Corrosion of Tin-Lead Alloy and Brass by Souring Substances

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Some organic acids present in food additives in India are corrosive to tinned brass vessels. Corrosion of tin-lead (50/50) alloy and brass (63/37) was studied in coupled and uncoupled systems. Films were formed over tin-lead specimens. In coupled system, tin-lead specimens underwent mostly pitting type corrosion.

Brass vessels used for cooking and storing foods are always tinned for protection against corrosive effects of acidic food stuffs. Due to high cost of tin, nowadays, lead is mixed with tin to make the tinning cheap. Lead salts are toxic to human beings [1-3] . Due to corrosion, lead of the alloy may enter the food stuff with undesirable consequences. In the present study, corrosive effects of different souring components like lemon, hogplum, tamarind, kokum, tomato, mango and curd are examined with and without addition of sodium chloride.

EXPERIMENTAL

Brass (63/37) specimens of thickness 0.048 cm and size 3.9 x 2.9 cm^2 and circular tin-lead (50/50) specimens of thickness 0.088 cm and diameter 2.26 cm were used in the study. Brass specimens were polished using 0 to 4/0 oakey emery papers successively. The final polishing was done using jeweller's rouge [4]. Tin-lead specimens were rubbed with pumice powder and rough cloth followed by smooth calico cloth. Finally both specimens were washed with distilled water and degreased [5]. Corrosion study was carried out both in coupled and uncoupled mode. In coupled systems, the two specimens were connected together at the top part of the specimens and fixed together with a plastic hook. In uncoupled system, brass and tin-lead specimens were fixed independently by plastic hooks. In both systems, the specimens were totally immersed vertically in Carning beakers of tall form containing 100 ml of corrosive media.

Solutions of different souring substance for study was prepared as follows:

Fresh lemons were washed and squeezed in a wooden squeezer and the juice was collected. Hogplum, tamarind and kokum were cleaned by removing the nuts; 500 g. of each of these substances was dried in air indoors, soaked in 1000 ml of distilled water for 12 hours. The entire mass was churned in a crusher to obtain a suspension.

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Ripe tomatoes were washed and crushed to form suspension.

The husk of unripe mangoes were separated from the seed and the pulp was crushed to obtain the suspension.

Curd was just churned to give the suspension. Souring samples so obtained was appropriately diluted to give 100 ml suspension and temperature set to 30°C. Such samples were prepared without any addition and also with addition of 0.585 gm NaCl in 100 ml to make it 0.1 M. The specimens were kept soaked in these souring suspensions for 7 days duration. At the end of 7 days, the brass speimens were cleaned with 5% sulphuric acid and tin-lead specimens with 1% boiling acetic acid. Finally they were washed with distilled water and degreased [5]. The loss in weight was taken as a measure of corrosion. The electrode potentials of the two specimens were measured in 0.05 M citric acid against SCE.

RESULTS AND DISCUSSION

In coupled systems, tin-lead specimens developed a black or ash coloured thin and loose film with tamarind, lemon, hogplum and kokum, the corrosion being shallow pit type. In tomatoes and mangoes, the plate below the black, thick and loose films was uniformly corroded. Brass specimens however, retained their original luster. In case of lemon, mango, kokum, tomato and curd, a faint, adherent circular tin-lead impression of the size of tin alloy was seen on the brass specimens indicating the coupled position. In case of tamarind sample, both sides of the brass sample were partially tinned quite faintly. With hogplum, no tinning impression was observed.

In uncoupled systems, the corrosion of tin-lead alloy was of uniform type: a thin, loose and black film was formed only with mangoes. However, brass specimens retained their original luster with all souring substances except lemon. In this last case, the specimen lost its luster and formed a thin, loose and black film.

Addition of sodium chloride had apparently not much effect on the observations made above with both brass and tin-lead alloys and both coupled and uncoupled systems.

Loss in weight (in mg) in each case is determined. In some cases, souring suspensions were used as such. In others, it was suitably diluted with distilled water. These results for different souring substances (with dilutions used) are given in Table 1. In many of the tests with brass there was actually weight gain. (+ indicates gain in weight).

In case of tin-lead alloy in uncoupled mode, loss in weight was somewhat less in presence of sodium chloride. In coupled case, loss in weight of tin-lead alloy was slightly higher in presence of sodium chloride. Brass specimens mostly exhibit some increase in weight. In presence of chloride, corrosion is slightly higher. Of all the samples, only lemon juice was quite corrosive to brass.

Low corrosion of brass in coupled systems is because brass becomes cathode to tin-lead alloy. Formation of "tinning" impression adds

Table 1

Weight loss of Tin-lead Alloy and Brass by Souring Substances
Temperature 30°C; Immersion period 7 days; NaCl added 0.585 g / 100 ml (Final solution 0.1 M in NaCl)

Corrodant Dilution	Tin-Lead Alloy				Brass			
	No NaCl		NaCl (0.1M)		No NaCl		NaCl (0.1M)	
	C	UC	C	UC	C	UC	C	UC
Lemon juice 5%	32	26	45	15	0.3	22	0.3	177
Hogplum 30 %	5.3	3.5	7.2	2.0	+2.1	+1.1	+1.1	+0.3
Tamarind 12 %	12	5.0	11	4.3	+2.2	+0.8	+0.8	6.3
Kokum 30%	5.4	1.9	4.5	0.7	+3.8	+2.4	+0.8	+2.4
Tomato pulp	17	0.6	7.9	0.4	+0.7	1.4	+0.4	0.5
Mango pulp	20	2.0	33	4.0	0.7	0.5	0.5	1.1
Curd	1.9	1.2	2.4	0.4	+0.5	+0.3	+0.6	+0.3

to the weight of brass. Tin-lead specimens undergo higher corrosion as compared to uncoupled systems.

Citric acid is a major component in lemon juice. The electrode potentials of uncoupled brass and tin-lead specimens measured wrt SCE in 0.05 M citric acid solution at 30°C are found to be 17 and -510 mV respectively. These values are in general agreement with galvanic series of similar commercial samples in salt water [6]. Further local cells on the tin-lead specimens are operative. Surface covered by brass in coupled system is less active than the exposed part. Corrosion of tin-lead alloy in uncoupled system decreased in presence of chloride probably because of the formation of insoluble, semi-protective layer of lead chloride. The weight loss values of tin-lead in presence of chloride in coupled systems is somewhat erratic.

CONCLUSION

All souring substances attack tin-lead alloys. Partially tinned brass (or where tin-lead layer is partly removed) can contaminate the food.

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