

**Project Planning for Small and
Medium Scale Industries No.7**

_____Galvanized Iron Sheet_____
_____Manufacturing Plant_____

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JAPAN CONSULTING INSTITUTE

This technical brochure was compiled to help in the drafting of a suitable plan for the construction of a Galvanized Iron Sheet Manufacturing Plant.

The production scale and manufacturing process have been described in this brochure on the basis of a typical instance.

The profitability was estimated by fixing certain required conditions, which may differ from country to country.

We hope that the data contained in the brochure will help you to draw up the most suitable plan for the industrialization of your project.

In case a government or public organization requests the Japan Consulting Institute to conduct a feasibility study of the above industry for the purpose of establishing the most suitable plan, it is possible for us to carry this out free of charge.

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1. Introduction

In this paper description will be made on the galvanized iron sheet and corrugated galvanized iron sheet manufacturing plant.

Galvanized iron sheet is a steel sheet which is coated with zinc, and corrugated galvanized iron sheet is a steel sheet which is formed into folds or alternate furrows and ridges by a corrugating machine.

The galvanized iron sheet is the most favorable materials for making roofs and for siding, i.e. for covering the outside walls of a frame house. Also, they are used for making pigpens, hen houses or for temporary building materials.

For instance, the roof made of galvanized iron sheet is very light in weight, and will serve effectively against an earthquake in such places where an earthquake visits frequently. Further, a house built using galvanized iron sheet being light in weight, it greatly helps reduce the construction cost.

This steel sheet can always be fixed easily and can be handled easily in the transportation and distribution. This way they are very convenient building materials.

By coating steel sheet with zinc, a layer of zinc forms on the steel sheet, making the surface a

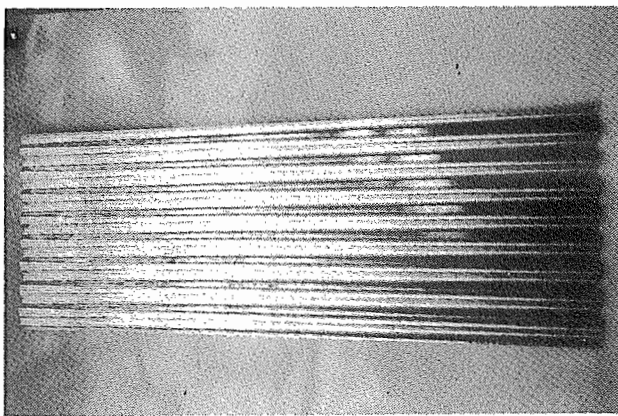


Photo 1 Corrugated Galvanized Iron Sheet

shining grayish-white color, and thus a spangle is formed, giving quite beautiful finishing touches. Being protected by the layer of zinc, the cold rolled steel sheet will have a strong resistance to rust.

In manufacturing the galvanized iron sheet, the hot dip process is being used. The characteristic of this process is that it is a simple process and the construction cost is low. As the manufacturing technique can be acquired relatively easily, the process has come to be adopted increasingly in developing countries.

2. Raw Materials

(1) Cold rolled steel sheet

The steel sheet, which is employed as raw material, is cold rolled steel sheet. Both the unannealed and annealed can be used.

The cold rolled steel sheet, which was trimmed and sheared, is used; in other words, the sheet, which was cut uniformly, is used. The following sizes of steel sheet can be manufactured.

Thickness	0.15mm to 0.50 mm
Width	762mm to 914mm (1,000mm)
Length	1,829mm to 3,048mm (3,658mm)

The sizes shown in the parentheses can be manufactured by changing the specifications of the equipment.

(2) Zinc ingot

Zinc ingot is melted in a galvanizing pot, and the cold rolled steel sheet is passed through the zinc layer for galvanization.

(3) Lead ingot

The galvanizing pot can receive about 30 tons of the melted lead. The lead layer provides the temperature necessary for galvanizing the cold rolled steel sheet.

(4) Ammonium chloride (NH₄ Cl)

Granular ammonium chloride is melted to form flux, which prevents the zinc surface from being oxidized, and at the same time, purifies the steel sheet surface before its galvanization. The flux is also sublimed to be used for the prevention of the zinc of the steel sheet surface after being galvanized, and the galvanized roll surface, from being oxidized.

(5) Hydrochloric acid (HCl)

Hydrochloric acid is used in the hydrochloric acid tank of the galvanizing equipment to remove scales, rust and impurities adhering on the surface of cold rolled steel sheet.

(6) Chromic acid

Chromic acid is used in the chromic acid tank to make the chromating treatment of the product surface so as to make it more resistant to rust.

3. Production Process

The production process of the galvanized iron sheet and corrugated galvanized iron sheet is shown in Fig. 1 "Production Flow Chart".

The production process can roughly be classified into the following items.

1. Pre-treatment
2. Galvanizing pot equipment
3. Post-treatment
4. Corrugating machine

3.1 Pre-treatment

The pre-treatment consists of two hydrochloric acid tanks and one hot water tank. In the hydrochloric acid tank scales, soil and rust adhering to the steel sheet are removed, purifying the steel sheet surface. In the hot water tank the hydrochloric acid, which remains a bit on the sheet, is washed away, and also the sheet is heated before being sent to the following process.

Unless pre-treatment is done perfectly, soil will remain on the sheet, making the galvanization of the part where the soil remains, impossible, and the product will be finished off very badly.

3.2 Galvanizing pot equipment

The galvanizing pot equipment is composed of the galvanizing pot, heating furnace and spangle conveyor. The galvanizing pot has the built-in inner guide, zinc box, flux box and galvanizing roll. (See Fig. 2)

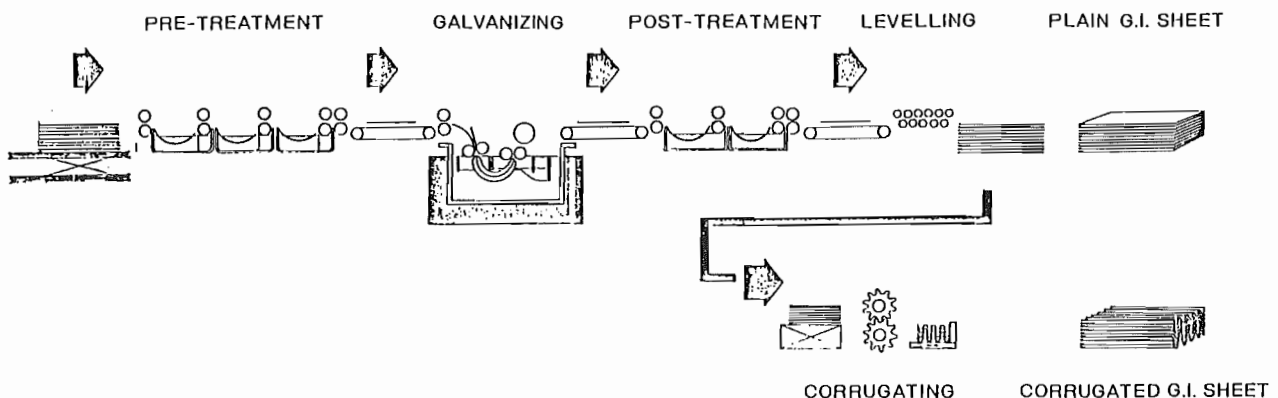


Fig. 1 Production Flow Chart

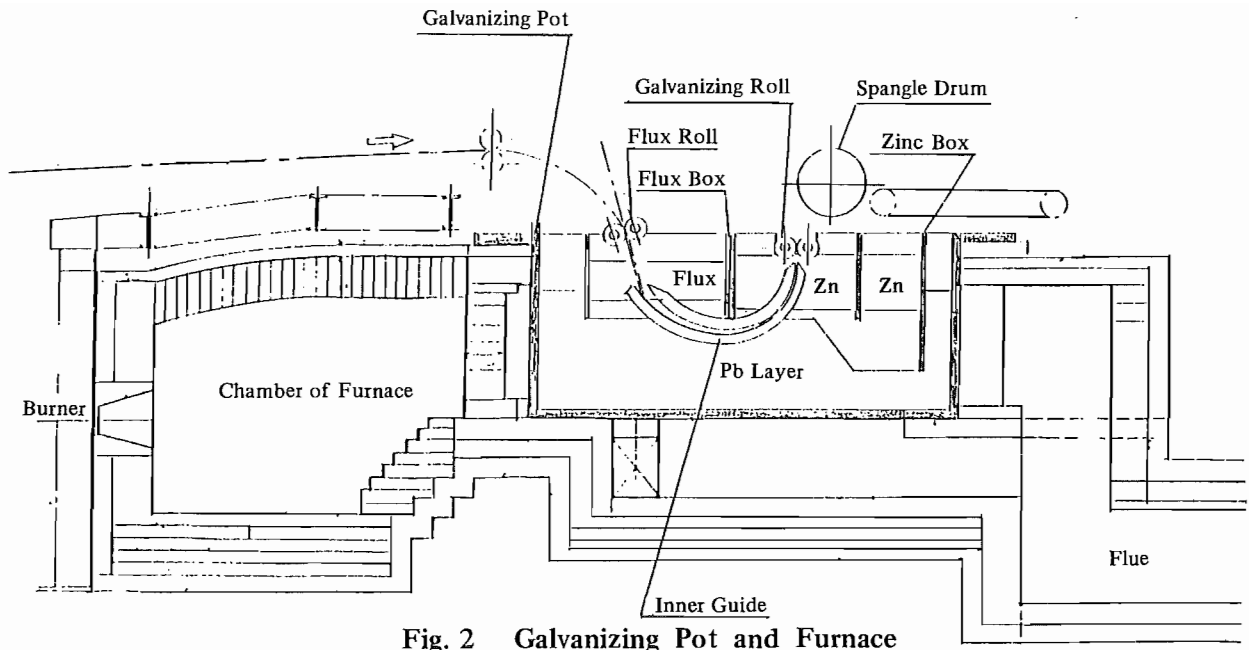


Fig. 2 Galvanizing Pot and Furnace

The sheet, whose surface became clean, and was heated in the pre-treatment, goes first into the flux layer, where the sheet is further purified, and then passes through the lead layer, where the sheet is provided with heat necessary for galvanization. Then, the heated sheet goes to the zinc layer, where the lead adhering to the sheet is displaced by zinc, and iron and zinc react each other, forming an alloy layer. In this way iron and zinc combine together tightly, finishing off the galvanization. However, zinc is still sticking closely on the sheet surface, the zinc coating must be controlled. The control of zinc coating is done by the galvanizing roll at the outlet of the inner guide.

The galvanizing roll finishes up the galvanized sheet surface, and at the same time controls the zinc coating to a fixed degree.

When the sheet gets out of the galvanizing roll, the zinc on the surface has not yet set well. Therefore, the sheet must pass through the spangle drum, where the sheet is cooled and gets spangled. The sheet surface, that passes through the spangle drum, comes to have spangle and luster.

The heating furnace heats the inside of furnace, where the galvanizing pot exists, by a heavy oil (B heavy oil) burner to keep the temperature of

lead and zinc in the galvanizing pot necessary for galvanization. (Fuel is not limited to heavy oil. Any other fuel can be used.)

In such an area where power supply stops frequently, an emergency electric generator is needed to prevent the zinc in the galvanizing pot from becoming solidify.

When electricity is cut off, the combustor stops, which causes the melted zinc in the galvanizing pot to become solidify, and the zinc comes to stick to the galvanizing roll, and the galvanizing roll will bend and become unusable. If zinc gets solidify, it must be melted again. And it will take a long time to resume work, and will reduce the rate of operation.

3.3 Post-treatment

The post-treatment process consists of one cooling tank and one chromic acid tank. The sheet just galvanized being still hot, it takes a shower bath at the inlet of the cooling tank, and is again cooled while passing through the tank, and then moves into the chromic acid tank, where the rust preventing treatment is performed by coating with chromic acid so that the galvanized iron sheet is protected from the deadly harmful white rust and from getting a scratch.

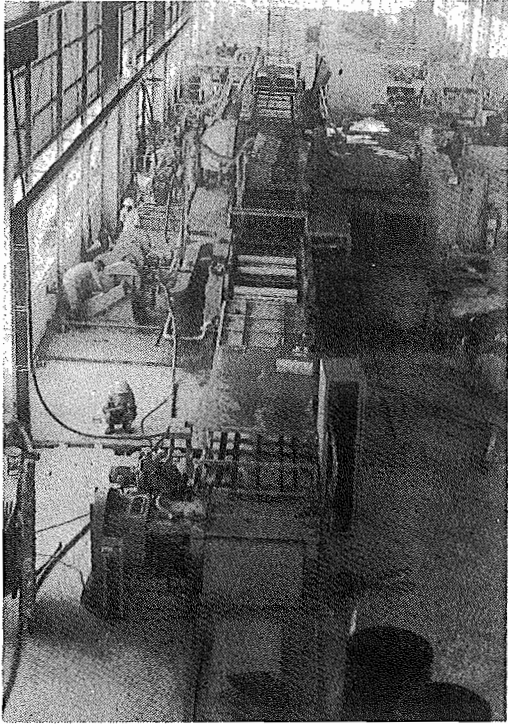


Photo 2 General View of Galvanizing Line

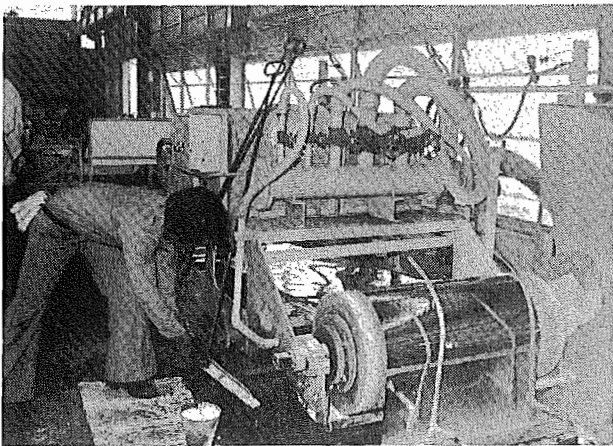


Photo 3 Galvanizing Pot and Spangle Drum

3.4 Corrugating machine

The steel sheet galvanized by a galvanizer is corrugated by a corrugating machine, and becomes a product. Then, the width of the sheet and the number of ridges is checked after corrugation, and also the number of products is counted.

In addition to the above equipment, the pre-treatment section has a feed table, which feeds the piled-up material sheets into the hydrochloric acid tank one by one, and the galvanizing section has a feed conveyor, each before and after the galvanizing pot, and the post-treatment section has a drying conveyor, a leveller and a piler.

4. Outline of the Galvanized Iron Sheet Manufacturing plant

4.1 Specifications

(1) Product

Galvanized iron sheet

(2) Production

Annual production of galvanized iron sheet

Monthly production capacity: 1,400 tons

$1,400 \text{ t/m} \times 12 \text{ months} = 16,800 \text{ t/y}$

(3) Quantity of raw material required

Cold rolled steel sheet: 14,871 t/y

(4) Quantity of sub-materials required

<u>Name</u>	<u>Unit consumption (kg/t)</u>	<u>Annual requirement (t)</u>
Zinc ingot	101.0	1,697
Lead ingot	1.6	27
Ammonium chloride	8.1	136
Hydrochloric acid	4.0	68
Chromic acid	0.04	0.68

Of the sub-materials, the following must first be stocked:

Zinc ingot 4 tons

Lead ingot 30 tons

(5) Utilities

<u>Name</u>	<u>Unit consumption</u>	<u>Annual requirement</u>
Industrial water	3 m ³ /t	50,400 m ³ /y
Electricity	40 kWh/t	672,000 kWh/y
Fuel (heavy oil)	59.6 ℓ/t	1,001 kℓ/y

(6) Area of plant site 8,800 m²

(7) Buildings

Office	360 m ²
Factory	1,560 m ²
Annex	570 m ²

Total floor space: 2,490 m²

4.2 Machinery and equipment

(1) General specifications of galvanizing equipment

(a) Type

Hot dip process cut iron sheet galvanizing equipment

(b) Size

Thickness of sheet	0.15mm to 0.50mm
Width of sheet	Max. 914 mm
Length of sheet	Max. 3,048 mm

(c) Designed line speed: Max. 50 m/min

(d) Theoretical production

Galvanized iron sheet
Base 0.18mm(t)x762mm(w)x1,829mm(ℓ)
2.22kg/sheetx18pcs/minx1,440min x 0.97
≐ 56 t/d

(e) Driving

Driving is made at each section separately.

(2) Galvanizing equipment

(a) Pre-treatment

Feed table one set
Loading capacity, max. 500 kg
Lifting distance, about 500 mm

Hydrochloric acid tank two tanks
Made of F.R.P
1,260 x 1,480 x 256 mm

Hot water tank one tank
1,260 x 1,480 x 256 mm

(b) Galvanizing equipment

Feeding conveyor two sets
1,450 x 3,930 mm
1,450 x 3,500 mm

Galvanizing pot one set
2,440 x 1,620 x 1,000 mm
(Galvanizing pot 1, zinc box 1, flux box 1, galvanizing roll 2)

Heating furnace one set
(Burner 2, heavy oil burning equipment 1, heavy oil service tank 1, chimney 1)

Spangle drum one set
504 φ x 1,000 mm

Working desk one set

(c) Post-treatment

Hot water tank one tank
1,500 x 1,250 x 300 mm

Chromic acid tank one tank
1,500 x 1,250 x 300 mm

Driving conveyor one set
1,450 x 6,300 mm

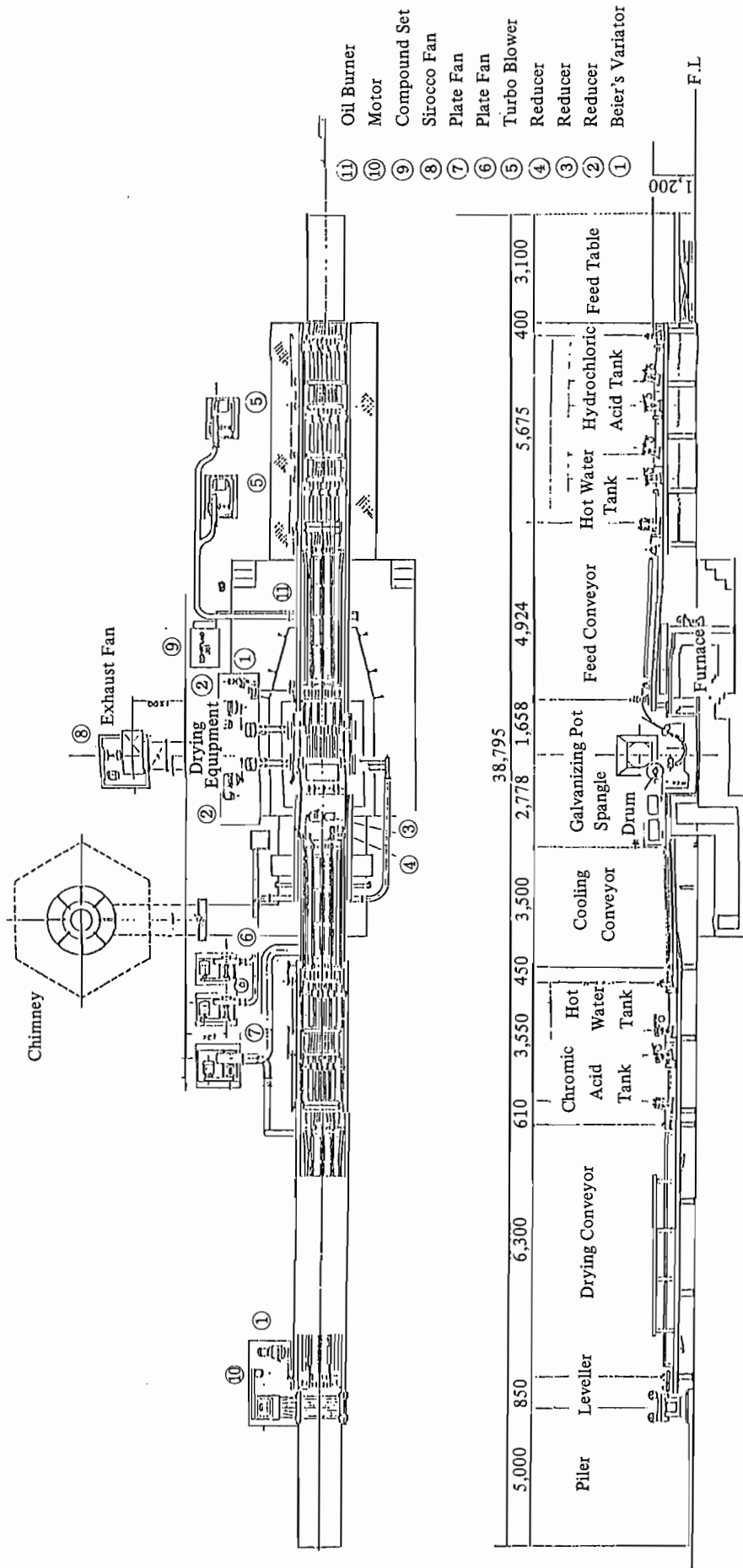


Fig. 3 ARRANGEMENT OF GALVANIZING EQUIPMENT

Leveller

Upper roll	one set
65 ϕ x 1,100 mm, 8 rolls	
Lower roll	one set
65 ϕ x 1,100 mm, 7 rolls	

Piler one set

(d) Electric equipment one set
Control panel, control desk

(3) Corrugating machine (See Fig. 4)

Type

Traversing corrugating roll (10')
(Direct-coupled flat roll)

Revolution 12 r.p.m.

Driving

Beier's cyclo variator, 11 kW

Note:

When corrugating the thick sheets of from 0.15 mm to 0.50 mm, it needs two sets of corrugating rolls. For corrugating the annealed sheet and the small furrows and ridges, it needs a special roll. Here, only one set of roll is used to corrugate a main size.

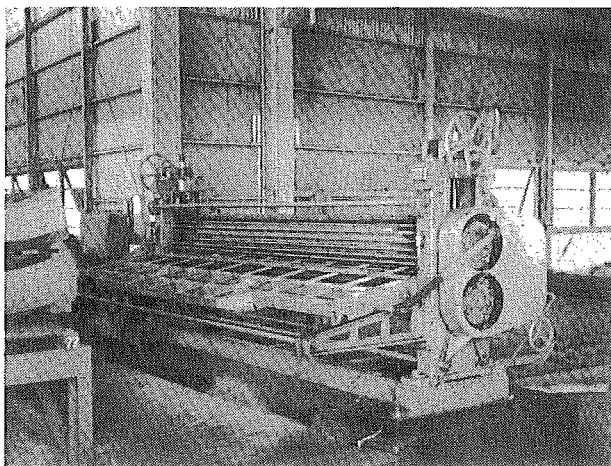


Photo 4 Corrugating Machine

(4) Supplementary equipment

Overhead traveling hoist crane one set
(Floor operation by push button control type)
5 tons x 11.5 m

Vertical tapered water type flow package boiler one set
500 kg/hr

Forklift truck, 5 tons one set

12' lathe one set

20" shaper one set

Drilling machine one set

A.C. electric arc welder, 32.5 kVA one set

4.3 Plant layout

The layout of the galvanized iron sheet manufacturing plant is shown in Fig. 5.

4.4 Labor required

Engineer 3 men/d

Skilled worker 61 men/d

8 men x 1 shift

4 men x 2 shifts

15 men x 3 shifts

Unskilled worker 24 men/d

8 men x 1 shift

2 men x 2 shifts

4 men x 3 shifts

Total 88 men/d

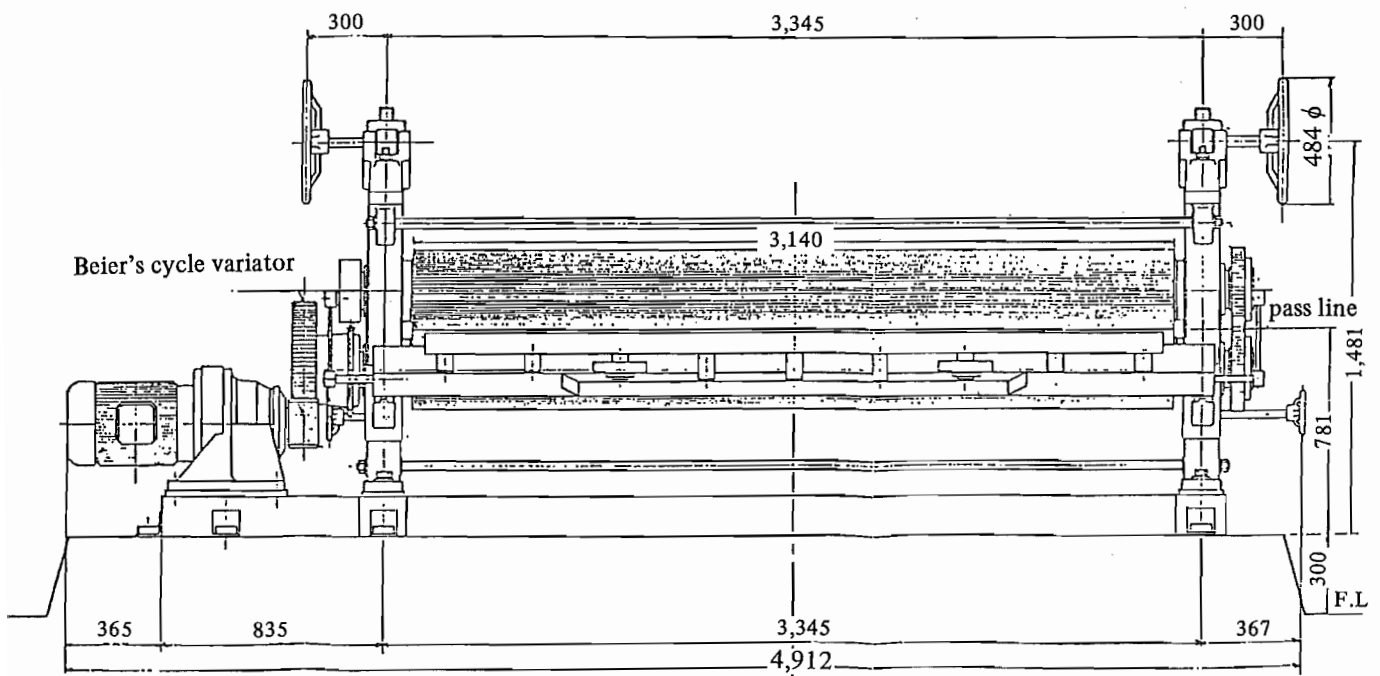
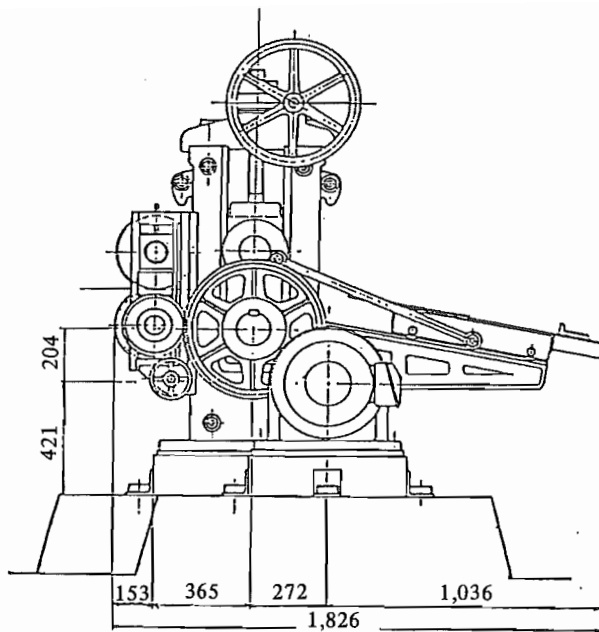


Fig. 4 Corrugating Machine

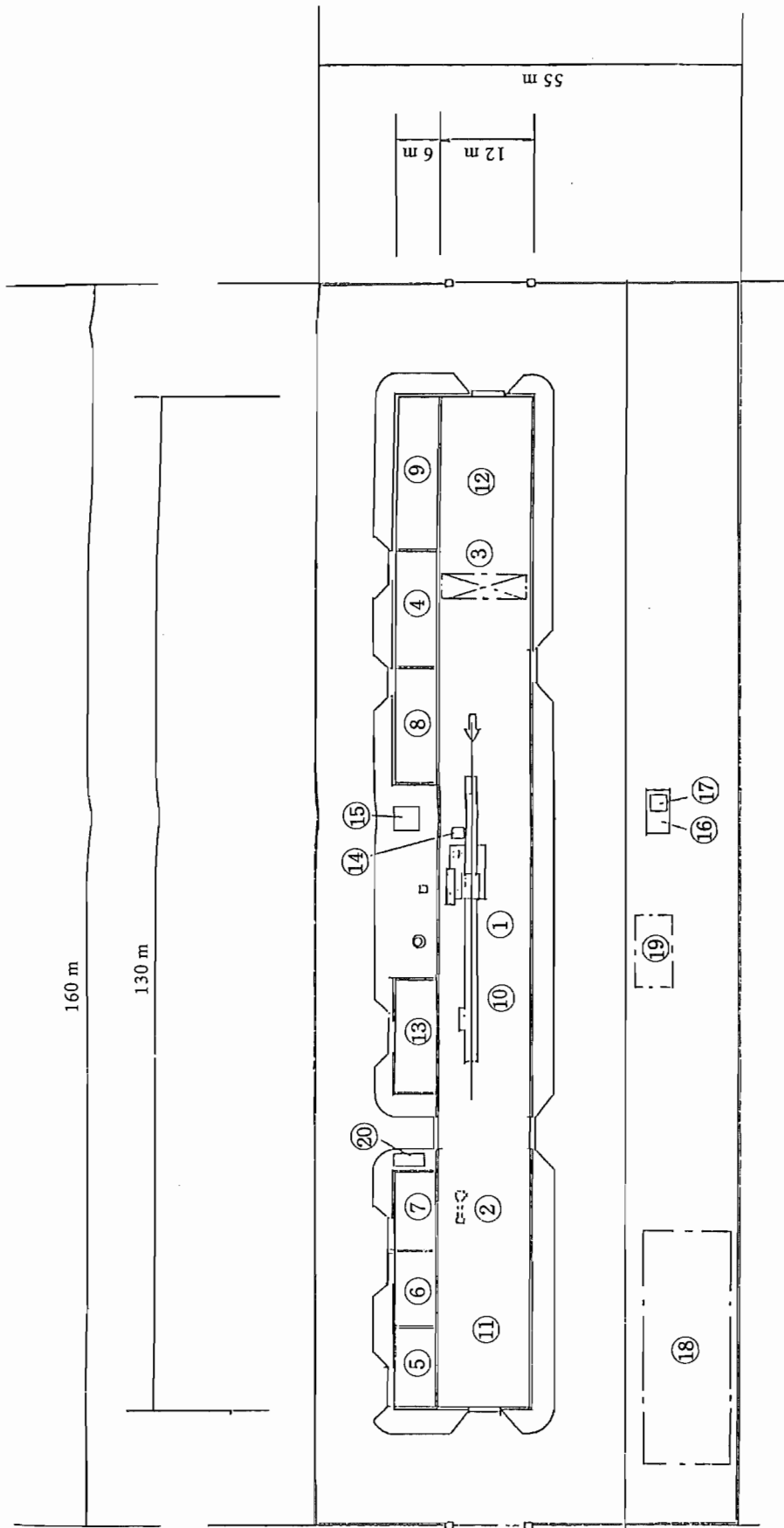


Fig. 5 Layout of Galvanized Iron Sheet Plant

- | | |
|---|--|
| ① Galvanizing Line | ⑪ Finish Products Space, abt. 1,100 tons |
| ② Corrugating Machine | ⑫ Black Sheets Space, abt. 1,500 tons |
| ③ Hoisting Crane, 5t x 11.5m | ⑬ Store House |
| ④ Spare Parts Storage | ⑭ Heavy Oil Service Tank |
| ⑤ Store House, fire bricks | ⑮ Heavy Oil Storage Tank |
| ⑥ Boiler Room | ⑯ Water Receiver Tank |
| ⑦ Generator Room | ⑰ Water Tower Tank |
| ⑧ Store House, NH ₄ Cl & lead ingots | ⑱ Main Office |
| ⑨ Workshop | ⑲ Production Office |
| ⑩ Auxiliary Space | ⑳ Light Oil Storage Tank |

6. Profitability

In order to estimate the profitability of a galvanized iron sheet manufacturing plant, it is necessary to calculate the production cost. But the basis of calculation being different according to a country, the profitability will be calculated in this paper on the basis of the following assumption.

6.1 Annual sales revenue

Corrugated galvanized iron sheet
 1,400 t/m x 12 m x US\$610/t =
 US\$10,248,000

6.2 Fixed capital

Land price	Not included
Factory building 2,490 m ²	US\$498,000
Machinery and equipment	US\$520,000
Sub-materials	US\$24,254
Stock for 1st year: zinc 4t, lead 30t	
Spare part cost	US\$59,000
Freight and insurance	US\$52,000
Erection cost	US\$26,000
Civil engineering cost for foundation	US\$26,000
Guidance and supervision cost	US\$52,000
Commissioning cost	US\$26,000
Training cost	US\$26,000
Contingency	US\$52,000
<hr/>	
Total	US\$1,361,254

Note 1:

The fixed capital was calculated on the following assumption.

Building US\$200/m²

Machinery and equipment
 FOB Japanese port

Freight and insurance

10% of the FOB price of machinery and equipment

Erection cost

5% of the FOB price of machinery and equipment

Civil engineering cost for foundation

5% of the FOB price of machinery and equipment

Guidance and supervision cost

10% of the FOB price of machinery and equipment

Commissioning cost

5% of the FOB price of machinery and equipment

Training cost

5% of the FOB price of machinery and equipment

Contingency

10% of the FOB price of machinery and equipment

Note 2:

The above machinery and equipment does not include the following items

- o Electric source involving an emergency engine generator
- o Lighting, ventilator, air conditioner, fire extinguisher, telephone, office furniture
- o Water and acid supply facilities
- o Waste water and acid treatment facilities
- o Air pollution preventive facilities
- o Storage tanks of hydrochloric acid and heavy oil
- o Lubricant and grease

Note 3:

In case the plant under contemplation is established in an area where pollution regulations are being enforced, it also needs to give consideration to the setting up of environmental pollution preventive facilities.

6.3 Working capital

(a) Raw material cost for one month

Material and sub-material	Unit Price US\$/t	Price US\$
Cold rolled steel sheet, 1,239 t/m	450	557,550
Zinc ingot, 141.4 t/m	1,121	158,509
Lead ingot, 2.3 t/m	659	1,516
Ammonium chloride, 11.3 t/m	271	3,062
Hydrochloric acid, 5.7 t/m	92	524
Chromic acid, 57 kg/m	2.5 (US\$/kg)	143
Sub-Total		US\$721,304

(b) Sales revenue for one month

Corrugated galvanized iron sheet, 1,400 t/m	610	854,000
Total working capital		US\$1,575,304

6.4 Capital required

6.2 + 6.3 US\$2,936,558

6.5 Production cost

6.5.1 Variable cost

(a) Raw material cost

Raw material and sub-materials	Unit Price US\$/t	Price US\$
Cold rolled steel sheet, 14,871 t/y	450	6,691,950
Zinc ingot, 1,697 t/y	1,121	1,902,337
Lead ingot, 27 t/y	659	17,793
Ammonium chloride, 136 t/y	271	36,856
Hydrochloric acid, 68 t/y	92	6,256
Chromic acid, 680 kg/y	2.5 (US\$/kg)	1,700
Sub-Total		US\$8,656,892

(b) Utilities

Item	Unit Price US\$	Price US\$
Industrial water, 50,400 m ³ /y	0.210/m ³	10,584
Fuel (B heavy oil), 1,001 kℓ/y	0.270/kℓ	270
Electricity, 672,000 kWh/y	0.083/kWh	55,776
Sub-Total		US\$66,630
Total variable cost		US\$8,723,522

6.5.2 Fixed cost

(a) Labor cost

	US\$/y	
Engineer	24,000	
Skilled worker	244,000	
Unskilled worker	48,000	
Sub-Total		316,000

(b) Maintenance cost

3% of the FOB price of machinery and equipment

US\$15,600

(c) Depreciation

Straight-line method was adopted for the depreciation of machinery and equipment

(Fixed capital – Building construction cost) x 7% =

US\$60,428

Depreciation of buildings

It was assumed to be 3% of the building construction cost

US\$14,940

Sub-Total

US\$75,368

(d) Insurance cost

0.5% of the fixed capital

US\$6,806

(e) Interest

One-second of the plant's fixed capital was assumed to be covered by a long-term loan, and its annual rate of interest to be 10%

US\$68,063

Total fixed cost

US\$481,837

6.5.3 Selling and administration cost

The cost was assumed to be 5% of the annual sales revenue US\$512,400

Note: The exchange rate of the U.S. dollar to the Japanese yen is assumed as US\$1.0 = ¥240.

6.6 Profitability

When the profitability of the present project is calculated on the basis of the above conditions, it will become as below.

Annual sales revenue of products		US\$10,248,000
Total cost		US\$9,717,759
Variable cost	US\$8,723,522	
Fixed cost	US\$481,837	
Selling and administration cost	US\$512,400	
<hr/>		
Profit		US\$530,241

Ratio of profit to sales $US\$530,241 / US\$10,248,000 \times 100 = 5.2\%$

Ratio of profit to capital $US\$530,241 / US\$2,936,558 \times 100 = 18.1\%$

With regard to the profitability of the present project, the ratio of profit to sales is about 5.2% which is not necessarily high, while the ratio of profit to capital is as high as about 18.1%. Therefore, the profitability of the project under contemplation can be considered good.

7. Conclusion

This paper showed an outline of a corrugated galvanized iron sheet manufacturing plant with an invested capital of approximately US\$2,940,000 and with a monthly production capacity of 1,400 tons.

As regards the profitability of this project, calculation was made by assuming various conditions. In industrializing it, however, various

factors available in the area where a plant is established must be studied, and the figures shown in this paper should be displaced by the ones applicable for the area.

As the project under consideration requires only a small amount of capital and its operation is relatively easy, it may be said that the profitability of the project is good.

Project Planning for Small and Medium Scale Industries

- No. 1 Rice Milling Plant and Rice Bran Oil Manufacturing Plant
- No. 2 Plastic Woven Bag Manufacturing Plant
- No. 3 Container Board Manufacturing Plant
- No. 4 Plastic Blow Bottle Manufacturing Plant
- No. 5 Concrete Block Manufacturing Plant
- No. 6 Glassware Manufacturing Plant
- No. 7 Galvanized Iron Sheet Manufacturing Plant

Project Planning for Small and Medium Scale Industries No. 7

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