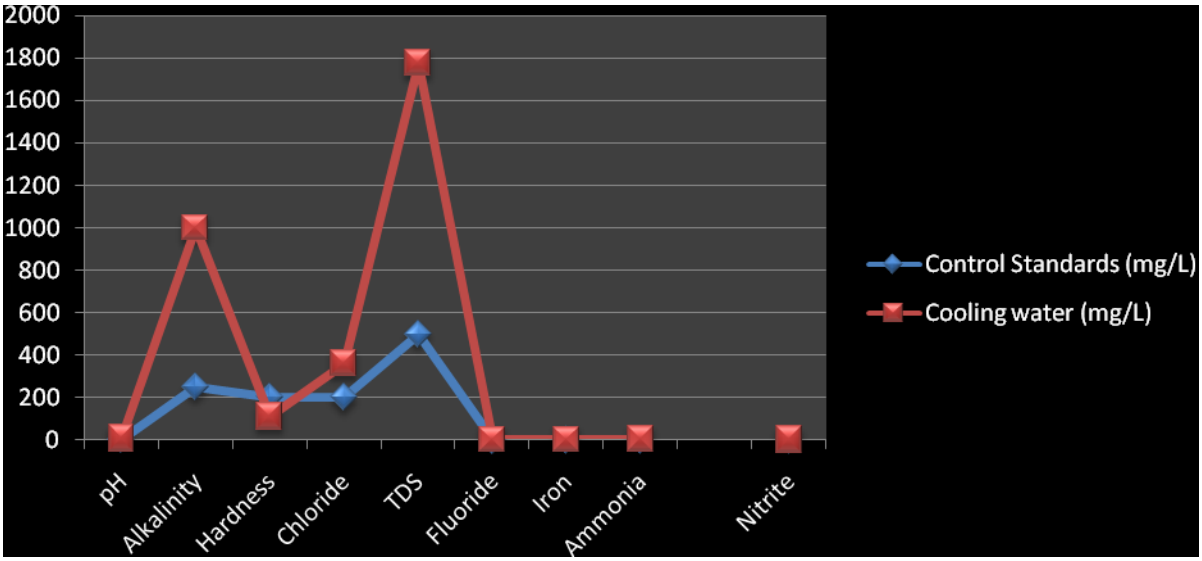
Cooling water quality analysis

In this section, results of the cooling water quality analysis, from dye industry were presented. The characteristics of the wastewater was evaluated in terms of total dissolved solid (TDS), pH, chloride, ammonia, fluoride, alkalinity, hardness, nitrite, nitrate and Iron. Details of the results are reported in Table 1 and also represented as Diagram 1.

Table 1: Results of the cooling water quality analysis

Parameters	Control Standards (mg/L)	Cooling water (mg/L)
pH	6.5 - 9.2	7.5
Alkalinity	250	1000
Hardness	200	110
Chloride	200	360
TDS	500	1776
Fluoride	1	2.5
Iron	1	2.5
Ammonia	1	3
Nitrite	1	1.5
Nitrate	1	2.7

Diagram 1: Comparison of Cooling water quality analysis and Standard controls



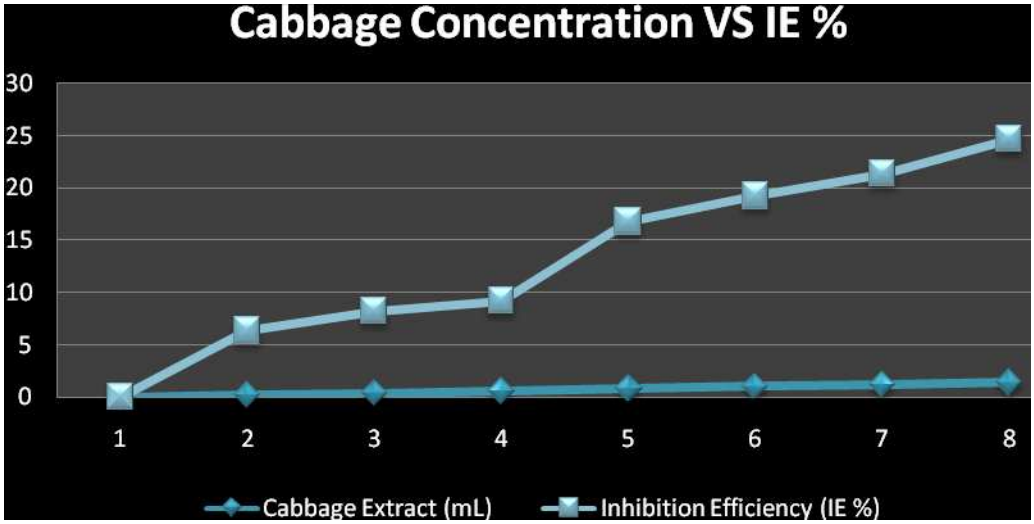
Performance of corrosion treatment

The inhibitive action of *Brassica Oleracca* extract and its main constituents on the corrosion of mild steel in cooling water (cooling water) was investigated through the weight loss and surface analysis. The weight was measured (before and after immersion) to determine the inhibition efficiency (IE) by using Equation (1). Table 2 and diagram 2 shows that the results of the IE for different concentrations of cabbage. At 35° C, the IE was in the range of 0 – 23.25% (at 0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4 mg/L of cabbage). These results demonstrated the inhibition efficiency (IE) of corroded nails increased when the cabbage extract concentration was elevated[8].

Table 2: Results of Inhibition Efficiency (IE %)

Cabbage Extract (mg/L)	Inhibition Efficiency (IE %)
0	0
0.2	6.12
0.4	7.84
0.6	8.65
0.8	15.95
1	18.22
1.2	20.14
1.4	23.25

Diagram 2: Inhibition Efficiency VS Cabbage Extract



CONCLUSION

This study has demonstrated that the characteristic for cooling tower complies with the standard requirements. All the parameters tested (e.g. TDS, Hardness, Alkalinity, pH, Iron, Chloride, Ammonia, Nitrite and Nitrate) comply with the parameter limit as stated in the Standard controls of the WHO and indicated that the wastewater is contaminated by some ionic pollutants which are responsible for corrosion of the iron pipe lines.

Based on the corrosion treatment, in the weight loss measurement analysis showed excellent ability of *Brassica Oleracca* extract in reducing the corrosion on the surfaces of the iron with a certain inhibition efficiency percentage. The inhibition efficiency (IE) of corroded irons increased when the cabbage extract concentration was elevated. In addition it has been proven that *Brassica oleracea* can be used as a natural corrosion inhibitor. It can be concluded that the cabbage extract a natural substance that is eco friendly, economical and effective corrosion inhibitor.

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