Corrosion of Brass in Solutions of Alkali Metal Salts of Various Anions

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Corrosion of 80 : 20 (α) and 59 : 41 ($\alpha+\beta$) brasses in solutions of alkali metal salts of various anions has been studied. The nature and extent of corrosion and its mechanism have been discussed.

Copper is one of the industrially important metals with valuable properties such as high electrical and thermal conductivities, resistant to atmospheric corrosion in rural areas. Some of its alloys, like brass, also retain these properties. Use of copper and brass, as heat exchanger tubes, particularly in sea water, is well known. Hence, studies in corrosion of copper and brass in various systems have been extensively carried out [1-11]

The study presents the nature and extent of corrosion of brass by neutral or nearly neutral solutions of alkali metal (Ca) salts of various anions and the role of various anions attacking the brass under simi larconditions.

EXPERIMENTAL

Brass sheets, of the following compositions cold rolled and annealed at about 550°C, were used :

1. α brass : 80%Cu; 20%Zn. 2. $\alpha+\beta$ brass : 59%Cu; 41%Zn.

A specimen of 6 cm. × 3 cm. was polished using emery papers. Subsequently a mirror like finish was obtained by jeweller's rouge. It was finally degreased, dried and immediately weighed. It was then vertically suspended in 230 ml. of 0.1 N salt solution in each case, the exposure period being 7 days. The temperature was maintained at 35°C (±2°C).

After completion of the exposure period, the specimen was washed with 5% sulphuric acid and then with distilled water. It was dried and weighed.

Copper was determined iodometrically. However, it was not determined where the corrosisn Losses were negligibly small. Zinc was obtained by difference.

The experiments were performed in duplicate but only mean results are recorded in Table-1.

TABLE 1

Potassium Salts (0.1 N) : Duration :- 7 days

Salt	80 : 20 brass Weight Loss mg/dm²	Ratio Cu:Zn	59 : 41 brass Weight Loss mg/dm²	Ratio Cu:Zn
$K_2S_2O_8$	2236.0	1.4	2180.0	0.55
KI	23.8	4.8	19.4	2.0
KCl	10.6	0.41	8.1	0.38
KBr	1.7	—	2.8	—
K_2SO_4	9.4	0.89	10.0	0.38
KNO_3	8.9	1.5	8.6	0.65
$KHCO_3$	20 3	2.7	23.3	1.4
K_2CO_3	1.4	—	2.2	—
KNO_2	3.3	—	6.4	—
$KMnO_4$	4.4	—	4.7	—
K_3PO_4	1.1	—	2.2	—
K_2CrO_4	0.8	—	1.9	—
$K_2Cr_2O_7$	0.8	—	1.7	—

DISCUSSION

Table–1 shows that the order of the corrosive action is almost similar in both the brasses except in a few cases.

The maximum attack has been observed in $K_2S_2O_8$ solution which is accompanied by dezincification. It is known that perdisulphates are strong oxidising agents and can act as powerful cathodic depolarisers. Many metals also dissolve in solutions of perdisulphates without evolution of

gas with the formation of their sulphates[12]. The plates of both the brasses were covered with violet but loosely attached films and the solutions turned dark blue in the case of 80:20 brass and blue in the case of 59:41 brass' The plates, after washing, were found to be reddish. This indicates that copper has been preferentially attacked and redeposited. The redeposited copper can act as an efficient cathode leading to very high corrosion losses and dezincification. Thus, the attack by perdisulphate is of the electrochemical type.

Among the halides, corrosivity is in the increasing order of bromide, chloride and iodide. It has been reported that NaI is most corrosive among sodium halides towards Cu-Zn alloys[13]. The plates of both the brasses were covered with white films presumably due to the formation of Cu_2I_2[14]. Cu:Zn ratio also shows decuprification indicating that the attack by KI is more towards copper rather than zinc. The action of KBr has resulted in the formation of very thin yellow film, protecting brass from further attack.

The extent of corrosion in K_2SO_4 and KNO_3 solutions are almost in the same range of KCl. In these cases. the formation of yellow or brownish films were observed. Also the attack by KCl, K_2SO_4 and KNO_3 is similar in nature as in each case dezincification has taken place.

It is interesting to observe that the attack by $KHCO_3$ is almost equal to that of KI but differs in the fact that dezincification has occured in $KHCO_3$ solution. However, the attack by K_2CO_3 is very poor. This may be due to the nature of the films formed. In the case of $KHCO_3$ the plates of both the brasses were covered with thick and loose films of brownish black colour, may be due to the formation of oxides. On the other hand, in the case of K_2CO_3, the films formed were very thin and adherent, which might have passivated brass from further attack. Thus HCO_3^- ions are more corrosive towards Cu-Zn alloys than that containing Cl^-, SO_4^{-2} or NO_3^- ions.

The mild attack by KNO_2 and $KMnO_4$ on both the brasses may also be attributed to the formation of very thin films observed. It has been reported that $NaNO_2$ and $KMnO_4$ have tendency to inhibit corrosion. The treatment of ferrous articles in 25-30% $NaNO_2$ solution for 3-5 minutes prevents rusting for 1 year[15]. Addition of $NaNO_2$ to water also favours the formation of the oxide film which acts as protective coating[16]. During the studies in corrosion of aluminium sheets by NaOH. it has been shown that it is inhibited in presence of $KMnO_4$ which is due to the formation of MnO_2 layer[17].

In K_3PO_4, K_2CrO_4 and $K_2Cr_2O_7$ these alloys are found to have minimum-almost neglible corrosion losses. Both the brasses in these solutions were covered with very thin yellow layers, Addition of phosphates, chromates or silicates leads to the formation of protective coatings on metal surfaces in water[16]. Na_2CrO_4 has also been found to inhibit corrosion of aluminium in NaOH due to the formation of protective Cr_2O_3 layer[17].

CONCLUSIONS

The nature and extent of corrosion of brass may depend upon various factors but mainly upon (a) the reactivity of the anion with metal (b) the nature of the film formed and (c) the depolarising action - anodic or cathodic.

The servere corrosion by $K_2S_2O_8$ is due to the cathodic polarising action and dezincification of the electrochemical type.

The extent of corrosion in other cases is due to the preferential attack towards zinc leading to dezincification and the formation of loosely attached films. It is only in the case of KI, decuprification has occured due to the reaction of copper with KI forming Cu_2I_2.

The anions, which can form very thin but adherent films, show very mild attack on brass or some times almost inhibition of brass from further attack.

Acknowledgement

Thanks are due to Ahmedabad Education Society for providing research facilities.

REFERENCES

1. K. Inamura, *Science Repts Tohoku Imp. Univ.* 16 (1927) 999.
2. C. W. Stillwell and E. S. Turnipseed; *Ind. Eng. Chem.*, 26 (1934) 740.
3. R. T. Mckay and R. Worthington; "Corrosion Resistance of Metals and Alloys" *Reinhold Publishing Crop. N. Y.* (1948) 433.
4. R.C.L. Bosworth; J. Proc, Roy. Soc. N.S. Wales, 83 (1949) 8.
5. C.V. Jr. Duijin Polytech Tijdschr, 6 (1951) 119 a.
6. H.H. Uhlig: "Corrosion Hand Book" *John Wiley and Sons Inc. N. Y.* (1955) P. 74-75.
7. C.M. Eisenbrown and P.R. Bervis. *Chem. Eng.* 20 (1963) 148.
8. U. R. Evans: "An Introduction to Metallic Corrosion" *Edward Arnold (Publishers) Ltd. U.K.* (1963) P. 60.
9. R. S. Shah and (Late) A. M. Trivedi; *Labdev J. of Science and Technology India*, 12 A No. 3 (1974) 132.
10. R. S. Shah and C. S. Desai; *Trans. SAEST, (India)* 11 No. 4 (1976) 469.
11. R. S. Shah and C. S. Desai; *Werkstoffe and Korrosion* 27 (1976) 706.
12. H. J. Emeleus and J. S. Anderson; "Modern Aspects of Inorganic Chemistry" *The English Language Book Society and Routledge and Kegan Paul Ltd. London*, (1961) P. 430.
13. Vide ref. 6
14. A. I. Vogel. "A Textbook of Macro and Semi Micro Qualitative Inorganic Analysis" *Longmans Green and Co. London*, (1955) P. 226
15. Z. I. Gavrilyuk; *Avtomobil i; Tractor Prom*, No. 2 (1957) 40-1.
16. Luigi Platt; Korrosion X Ber Korrosionstag. Koln. (1957) 31-5.
17. Nello Collari and Nella Fongi Alumino, 16 (1947) 13-21.