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APPLICATION OF HOT-DIPPED AND ELECTROLYTIC TIN PLATE IN PACKAGING 1/

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1. INTRODUCTION

Ever since the first tin plate container came into being the consumption of tin plate for packaging purposes has been growing and nowadays about 90 per cent of the total world tin plate production of more than 13,000,000 tons is used for making containers for food, beverages and other commodities.

The consumers are interested in tin plate for packaging not because it is tin coated, but because it is a useful material for making packages. The reasons why tin plate is used for packaging purposes are based on the same considerations which promoted its invention several hundred years ago, namely corrosion resistance, formability, solderability and low cost. With the increase of tin plate production the consumption of tin had risen very rapidly in comparison with its smelting and together with the cost this factor had strong influence on the technological advancement of the tin plate manufacturing process.

In 1942 electrolytic tin plate started to be produced, and in 1967 only about 12 per cent of world tin plate production was made in all countries by the traditional method of hot-dipping.

But in spite of the fact that the share of hot-dipped tin plate is declining in the world production of tin plate, its role in packaging, especially for the developing countries, is still important and consideration of some aspects in application of hot-dipped and electrolytic tin plate for packaging purposes would be of interest to many of them.

In 1967 only two developing countries, the Phillippines and Turkey, were producing entirely electrolytic tin plate, each of them about 45,000 tons. Two others, Brasil and Mexico, were using both processes. Six countries, India, Chile, Spain, Hungary, the Republic of China and Thailand were producing only hot-dipped tin plate.

Altogether these nine countries produced in 1967 approximately 380,000 tons of electrolytic (200,000 tons were made in Brasil) and 220,000 tons of hot-dipped tin plate.

The number of tin plate consumers in the developing world is much higher. According to the statistical data of the International Tin Council some fifty of the developing countries are consuming over one million tons of tin plate without producing it locally, for that reason the problem of tin plate application is essential not only for a small group of producers, but practically for all of the developing countries of the world.

2. TYPES OF TIN PLATE

A variety of tin plate specifications have been developed for specific job requirements by steelmakers working closely with can companies and container users. However, the industry has long recognized the need for overall standardization of the available specifications.

In September 1969 the first edition of the International Standard Organisation R 1111 "Cold-reduced tin plate and cold-reduced black plate" (ISO/R 1111-1969(E), was issued in Switzerland. This document was approved by thirty-two member bodies of ISO among which were the main tin plate producers like USA, USSR, The Federal Republic of Germany, Japan and the United Kingdom together with the representatives of the developing countries like UAR, Turkey, Thailand, Spain, India, Hungary, Chile and Brasil.

The recommendation in the report gives the main definitions: quality requirements dimensional requirements etc. and could be a useful guidance for tin plate producers and consumers in developing countries to establish their national specifications.

According to the ISO Recommendation, tin plate is a low carbon mild steel sheet coated on both sides with tin, applied either by dipping in molten tin or by electrodeposition. Tin plate produced by hot-dipping process is called hot-dipped tin plate; that produced by electrodeposition is called electrolytic tin plate.

The difference in the types of tin plate depends also on the quantity of tin deposited on $1m^2$ of steel.

For hot-dipped tin plate the ISO Recommendation specifies four coating weights of tin as shown in Table 1. The values stated represent the total weight (mass) of tin on both surfaces of a tin plate sheet of area $1m^2$.

TABLE 1 - Coating weights for hot-dipped tin plate

Code*	Nominal coating weight*	Minimum average coating weight
	g/m²	g/m²
H12/12	24.0	21.0
H14/14	28.0	24.6
H15/15	30.0	26.0
H17/17	33.6	28.0

* The code figures are derived from the nominal coating weight on each surface of the tin plate. In hot-dipped tin plate it is not possible, as for electrolytic tin plate, intentionally to vary the distribution between the two surfaces and the total coating is assumed to be equally divided between the two surfaces.

For electrolytic tin plate there is an additional division on equally coated and differentially coated tin plate.

For equally coated as well as for differentially coated tin plate the ISO Recommendation specifies also four coating weights (See tables 2 and 3).

TABLE 2 - Coating weights for electrolytic tin plate - equally coated

Code*	Nominal coating weight*	Minimum average coating weight
	g/m²	g/m²
E2.8/2.8	5.6(2.8/2.8)	4.9
E5.6/5.6	11.2(5.6/5.6)	10.5
E8.4/8.4	16.8(8.4/8.4)	15.7
E11.2/11.2	22.4(11.2/11.2)	20.2

* The code figures are derived from the nominal coating weight on each surface of the tinplate. The nominal coating weight values refer to the total weight (mass) of coating on both surfaces; thus the nominal coating weight on each surface is half of the stated value, for example, E2.8/2.8 has 2.8 g/m² on each surface and a total of 5.6 g/m² on both surfaces.

TABLE 3 - Coating weights for electrolytic tin plate - differentially coated

Code*	Nominal coating weight*	Minimum average coating weight
	g/m²	g/m²
D8.4/2.8	8.4/2.8	7.85/2.25
D11.2/2.8	11.2/2.8	10.1/2.25
D11.2/5.6	11.2/5.6	10.1/4.75
D15.1/5.6	15.1/5.6	13.4/4.75

* The code figures are derived from the nominal coating weight on each surface of the tin plate. The nominal coating weight values refer to the nominal weight (mass) of coating on each surface, for example, D8.4/2.8 has a 8.4 g/m^2 on one surface and 2.8 g/m^2 on the other.

In addition to that the ISO recommends the use of the Rockwell HR 30T hardness test for the so-called "temper classification". The term "temper", when applied to tin plate, summarises a combination of interrelated mechanical properties and no single mechanical test can measure all the various factors which contribute to the fabrication characteristics of the material. However, the Rockwell 30T hardness test (HR 30T) is the best single test available and serves as a guide to the properties of the material. This test forms the basis for a system of temper classification (shown in Tables 4 and 5) which give the hardness values at which the manufacturer should aim.

TABLE 4 - Rockwell HR 30T hardness values normally associated with the temper classification of batch annealed tin plate

Temper classification	Rockwell HR 30T hardness aim	
	Mean	Maximum deviation of sample average
T 50	52 max.	
T 52	52	+ 4
T 57	57	+ 4 + 3
T 61	61	+ 4
T 65	65	+ 3 + 4
T 70	70	+ 3 + 4

TABLE 5 - Rockwell HR 30T hardness values normally associated with the temper classifications of continuously annealed tin plate

Temper classification	Rockwell HR 30T hardness aim	
	Mean	Maximum deviation of sample average
CA 61	61	+ 4 -
CA 65	65	+ 5 - 4
CA 70	70	+ 3 - 4

Of course the special arrangements between the manufacturer and user may contain other provisions but this ISO Recommendation gives the main idea about different types of hot-dipped and electrolytic tin plate now used in the world.

3. FACTORS AFFECTING THE APPLICATION OF TIN PLATE

The choice between electrolytic and hot-dipped tin plate depends on two main factors: corrosion resistance and cost. Both these factors are not simply figures which could easily be obtained from a handbook. Their real value could only be estimated for each particular case after appropriate calculations. For the developed countries where the technological conditions of the canning process, data of different laboratory tests and market prices for tin plate are available, it is not as a rule difficult to make a choice. Practically in all of them there are recommendations for the application of hot-dipped and electrolytic tin plate for different purposes.

In the developing countries it is not always so. Canning processes, climatic conditions, transportation and storaging differ a great deal from those in the developed countries and so their experience cannot be accepted straight away without additional investigations.

Cost factor for the developing countries is not only comparison of world market prices for tin plate but a result of calculation of all the steps beginning from the local production of tin plate and ending with the output of finished containers.

Below are several examples of recommendations on the application of hot-dipped and electrolytic tin plate existing in some of the developed and developing countries to illustrate solutions of the problem in different cases.

4. CORROSION RESISTANCE OF TIN PLATE

When considering corrosion resistance we mainly concentrate on the tin plate intended for food containers, as its properties are more stringent than for other applications, and so more thorough.

The shelf life of many canned foods is limited by damage done to the container by corrosive action of the food. Shelf life ends when the corrosion reactions produce enough hydrogen to swell the can, or when the can is perforated, or when the quantity of tin and iron dissolved in the food exceeds certain limits.

The amount of damage done to the can by corrosion during its storage life varies very much according to the processing conditions and is greater when the cans have large head space volumes or poor vacuum or are subjected to severe heat treatments.

The risk of the corrosion on the outside is much less, especially if the storage room has normal storage conditions with the relative humidity not more than 70 per cent and temperature about 20°C. Of course the possibility of outside corrosion should be taken into account in tropical countries with hot and wet climates and suitable protective measures must be taken.

In the developed countries of the world various tests were made to estimate the difference in corrosion resistance of electrolytic and hot-dipped tin plate as well as the suitability of different types of tin plate for different products.

In Table 6 the results of the American tests to determine the storage life of fruit and vegetable preserves in cans with varying coatings of tin are given to show the difference in preserving properties of these materials.

TABLE 6 - Results of American tests to determine the storage life of fruit and vegetable preserves in cans with varying coatings of tin

Food	pH	Tinning	Body of can g/m² sheet	Body of can g/m² area	Top/bottom g/m² sheet	Top/bottom g/m² area	Storage life in months
Apples	3.4	H	33.6	16.8	11.2	5.6	36
Apples	3.4	H	22.4	11.2	5.6	2.8	18+
Apple sauce	3.3	H	33.6	16.8	11.2	5.6	36
Apple sauce	3.3	E	22.4	11.2	5.6	2.8	12
Apricots	3.7	H	33.6	16.8	33.6	16.8	36
Apricots	3.7	H	22.4	11.2	5.6	2.8	18+
Blackberries	3.5	H	33.6	16.8	33.6	16.8	12+
Blackberries	3.5	H	22.4	11.2	22.4	11.2	12
Cherries, Sweet	3.4	H	33.6	16.8	33.6	16.8	12+
Cherries, Sweet	3.4	E	22.4	11.2	5.6	2.8	6-12
Fruit salad	3.8	H	33.6	16.8	11.2	5.6	36
Fruit salad	3.8	H	22.4	11.2	5.6	2.8	24
Grapefruit	3.2	H	28	14	28	14	36
Grapefruit	3.2	H	22.4	11.2	22.4	11.2	12
Peaches	3.7	H	33.6	16.8	33.6	16.8	36
Peaches	3.7	H	22.4	11.2	5.6	2.8	18-24
Pears	4.2	H	33.6	16.8	11.2	5.6	36
Pears	4.2	H	22.4	11.2	5.6	2.8	24-36
Pineapple	3.7	H	28	14	28	14	36
Pineapple	3.7	E	22.4	11.2	22.4	11.2	24
Lima beans	5.9	E	11.2	5.6	OTD		36+
Lima beans	5.9	E	5.6	2.8	5.6	2.8	18-30
Carrots	5.2	H	28	14	OTD		36+
Carrots	5.2	H	22.4	11.2	5.6	2.8	18
Maize	6.3	H	11.2	5.6	OTD		36+
Maize	6.3	H	5.6	2.8	5.6	2.8	36
Peas	6.0	H	11.2	5.6	OTD		36+
Peas	6.0	E	5.6	2.8	5.6	2.8	18-36
Spinach	5.4	H	33.6	16.8	OTD		36+
Spinach	5.4	E	28	14	5.6	2.8	12-18
Tomatoes	4.3	H	28	14	28	14	48+
Tomatoes	4.3	E	22.4	11.2	5.6	2.8	24+

Table 7 gives the results of storage tests at 21°C and 38°C to determine the storage life of various foods in electrolytically tinned and hot-tinned cans.

TABLE 7

Food	Tinning	Storage temperature 38°C Tin coating				Storage temperature 21°C	
		g/m² sheet	g/m² area	Days	Spoilage (%)	Days	Spoilage (%)
Chicken noodle soup	H	28	14	342	0	438	0
	E	11.2	5.6	342	31.9	438	0
Sausages	H	28	14	272	0	309	0
	E	11.2	5.6	272	92.0	309	0
Tuna fish	H	28	14	142	0	243	0
	E	11.2	5.6	142	100.0	243	24.0
Grapefruit juice	H	28	14	159	0	348	0
	E*	11.2	5.6	159	0	348	6.0
	E**	11.2	5.6	159	65.3	348	40.0
Tomatoes	H	28	14	145	0	339	0
	E*	11.2	5.6	145	0	339	0
	E**	11.2	5.6	145	33.4	339	8.0
Condensed Milk	H	28	14	66	0	289	0
	E*	11.2	5.6	66	60.0	289	24.2
	E**	11.2	5.6	66	100.0	289	81.5

Surface treatment:

* = melted
** = buffed

From both these tables it is clear that in all cases corrosion resistance is higher for hot-dipped tin plate. But in all these experiments thickness of the tin coating is different, hot-dipped tin plate was always coated thicker.

In the USSR Mr. L.I. Kadaner and Mr. T.A. Dik were studying the dissolving of tin in different food products from electrolytic and hot-dipped tin plate cans. The results of their work are given in Table 8.

TABLE 8

Cans	Quantity of tin (Mg/Kg) in the canned food					
	Hot-dipped Tin plate		Electrolytic Tin plate		Electrolytic Tin plate with lacquer coating	
	Just after sterili-sation	in three months	just after sterili-sation	in three months	just after sterili-sation	in three months
Fish in tomato sauce	53.4	66.0	43.3	67.0	12.6	30.2
Fish in oil	9.0	25.8	8.5	32.7	2.3	30.0
Pork stew	24.2	38.7	20.5	43.6	21.0	28.4
Veal stew	23.8	41.6	15.3	52.0	21.0	37.0
Meat in tomato sauce	36.2	59.9	27.2	76.0	8.2	42.2
Paste of green tomatoes	127.2	379.4	103.0	488.3	15.1	62.2
Stuffed peppers	75.4	160.2	53.3	130.1	20.2	50.4
Blackcurrant jam	40.8	44.1	39.4	53.1	24.1	43.3

The authors came to the conclusion that the speed of dissolving tin from the electrolytic tin plate cans is lower, as the tin in these cans is much purer than in hot-dipped tin plate and the rapidity of spoilage of electrolytic tin plate cans depends mainly on the thickness of the coating. It means that under the same conditions corrosion resistance of electrolytic tin plate is not lower than that of hot-dipped tin plate and may even be higher.

This study also supports the view that application of lacquered cans improves the corrosion resistance and could permit the use of thinner coated electrolytic tin plate instead of hot-dipped tin plate with thicker coating.

In practice, this replacement has taken place in the United States and in Europe. Some firms which are mainly manufacturing can containers for short term storage (up to approximately two years under normal storage conditions) have given up the use of hot-dipped tin plate. Table 9 gives the recommendations of one of the European companies to their customers.

TABLE 9

Cans	Tin plate		Lacquered	
	Body	Top and Bottom	Body	Top and Bottom
Meat cans	E5.6/5.6	E5.6/5.6	once inside	once inside
Fish cans	E5.6/5.6	E5.6/5.6	twice inside	twice inside
Haricot beans, celery, apple	E11.2/5.6	E5.6/5.6	none	once inside
Red cabbage, beetroot, white cabbage, onions, hot peppers, salad, peppers, pasta, celery	E11.2/5.6	E5.6/5.6	once inside and outside	once inside and outside
Stuffed peppers, ravioli	E11.2/5.6	E11.2/5.6	once inside	once inside

The long duration storage of food raises the question as for which type of food electrolytically tinned cans are suitable in this case. According to the experience gained so far hot-dipped tin plate cans with lacquer coating are still usually recommended for long duration storage, except for dry foods, which will keep for very long periods in electrolytic tinned cans.

The Israelian food industry, for example, recommended on the basis of comprehensive studies hot-dipped tin plate for the majority of food items, dividing them into strongly corrosive, moderately corrosive and slightly corrosive foods.

These recommendations have been published and are reproduced in Table 10.

TABLE 10

Food	Type of tinning	Body of can Coating of tin g/m² sheet	g/m² area	Internal surface	Top/bottom g/m² sheet	g/m² area	Internal surface
		Strongly corrosive foods					
Apple sauce	H	33.6	16.8	lacquered	33.6	16.8	lacquered
Cherries in syrup (colouring added)	H	33.6	16.8	lacquered	33.6	16.8	lacquered
Strawberries in syrup	H	33.6	16.8	lacquered	33.6	16.8	lacquered
Sauerkraut	H	33.6	16.8	bright	33.6	16.8	bright
Beetroot in vinegar	H	33.6	16.8	lacquered	33.6	16.8	lacquered
Gherkins	H	33.6	16.8	lacquered	33.6	16.8	lacquered
Green olives	H	33.6	16.8	bright	33.6	16.8	bright
Mixed pickles	H	33.6	16.8	lacquered	33.6	16.8	lacquered
Pickled meat	H	33.6	16.8	bright	33.6	16.8	bright
Lemon juice, Lemon concentrates, Purée and syrup.	H	28	14	bright	28	14	bright
Grapefruit juice and concentrates, Orange juice concentrates.	H	28	14	bright	28	14	bright
Jam (small amounts of colouring matter added)	H	28	14	bright	28	14	bright
Cherries, white, in syrup	H	28	14	bright	5.6	2.8	lacquered
Orange and grapefruit pulp	E	22.4	11.2	lacquered	22.4	11.2	lacquered
		Moderately corrosive foods					
Pineapple in syrup	H	28	14	bright	28	14	bright
Orange, grapefruit and lemon oil	H	28	14	bright	28	14	bright
Ketchup	H	28	14	lacquered	28	14	lacquered
Pearl onions	H	28	14	lacquered	28	14	lacquered
Pears in syrup, Figs in syrup, Apricots in syrup, Peaches in syrup, Apples in syrup, Apple sauce, Fruit cocktail.	E	22.4	11.2	bright	5.6	2.8	lacquered
Oranges, orange juice, Oranges in syrup, Grapefruit, Grapefruit juice, Mixed citrus juice.	E	22.4	11.2	bright	22.4	11.2	bright
Black olives	E	22.4	11.2	lacquered	22.4	11.2	lacquered

TABLE 10 (continued)

Food	Type of tinning	Body of can Coating of tin g/m² sheet	g/m² area	Internal surface	Top/bottom g/m² sheet	g/m² area	Internal surface
		Slightly corrosive foods					
Asparagus	H	28	14	bright	28	14	bright
Carrot juice, Spinach, Cauliflower, Kohlrabi, Wax and green beans, Baked beans in tomato sauce.	H	28	14	bright	5.6	2.8	lacquered
Tomato concentrates	H	28	14	bright	28	14	bright
Whole carrots, Green tomatoes in vinegar or carrots and peas, Tomato juice, Tomato soup, Mixed vegetables with meat, Spaghett in tomato sauce.	E	22.4	11.2	bright	5.6	2.8	lacquered
Condensed milk products	E	16.8	8.4	bright	16.8	8.4	bright
Liver paste, Sardines of all types, Herrings, Tuna fish and Tomato sauce.	F	11.2	5.6	lacquered	11.2	5.6	lacquered
Poultry of all types, Butter, Peas, Baked beans in sauce, Beef and rice, Beef and noodles, Mushrooms, Frozen fruit concentrates, Cheese, Margarine, Maise, Syrup, Lima beans, Sweets.	E	5.6	2.8	lacquered	5.6	2.8	lacquered
Ground coffee, Goose fat, Dried vegetables, Roasted peanuts, Tea and instant tea	E	5.6	2.8	bright	5.6	2.8	bright

Of course there are many other recommendations on this matter which could be found for example in the Report on literature concerning the use of electrolytic and hot-dipped tin plate cans, prepared by the Food Technology and Packaging Institute (Munich, Federal Republic of Germany), but for the developing countries who are starting their own production of tin plate containers it is necessary to have a judgement based on their local conditions. This judgement could be made by national specialists trained overseas and equipped with rather modest laboratory apparatus for research and testing. The training of a specialist from any of the developing countries and equipment for laboratory could be provided, after appropriate government requests, under UN Technical Assistance Programmes and particularly with the help of UNIDO SIS funds.

The investigation of the Applied Scientific Research Corporation of Thailand to determine the suitability of the local hot-dipped tin plate for packaging can be cited as a good example of suitability-test in this field.

The annual demand for tin plate in this country is about 32,000 tons, of which about 25,000 tons are imported, primarily for the food packaging industry, and the rest of the demand is met by locally produced hot-dipped tin plate. The home capacity is about 24,000 tons but only a quarter of it is being utilized since orders for tin plate from the food industry continue to be placed overseas. The main reason for this is attributed to the lack of confidence in the quality of the local product on the part of the food processing industry.

The aim of the investigation was to evaluate the quality of the locally produced tin plate and to recommend appropriate measures that might be necessary to maintain the quality of the product at a higher level to meet the requirements for food containers.

The criteria of the tests were based on the recommendations of the International Tin Research Council which has been accepted in the can industry of the country. In addition to the standard tests a comparison of the corrosion resistance of the local and imported tin plate had been made. The tests showed that the quality of the locally produced tin plate was satisfactory for application in the packaging industry for most items of food and other contents; the corrosion resistance of the local hot-dipped tin plate was found higher than that of the electrolytic tin plate imported by some of the local food packaging companies.

The Thailand tin plate example shows that, in addition to production facilities it is important to have in the country people with appropriate laboratory equipment for testing locally produced and imported packaging materials to work out the national recommendations on their use and application.

5. COST OF TIN PLATE

The greater portion of the cost of tin plate is the cost of the primary metals used for its production - steel and tin.

For a hot-dipped line with annual capacity of 40,000 tons of tin plate, for example, the share of steel in the cost of the final product is about 47 per cent and of tin about 33 per cent. These figures are of course different for other plants but the cost of primary metals is always much higher than 50 per cent of the tin plate cost.

In the booklet "Tin in Your Industry" published in the United Kingdom on behalf of the Tin Industry Board there is an indication that in 1967 about 44 per cent of world tin production was sold to the tin plate industry, the value of this sale was more than £100 million. This expenditure by the tin plate industry represents approximately 12 per cent of the total sales value of its shipments.

So if we assume that the cost of steel is more or less a stable factor in the cost of tin plate, the cost of tin for the production of one ton of tin plate would indicate the efficiency of the manufacturing of tin plate in each particular case.

Generally, the difference in the cost of tin for production of one ton of tin plate is the reason for the difference in prices for hot-dipped and electrolytic tin plate on the market. This difference is caused not only because of heavier coating of hot-dipped tin plate but also because of a lower coefficient of tin utilisation during the technological process.

At the USSR plants, for example, this coefficient reaches 0.9-0.95 for electrolytic lines and only 0.8-0.85 for hot-dipped.

Saving of tin during the electrolytic process explains the tendency to apply electrolytic tin plate on a more wider range instead of hot-dipped even if additional protection of the material or improvement of packaging technology are needed in this case.

The reason for this tendency is not only because of the high price of tin on the market but also because of the restricted supply of it. In many cases the expenses involved in the production of tin plate containers for domestic or export markets should be thoroughly analysed before deciding on the appropriate material to be used.

The cost of tin plate should be taken into account when considering the demand for tin plate containers in the developing countries

The share of tin plate in the cost of tin plate containers varies from 30 per cent to 60 per cent, depending upon container specifications. For the container made from electrolytic tin plate, protectively lacquered and printed, this figure would be less than for an unlacquered container produced from hot-dipped tin plate but it does not mean that the cost of the container would be less. Protection of the container with lacquering inside and outside and with outside printing, needs additional investments for the coating and printing equipment as well as for the production of the lacquers. In addition to that, canning processes should use the equipment which would not damage the lacquer coating and prints during the can processing. This means that all stages of packaging from the tin plate sheet to the final can product should be properly organised. This of course is not always feasible for developing countries because of the complicated equipment and very high initial investments.

For these reasons it seems quite possible that the application of hot-dipped tin plate with thicker coating, which is more expensive but which requires simpler and cheaper technological equipment not only in its production but also in container manufacturing, might make it easier to meet the requirements of some of the developing countries with relatively small markets.

If the possibility of producing tin plate locally is taken into account, then the heavier investments into the electrolytic tin plate lines, required by the complicated equipment for this kind of tin plate production should be considered. Experience of different countries shows that electrolytic process is more economic when the production capacity is well over 100,000 tons per year. In this respect countries with a small demand and with the available resources of tin the hot-dipped method could be recommended to start local production of tin plate to supply the packaging industry. In Thailand where the local demand is only about 30,000 tons of tin plate per year and while the country is one of the main world procuers of tin, the establishment of the hot-dipped tin plate line is considered appropriate.

Local production of tin plate containers in the developing countries could be organised by several schemes:

(a) Steel sheet (local production), tin (local production), tin plate (local production), tin plate containers (local production).

(b) Steel sheet (local production), tin (imported), tin plate (local production), tin plate container (local production).

(c) Steel sheet (imported), tin (imported), tin plate (local production), tin plate container (local production).

(d) Steel sheet (imported), tin (local production), tin plate (local production), tin plate container (local production).

(e) Tin plate (imported), tin plate (local production).

In all these cases the cost would vary for the different stages of tin plate container production and would depend strongly on local conditions prevailing in the country.

To estimate properly in which case the locally produced tin plate container would have an optimum value of the cost and specification to meet the requirements of the local canning industry, the country should have appropriate specialists and laboratory testing equipment.

Receiving an expert to advise in this respect, training of the national specialists for this work and purchasing of the necessary equipment could be organised through the UN Technical Assistance Programmes after appropriate requests of the government. Bearing in mind that the creation of research and training facilities in developing countries promotes production of the packaging materials, container manufacturing and the canning industry, UNIDO, as one of the UN bodies, is very much in favour of implementing such projects. The United Nations Industrial Development Organization has already gained experience in this field and found that technical assistance projects where expert advice from developed countries, joined with training national fellowship recipients and with expanding or setting up information, research and testing facilities in developing countries are very effective in promoting the development of the industrial sector.

6. CONCLUSIONS

(a) Application of hot-dipped or electrolytic tin plate for packaging depends on two main factors - corrosion resistance and cost of the material.

(b) It is recognized that the corrosion resistance of hot-dipped tin plate is higher, mainly because of its heavier coating. Nevertheless, application of the protective lacquering of electrolytic tin plate and modern canning technology have made the latter more widely used.

(c) The strong influence of the cost of primary metals on the cost of tin plate, determines lower cost of electrolytic tin plate with thinner tin coating and better utilization of tin during the technological process.

(d) The specific conditions of the developing countries: small markets; lack of money for investments into modern and high productive equipment for manufacturing tin plate, tin plate containers and cans; climate; requirements for simpler technology make hot-dipped tin plate suitable for many of them.

(e) Expert advice on specific problems of tin plate production and application could be made available by the UN which could also arrange training of national specialists in this field; supply with testing and laboratory equipment for promotion of local production through its technical assistance programme after appropriate requests by the governments.

[redacted]

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