UTENSILS — THE MAJOR NON-FERROUS INDUSTRY OF INDIA

E. H. BUCKNALL & M. S. MITRA
National Metallurgical Laboratory, Jamshedpur

Abstract

Aluminium and brass domestic utensils are major products of the Indian non-ferrous industry amounting to 80 per cent of the total consumption of these metals in India. The utensils industry is thus a much more significant part of the non-ferrous metal industry in India than elsewhere in the world. The annual production of brass utensils is over 40,000 tons, of which only 7000 tons are produced in registered factories, the balance being manufactured by the cottage industries. Aluminium utensils, on the other hand, are mostly manufactured in factories, the annual production being estimated at over 12,000 tons. India is an exporter of aluminium wares and utensils (978 tons worth Rs. 61 lakhs in 1951) and brass wares and utensils (worth Rs. 35 lakhs in 1951) mostly to the East African, Middle Eastern and South Asian countries.

Production of aluminium and copper in India is not able at present to meet the demands of industry and has to be augmented by imports to the tune of Rs. 750 lakhs (including zinc). Aluminium is the only non-ferrous metal production of which can be readily increased to any large extent in India; this is being organized under the country's first Five Year Plan. From the point of view of national economics it is necessary that for utensils copper alloys be replaced by aluminium and its alloys in so far as this can be done without any prejudice to the indigenous manufacture of copper. This replacement could be easily effected if conservatism and antipathy of consumers against aluminium utensils could be eradicated by suitable publicity accompanied by improved design and manufacture of aluminium utensils. The need for technical control and standardization is emphasized.

Development of Utensils

THE earliest vessels for cooking and other domestic purposes were made from stone. Stone ware even today is rather extensively used in Indian homes. Pottery came next and has continued in popularity, but side by side with this metal utensils have come into use. In ancient times the rich man ate off plates of shining gold. In imitation of this country people the world over have always used shining copper and brass for saucepans and kettles, though efforts towards preserving them in a tarnish-free condition are at best a labour of love and often labour in vain. The townsmen in industrial areas have rarely copied this example. In the early days of the industrial revolution in Europe when cooking was done over open fires, saucepans were heavy iron castings machined inside. They were difficult to keep clean and never looked bright, but they did not cause any appreciable deterioration of taste or colour of food cooked in them, nor did they easily permit local overheating because of their low thermal conductivity and comparatively heavy gauge. Later enamelled iron became the standard material for the townsmen, where an internal glassy layer made the pots nearly as good as stone ware pottery jars when of good composition and well applied. These coatings were first applied to cast iron.

With the advent of the gas stove, the next development was the use of vitrious enamelled light steel pressings for utensils. This type of ware has continued in popularity in Europe and America side by side with aluminium ware. Gas flames are readily adjustable and light gauge aluminium is acceptable on an equal footing with enamelled iron.

Further developments have occurred only where electric cooking is general. With many designs of electric stove it is desirable for economy's sake that the bottoms of the utensils sit flat on the hot plate. Normal and spun or pressed aluminium ware will not do so. Heavy gauges must be used and the bottom turned. Where elaborate means are used to produce the saucepans, the question arises, why not use still more expensive materials if the finished product is more attractive in appearance or more serviceable with little proportionate increase in cost ? Stainless steel utensils come in this category.

A few firms in Europe and America make solid nickel or high-nickel alloy (e.g. inconel) cooking vessels for a market which is mainly confined to hotels and hospitals. An interesting development in this direction was the introduction in the United States of a material known as Rosslyn metal (which has since found use in gas turbines). This comprises a sandwich of copper in a corrosion-resistant nickel-base alloy. Such a sandwich has excellent lateral conductivity, but only limited conductivity through the section. This thoroughly eliminates hot-spots and allows fast heat exchange by 'spreading the heat' over a large area.

In Europe cake tins and meat-cooking dishes for oven use are traditionally of tin plate, but black iron serves in some households.

'Pyrix' and other boro-silicate glass wares are also extensively used for various cooking purposes in Europe and America.

Utensils Industry in India

The domestic utensils industry in India is a major consumer of non-ferrous metals, both indigenous and imported. The most important products are brass wares and aluminium wares. Copper, bell-metal, bronze, nickel-silver and silver wares are also manufactured in minor quantities. The high proportion of imported metals used, the extent to which the choice of materials for domestic vessels in India differs from that made elsewhere, and lack of attention sometimes given to detailed steps in manufacture and in control of materials, considered essential elsewhere, justify serious consideration being given to the rationalization of the industry.

Consumption of non-ferrous metals and alloys in India during 1948 for the manufacture of domestic utensils was as shown in the following table[1]:

TABLE 1

	Domestic utensils		Other products, tons
	Tons	Value, lakhs Rs.	
Aluminium	7636	394	1105
Brass	6325	238	1845
Copper	134	5·41	—

It is to be observed from Table 1 that over 80 per cent of the total requirement of aluminium and brass was consumed for the manufacture of utensils. This compares with the estimated 2 per cent in U.S.A. and Europe. The utensils industry is thus a much more significant part of the non-ferrous metal industry in India than elsewhere in the world, and the estimated value added by manufacture was over Rs. 480 lakhs.

The total number of registered factories (large units only) in 1948 engaged in this was 202 and the number of their employees over 30,000. Their capital was 13·5 crores. The making of brass and copper utensils is, however, mostly a cottage industry spread throughout India. No reliable statistics can be obtained about labour employed, etc., of these cottage industries, but some idea of their production is given by the estimated consumption of brass sheets for domestic utensils which is 40,000 tons annually[2]. The consumption of aluminium for the year 1946 has been estimated at about 13,000 tons[2]. Only about 10 per cent of the total was intended for manufacture other than utensils. Chief centres of the cottage industries are

Berhampore, Nadia, Vishnupur and Karar in West Bengal; Poona, Nasik, Hubli and Pardi in Bombay; Moradabad, Hathras, Mirzapur and Benares in U.P.; Chittoor, North Arcot, Trichinopoly, Tanjore and Madura in Madras, and Jagadhari and Amritsar in East Punjab. Art brass wares of Jaipur, Baroda and Kashmir are also very well known.

India also has good export trade for aluminium and brass wares and utensils. Aluminium wares and utensils worth Rs. 61 lakhs (978 tons) and Rs. 55 lakhs (878 tons) were exported in 1951 and 1952 respectively mostly to East African, Middle Eastern and South Asian countries. Exports of brass and copper wares and utensils for the same periods have been valued at Rs. 35 lakhs and Rs. 13 lakhs respectively. In the export trade this accounts for 10 per cent of aluminium and 1 per cent of brass wares and utensils production of India.

Processes of Manufacture

In general, brass utensil making is organized according to mechanized production or is on a cottage industries basis.

The main stages are:

1. Alloying and casting
2. Rolling sheets or circles
3. Cutting of blanks
4. Fabrication of utensils by spinning or beating
5. Finishing.

Not all the factories perform all these stages of manufacture. Many of the factories purchase sheets or cut-blanks from rolling mills like the Indian Copper Corporation or Metal & Steel Factory, Ishapore, and perform only the fabrication and finishing operations. Other factories melt together imported copper and zinc pigs in pit-type furnaces under a cover of borax and cast the resulting alloy into small, closed clay moulds through a hole on the top, to yield flat, circular cakes weighing between 2 and 10 lb. The composition of the alloy is usually 68 per cent copper and 35 per cent zinc.

The cakes are then generally hot-rolled singly and subsequently in packs into round disks of desired thickness and size. Blanks are cut from the rough disks by means of hand shears.

From the blanks, utensils are made on spinning lathes either with or without a previous operation of stamping or pressing and are also often formed by hand-beating as in many cottage industries. To finish the parts, they are generally scraped and/or burnished on lathes.

Aluminium wares, on the other hand, are mostly manufactured by large concerns. It was estimated that over 95 per cent of the total Indian output was produced by the five larger concerns[2].

Aluminium ware is manufactured by pressing, spinning or casting. In pressing, the blank after lubrication is pressed into shape in power presses. Deeper pressing is done in two successive stages. The wrinkles produced are removed and the edge trimmed and beaded during spinning. Pressing is used for the manufacture of many articles like saucepans, dishes, tea-trays, dekchis, tea-kettles, etc.

In the spinning process the blank or partially drawn article is held between a chuck and a tail-piece in a lathe. A wooden or metal former having the internal shape of the article to be produced is attached to the chuck and while the whole assembly rotates the blank is forced against the chuck with the aid of tools. Spinning is adopted in the case of all re-entrant shapes and also for edge curling, beading and seaming.

Some articles are also made by hammering the blanks with mallets over wooden moulds. Smaller concerns use this process for most of their operations.

Ordinary sand castings are used for making certain utensils and many parts of aluminium ware. The several parts are joined together by riveting or by welding.

Aluminium ware is finally finished by buff polishing, tool finishing or matt finishing.

Besides the brass and aluminium wares, bell-metal (Cu 7, Sn 2), gun-metal and nickel-silver wares are manufactured mostly on cottage industry basis. Bell-metal and nickel-silver wares are worked similar to cottage industry style brass wares. Gun-metal and other inferior alloys containing copper and zinc and which are not so malleable as bell-metal or brass are usually cast. The cast articles are then filed to remove surface irregularities and defective castings are soldered. They are finally scraped by means of chisel on an improvised lathe and finished.

Moradadad articles are given a final coating of pure tin (*qualai* work). Moradabad ware is also increasingly electroplated with nickel or silver. Art wares are finished by engraving or embossing.

Dependence of Industry on Imports

The metals required for the utensils industry are copper, zinc, aluminium and tin. Of these metals some aluminium and small quantity of copper are produced in India. The brass ware industry consumed 30,000 tons of brass sheets in 1947[2] and the average annual consumption has been estimated at about 40,000-50,000 tons per annum[3]. Of the 40,000 tons of brass required for the utensils industry approximately 10,000 tons are made by the Indian Copper Corporation from Indian copper and another 6000 tons by refining scrap. The balance of 24,000 tons of brass is manufactured every year from imported copper and zinc. The estimated landed cost of these without duty is over 5 crores.

The present production of aluminium is 4000 tons and imports average 10,000 tons per year valued at Rs. 2½ crores. Aluminium production at present meets only a part of the country's demand. The two factories producing aluminium are increasing their production to 10,000 tons and there is a proposal to establish an additional reduction plant of 10,000 tons capacity in Orissa[4].

In the country's first Five Year Plan this increase in aluminium production has been envisaged. Copper production by the Indian Copper Corporation is about 7000 tons per year. The country's resources of copper ore cannot justify any plan to increase this rated capacity. In any foreseeable plan, production of tin and zinc cannot be envisaged[3].

From the foregoing it can be seen that aluminium is the only metal production of which can be increased to any large extent. Reserve of aluminium ores and the development of cheaper hydro-electric power make it possible for India to have a large aluminium industry.

The question, therefore, arises if it is not necessary from the point of view of national economics to replace copper alloys by aluminium wherever possible. Much headway has been made as regards electrical transmission, but no attention has been paid to the major consumer of imported non-ferrous alloys — the utensils industry. There is much scope of success since aluminium, due to its cheapness, has already replaced quite a fraction of our kitchen equipment.

Aluminium as an Alternative

There is still some lurking suspicion in the minds of both the educated and others about the toxicity of aluminium. Our foods are often complicated mixtures of soluble and insoluble proteins, starch, glycogen and fibrous materials; fats; pectins, gums, etc.; sugars; inorganic and organic salts and organic acids. They can be broadly divided into those which have a more or less neutral reaction, e.g. meat, fish, milk and vegetable products, and those with an acid reaction like fruits, fruit juices, pickles and sour milk products. There are probably no alkaline foods, but alkali is sometimes added in cooking certain vegetables. Generally, neutral products free from salt cause little or no trouble in contact with aluminium. Acid products, while usually harmless in the cold, may dissolve aluminium to a greater or less extent when heated. Alkalis are, of course, definitely harmful. The matter is complicated, however, by the fact that salt is often present either naturally or as an addition. It is, therefore, necessary to consider foods individually since the net results as regards corrosion will depend on whether inhibitors of corrosion, such as colloids, fats and sugars, and buffering substances, etc., will counteract the corrosive effects of acids and salts[5].

In determining the amount of aluminium taken up in preparing various classes of foods, allowance must be made for that portion which occurs naturally. Beal and his co-workers[5,6] estimated that in a balanced English diet about 12 mg. of aluminium would be ingested daily if all the foods were prepared in aluminium vessels and of this not more than 40 per cent would be obtained from the utensils. A higher figure is given by Von Gellenberg, who estimated that approximately 8-10 mg. of aluminium would be taken up from cooking utensils in the daily diet together with a similar or somewhat larger amount occurring naturally in the food[5,7].

As already pointed out, type of food affects to a great extent the quantity of aluminium contamination. While during cooking of oat-meal for 150 min. average increase in aluminium is as low as 0·55 p.p.m., the increase during the cooking of creamed cabbage for 45 min. is 90·5 p.p.m.[5,6]. A thorough investigation would, therefore, be necessary with representative Indian dishes to assess aluminium contamination of the average Indian diet.

The evidence concerning the effect of ingested aluminium on animals and human beings has been very conflicting and confusion has arisen through lack of distinction between the effects of aluminium salts when consumed in foodstuffs and when injected directly into the blood stream. The subject has received thorough investigation particularly by Burn who exposes fallacies in various arguments concerning the alleged toxicity of aluminium[5,8]. It is believed that Monier-Williams has put the whole matter into perspective by saying: 'There is no convincing evidence that aluminium in the amounts in which it is likely to be consumed as a result of using aluminium utensils has a harmful effect upon the ordinary consumer. It is possible that there may be individuals who are susceptible to even such small doses of aluminium as may be derived from aluminium utensils, but evidence of this is inconclusive '[5,9].

The conclusions of the six years' investigation at the Mellon Institute, Pennsylvania, are[5,10]:

1. Aluminium is not a poisonous metal and does not give rise to any disease;
2. Aluminium utensils are very resistant to corrosive foodstuffs cooked therein; and
3. Aluminium does not accelerate the destruction of vitamins or other food substances accruing during cooking.

The views of the Council of Public Hygiene of France[5,11] and of the German Board of Health[5,12] are also clearly to the effect that there is no more likelihood of producing organic disease or food poisoning by the use of aluminium cooking vessels than by the use of any other sort of cooking vessels. The corrosive action of natural waters on aluminium has been studied extensively. In general, waters are liable to be corrosive if they are acid or alkaline or contain appreciable amounts of chloride and, in particular, if they are contaminated with salts of heavy metals derived from the soil or picked up in pipe systems, etc. Apart from these conditions, it can be stated that the action of tap and industrial waters on aluminium and its alloys is usually small and they are likely to give good service in contact with waters. Analyses have shown that the amount of aluminium normally taken up by water is very small, being often of the order of one to five parts per million. According to Lichtenberg[13], soft waters and those softened artificially are more corrosive than hard waters, because protective coatings are more readily formed on aluminium in the latter. There is, of course, the possibility of overheating as well as mechanical damage to be recognized where this aluminium ware is used with hard waters. Also with natural waters the general experience is that aluminium is normally less acted upon by waters the greater the degree of purity of the metal[14].

Advantages and Drawbacks of Aluminium Wares

A cooking utensil must have advantages other than superior lightness if it is to be successful in this highly competitive field. The modern aluminium utensil does have other advantages, the chief of these are ductility, ease of fabrication and high heat conductivity. The low density is also an advantage from the cost angle since an aluminium utensil weighs only about one-third as much as those of most other metals which might be used. Another important consideration is that the effect of small amounts of dissolved aluminium on foods themselves is usually negligible. Aluminium salts are colourless, tasteless and, so far as is known, harmless to human beings. Metals such as copper, iron and tin form dark-coloured or black sulphides and are prone to tarnish in contact with foods containing sulphur compounds, while the presence of mere traces of dissolved salts of some metals brings about discolouration of foods and destruction of vitamins.

Why then with all the advantages aluminium possesses it has failed to replace other metals and alloys, principally brass, copper and bronze, in Indian kitchens? These can be analysed as:

1. Cottage industry basis of brass ware manufacture;
2. Religious and social conventions;
3. Ignorance about proper maintenance and cleaning;
4. Non-adaptation of Indian aluminium wares to Indian methods of cooking.

1. The cottage industry basis for brass and bell-metal ware manufacture makes it difficult to do away with them without finding an alternative work for the craftsmen. This, therefore, cannot be done in a hurried way and metal-workers in cottage industry have to be trained for work with aluminium.

Aluminium working is very similar in nature to brass or bell-metal working and then craftsmen would easily adapt to the change-over. Already a small percentage of aluminium utensils are made by cottage industry craftsmen.

In the early days of aluminium utensils the quality of metal used to vary widely. Some of the larger concerns by maintaining a good standard of the quality have established a reputation for this product. The smaller concerns and the cottage industries are unable to compete profitably with the larger concerns, which in some cases also have control over the basic industries manufacturing aluminium ingots or sheets. The smaller concerns often manufacture utensils from ingots made by melting unclassified aluminium scrap and sell these at cheaper rates. These utensils are generally not satisfactory. The practice has been harmful for the aluminium utensils industry as a whole and in particular for the smaller concerns and the cottage industries by alienating the interest of the consumers from their products. For safeguarding the unwary consumers it is thus necessary to institute a system of quality control of the utensils.

To make the manufacture of aluminium utensils in the cottage industries a success, the essential prerequisite would be the supply of uniformly good quality circles or annealed, primary pressings to the cottage industries. The craftsman needs better and more constant metal than a factory would for the production of utensils economically. The cold-rolled sheets, from which the circles are blanked, should be free from directionality in properties. Annealing and direction of rolling must be very well controlled for this purpose. Any directionality in mechanical properties would give rise to non-uniform flow of metal during pressing and spinning.

The uniformity of thickness and the quality of surface are also important considerations for the craftsmen who would otherwise have to finish by scraping.

2. Religious and social conventions are the major causes of antipathy against aluminium of an average Indian. In religious performances, copper and brass utensils only are used, just as vegetables like tomatoes introduced into India by foreigners are not used for religious offerings. Orthodox people would not eat food cooked in aluminium vessels since aluminium is a metal not mentioned in scriptures. This suspicion has been further strengthened by early adverse propaganda against aluminium. Stainless steel utensils, on the other hand, have been adopted even in orthodox homes. The fine corrosion resistance, the polished surface and the heaviness of the material along with ease of maintenance and cleaning have been appreciated. But above everything it is the knowledge that the material is only a kind of steel and nothing new out of our scriptures which has helped its ready adoption even by orthodox people. The other convention, specially with poorer people, which is against aluminium is that poorer families desire to have something substantial in the home. It is the same desire which prompts the richer people to purchase gold and silver ornaments when there is some money to spare. Purchasing of kitchen equipment is mostly done at the instance of housewives. This desire of having something substantial around the home makes them decide for brass or more costly bell-metal wares.

3. Aluminium wares get into trouble due to carelessness in the choice of materials for cleaning. The good appearance of aluminium utensils is easier to maintain than to restore. The maintenance of clean surfaces on an aluminium utensil is not difficult. What is required is a mild abrasive and a little soap or other detergents together with plenty of water. Alkaline substances such as washing soda are very corrosive and harmful to aluminium. A smooth surface is not only more readily cleaned than a rough surface, but is also more resistant to general corrosion. The use of coarse abrasives which both roughen the surface and disrupt the protective film of oxide should, therefore, be avoided. Aluminium equipment should be kept dry when not in use. Thin films of moisture and water trapped in pockets induce corrosion and are to be avoided. In Indian houses mixed brass and aluminium wares are cleaned the same way with coarse abrasives. The protective film of oxide is almost nearly removed and as a result the ware is more readily corroded and pitted. This is probably the reason for the usual bad appearance and a bad name for aluminium wares in Indian homes. Food often is burned and if the surface is smooth it is easier to remove the burnt or otherwise accumulated food. Maintenance of smoothness is essential for kitchen wares, and because of the softness of aluminium compared to usual brass and bronze alloys, aluminium in Indian homes suffers by equitable treatment with these. Indian homes which can afford, therefore, avoid aluminium wares.

4. Methods of Indian cooking in general are quite different from European methods. While introducing aluminium wares in India this has been done simply by copying the brass and bronze wares in lighter gauges or by copying European type pans. Indian cooking is usually done at higher temperatures. For cooking a watery mass only, e.g. boiling milk, rice, dhal, etc., the light gauge usual equipment has proved quite successful. But for Indian dishes which require heating a semi-fluid mass over the fire for a pretty length of time or slow frying light gauge aluminium ware has been inadequate. Food often gets burnt due to local overheating. Heat capacity of the

light aluminium wares being lower than that of heavier brass or bronze, the cooking cannot be continued for any length of time outside the top of the furnace after the proper temperature has been reached.

Indian meal is cooked over a furnace burning coke or firewood, and control of temperature is difficult unlike gas or electric stoves. Heating is quick and strong and cases of overheating with light gauge wares are pretty common.

Moreover, the thin gauge aluminium wares are not very rigid and are apt to be dented very soon. These dents, which spoil the good looks of the ware, are hard to clean and are as well convenient spots for corrosion. The commercial purity aluminium, which is mostly used for aluminium wares in India, is soft and the wares get easily dented. The cold-work accompanying the dent makes the dented part very liable to grain growth while being heated during cooking. The grain growth makes the material weak and failure is enhanced.

Besides the cooking utensils, metal is also used in Indian houses as dishes, bowls and tumblers. For these things aluminium has failed miserably due to its virtue of lightness. Light dishes which move with the slight friction of the hand during the process of eating and light tumblers which not being bottom heavy tumble too readily, are just not acceptable. The heavier conventional articles can never be replaced by aluminium, and stainless steel is probably the only alternative to brass and bronze.

Recommendation for Replacement of Brass and Bronze Wares

From the analysis of the causes for sentiment against aluminium wares and the desirable qualities in brass and bell-metal wares, it can be seen that aluminium, as it is, cannot adequately replace brass and bronze. Brass and bronze wares are not, for that matter, ideal for domestic utensils, but possess a very fair combination of the qualities desired.

The main defects of aluminium ware have been shown as softness, inability to retain the highly polished surface of new articles, development of hot-spots during cooking, and extreme lightness. The very low scrap value of aluminium against brass and bronze may also be put up as a point of disfavour.

The apathy due to religious convention would possibly be overcome with enlightened propaganda and education as well as by economic considerations. Instructions issued with aluminium utensils for proper cleaning and maintenance, especially the harmful effects of alkaline and strong abrasives, would increase the durability of aluminium utensils and make them cheaper even in the long run. It is pretty often argued that brass and bell-metal wares are cheaper in the long run, but it should not be so. Normal life of brass and bell-metal wares may be estimated to be approximately 10 and 15 years respectively in regular daily service. Ordinary aluminium wares on the same basis would require renewal after four years. The cost of a bell-metal pan is about nine times that of an aluminium vessel of similar capacity, and even taking into account high scrap value (over 60 per cent) of the bell-metal ware, aluminium proves cheaper.

For acceptance on the same basis of brass and bell-metal, aluminium ware must be made more rigid. One method would be to use heavier gauge. Heavier gauge aluminium wares are possible and the trend abroad is for heavier gauge. Between cast and sheet metal utensils, it is not usually possible to ascribe superior virtue to any particular type, while it is true that sheet metal generally is denser and without the porosity sometimes found in cast metal; it is also true that by the proper choice of alloy and by the use of good foundry practice and technique, cast utensils may be made as sound as sheet utensils. Cast utensils in general are heavier in cross-section than sheet utensils. Sheet utensils, however, as heavy in cross-section as cast utensils are available abroad. Casting of aluminium alloys normally used for domestic utensils requires rather rigid control in the foundry and it would not be practical to cast utensils on cottage industry scale. For cottage industries the operation of pressing, spinning and subsequent finishing would be possible. The cottage industry craftsmen have to be supplied with uniformly good quality circles, which would be finished into utensils by them.

The other method of strengthening the aluminium wares would be by alloying. In general alloying elements lower the resistance of aluminium to corrosion by acids. Copper and zinc are harmful and their effect is greater the lower the solid solubility in aluminium. Nickel also has a detrimental effect on corrosion of the various alloys; those containing manganese, with and without magnesium, are generally considered to be the most resistant to acid solution and are only slightly inferior to aluminium itself, but their effect depends somewhat on whether the elements are in solid solution or are precipitated, the latter condition being undesirable from a corrosion point of view. The choice of alloy is, therefore, limited to aluminium alloy containing about 1·2 per cent manganese. This alloying improves only to a little extent the hardness and tensile strength over that of commercially pure aluminium.

Increasing the gauge of aluminium wares is thus the only possibility at the present moment for making stronger and more rigid aluminium utensils. More investigations of the possibilities of using an aluminium alloy in place of pure aluminium for the manufacture of utensils are desirable.

One method combining the high strength of duralumin type alloys with corrosion resistance of pure aluminium would be the cladding of duralumin with extra-pure aluminium or manganese aluminium alloy. Alclad 24 S-T (Core: Cu 4·5, Mn 0·6, Mg 1·5 and coating on extra-pure 99·75 per cent Al), Alclad 17 S-T (Core: Cu 4·0, Mg 0·5, Mn 0·4; coating gum as 24 S-T) and Duroplat (Core: duralumin; coat: Al-Mg-Mn alloy) which have been used successfully combining high strength and good corrosion resistance in aircraft industries may be tried for utensil making as well.

Also with the introduction of chromium plating, attractive articles are now made which permanently retain a high polish without the use of polishing material and do not readily scratch.

Stainless steel utensils have been recently introduced in India. These utensils are much favoured, but the deterrent factor in their large usage is the high cost. Moreover, these utensils are at present made only from imported sheets. With larger capacity of steel making in the near future stainless steel sheets may be in time manufactured in India. Nickel and chromium required for the manufacture of stainless steel shall have to be imported. New austenitic stainless steel, with 16 per cent Mn, 16 per cent Cr and 1 per cent Ni, is a good alternate for 18-8 stainless steel. Formability, strength, fatigue and corrosion resistance of this steel compare closely with those of 18-8 stainless steel. This alternate manganese stainless steel would require import of less quantity of alloying elements from abroad since suitable manganese for alloying may be produced in India. However, the initial high cost of stainless steel utensils, in spite of their durability, shall prevent their wide use in Indian homes.

Low cost aluminium alloys have not been found suitable for metal dishes, tumblers, bowls, etc., which are used in Indian homes. Stainless steel would possibly be the only alternative to brass and bell-metal.

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