METAL FINISHING IN KOREA*

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PREFACE

The importance of the metal finishing industry in Korea has been only recently understood with the progress of industrialization in the fields of machinery, automobile, electronics and heavy chemical industry. Especially during the past 15 years, Korean industry has grown at high rate by policy of the government based on a 4 separate 5 year economic development plans. Consequently the metal finishing industry has diversified to meet the requirements in various industriality and productivity of metal finishing products. However, our metal finishing industry has not improved in practice as expected. Therefore we do need more active progress than usual in engineering and management. It seem that the increased cooperation among metal finishing plants and regional information services in collaboration with other international information net works is essential to improve the technology of metal finishing. In this sense, this Asian Metal Finishing Forum is meaningful and of benefit to the development of the metal finishing industry in every country. Lastly, it is requested to keep in mind that statistics data for metal finishing in this report refers to electro-plating which occupies an important position in the Korean metal finishing field.

1. Industrial background

1-1 Economic growth

The Korean economy has sustained high-level economic growth since the 1960s. During the 18 years from 1962 to 1979 the Korean economy maintained a 9.7 percent annual average growth rate, more than double that of the world’s major economies as shown in Fig. 1. That attainment was founded on rapid industrialization and export growth. The yearly average growth rate of the mining and manufacturing industries amounted to 17.2 percent, and commodity exports grew by nearly 40 percent per year from 1962 to 1979.

The per capita GNP for 1979 rose to US$1,624 from US$87 in 1962, an 18.7 fold increase. This high rate of growth was essential to the nation’s achievement of modernization, enabling not only quantitative expansion but also significant qualitative changes in the industrial infrastructure, a higher standard of living and improvements in the living environment.
1-2 Industrial structure

In 1979, the portion of industrial activity accounted for by secondary industry increased to 33.9 percent from 10.0 percent in 1961. The proportion of primary industry decreased sharply to 18.8 percent in 1979 from 47.1 percent in 1961 as shown in Fig. 2. Thus the national industrial structure made great strides via its high economic growth rate.

During this period, the share of the tertiary industry stood at approximately 45 to 50 percent,
with no appreciable fluctuations. The share of the tertiary industry, which corresponds to the proportions in developed countries, is attributable to the specific character of the Korean economy, which was heavily dependent on foreign aid in its pre-industrial period. Thus the service sector has been a large part of the economy as a whole for some years. The leading edge of this transformation has been the growth of exports and particularly manufactured exports.

1-3 Export structure

By 1979 commodity exports had risen to $15 billion, realizing a growth rate of 37.5 percent per annum. The predominant type of manufactured exports has also changed dramatically, from light industrial products such as textiles to sophisticated, skill-intensive products, including transport equipment and ships, industrial machinery, precision instruments, metal products and chemicals as presented in Fig. 3 and table 1. The more traditional exports nevertheless have continued to expand in absolute if not in relative terms, giving Korea a sizable export volume in an increasingly wide range of commodities.

At the same time trade with the United States and Japan, while growing in volume, decreased from 65 percent of the total external market in 1962 to 51 percent in 1979 as presented in Fig. 4, reflecting the policy of the Government to diversify markets and to seek out new trade with any friendly country, regardless of ideology.

1-4 Industrialization rate

Korea’s industrialization has been compressed into a relatively brief period when compared with the measured development of the advanced nations. In terms of Hoffmann’s industrial development stages, the Korean economy required only eight years, from 1960 to 1967, to reach the second stage, while the major western nations achieved that level in 20 to 30 years. It is considered likely that Korea can also reduce, by more than one-third, the period necessary to move from the second to the third stage.

![Fig. 3 Composition of Exports by Industry](image)

**Table 1. Export Structure by Sector**

<table>
<thead>
<tr>
<th>Year</th>
<th>1966</th>
<th>1973</th>
<th>1976</th>
<th>1979</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy &amp; Chemical Industry Products</td>
<td>15.3</td>
<td>28.9</td>
<td>37.0</td>
<td>44.7</td>
</tr>
<tr>
<td>Light Industry Products</td>
<td>84.7</td>
<td>71.1</td>
<td>63.0</td>
<td>55.3</td>
</tr>
<tr>
<td>Others</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
As shown in Fig. 5, prior to the 1950s, the nation's industrialization rate remained below 10 percent and consumer goods such as textiles, foods and beverages, leather and rubber, accounted for over 75 percent of the total value added by manufacturing. The proportion of the heavy and chemical industries stood at only 23.4 percent in 1960. It was composed of machinery (9.9 percent), non-ferrous ores (4.9 percent), chemicals (3.8 percent) and iron and steel (2.7 percent).

Since the implementation of first Five Year Economic Development Plan in 1962, Korea's industrial structure has shifted toward the pattern of the industrialized economies. The proportion of the heavy and chemical industries in the total value added by manufacturing increased to 31.4

![Heavy and Chemical Industrialization Rate](image-url)
1-5 Status of Manufacturing Industry

1-5-1 Iron and Steel Industry

Steel production is the key to the development of all other heavy industries, especially shipbuilding, machinery and electronics. While Korea invented the world’s first iron-clad ship in the 16th century and the first movable metal type some 750 years ago, a modern steel industry did not come into being until the 20th century. And until 1973, when the Pohang Iron and Steel Company Ltd. (POSCO) was completed, Korean industry was seriously hampered by a lack of iron and steel. As of 1981, annual steel production capacity had risen to 12,100,000 tons on crude steel basis including 8,500,000 tons of which were produced by POSCO and the rest by other steel mills. Korea thus become the 18th largest producer in the world of steel.

1-5-2 Non-ferrous Metal Industry

Production of non-ferrous metals cannot match the total output of iron and steel. Nevertheless, non-ferrous metals are basic materials indispensable for the development of related industry. In accordance with the nation’s prosperity and various non-ferrous metals is expected to increase rapidly. In the meantime, the output of non-ferrous metals has expanded to great extent as a results of the enlargement of smelting facilities. Production capacity of electrolytic copper in 1981 was 105,000 tons from 1,000 tons at the beginning of 1960s. During the same period the output of lead, zinc and aluminum had increased to 11,000 tons, 90,000 tons and 18,000 tons from less than 500 tons, 100 tons, and zero, respectively.

1-5-3 Machinery Industry

The government initiated a series of measures to boost local industries, and to improve the payments by substituting domestic products for imported products in 1967. Moreover, to encourage the use of locally made products, the government began in 1968 to restrict the import of machinery competitive with domestic products. In addition, those who use domestically made machines are given the privilege of a 10 percent tax deduction on their investments. During the fourth plan period, highest industrial investment will be given to the machinery industry. Owing to these favorable measures, the output of machines and the share of the machinery industry in the total manufacturing sector in recent years has increased remarkably.

1-5-4 Shipbuilding Industry

Shipbuilding developed rapidly from the building of wooden fishing vessels in the 1960s to producing 2,800,000 gross tons in 1979. It is expected that shipbuilding capacity will reach 4,250,000 gross tons by 1981 through the expansion of the Hyundai shipyard, already one of the largest single shipyards in the world, and the construction of the Daewoo and Chukdo shipyards on Koje Island. When these yards have been completed, Korea will emerge among the world’s ten leading shipbuilding nations.

1-5-5 Electronics Industry

The electronics industry has grown faster than any other industry in Korea during the past several years and is being developed as one of the major export industries of the future. In 1979, Korea produced $3.3 bill. worth of electronic goods. Items now being produced include amplifiers, tape recorders, T.V. sets, radios, electronic watches C.B. transceivers, T.V. games and calculators. Korea thus has become the tenth largest producer of electronics in the world.
1-5-6 Automobile Industry

The automobile industry in Korea came into existence with the introduction of modern assembly plant in 1962. With the increase and technical development in automobile production, new model cars were designed and produced in 1975, and automobile exports reached 1,356 units or $7,165,000 and 13,957,000 units and parts were exported in 1976. The automobile industry has the potential to become a major export industry in the future. In the meantime, the domestic demand for cars and trucks is increasing rapidly. As of 1981, total production capacity of cars, trucks and buses was 300,000 units.

1-5-7 Chemical Industry

The Korean chemical industry moved quickly from the production of soaps, paints, pharmaceuticals, explosives and a few basic chemicals to the production of all basic chemicals and sophisticated petrochemical products. Therefore, the major emphasis is now placed on the expansion of existing chemical plants and the construction of chemical industrial complexes.

2. Present Status of Metal Finishing Industry

2-1 Number and Distribution of Metal Finishing Plant

Number and distribution of metal finishing plant are shown in Table 1. Most of plants were concentrated in Seoul and its outskirts. This has resulted in characteristics of metal finishing industry which is to be subcontract system with allied industries. At present, government policy is encouraging the movement of plants to local areas or industrial complexes to lessen the pollution within the city, and also promoting the setting up of specialized estates for the metal finishing industry.

Table 1. Regional distribution of metal finishing plants

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of plants</th>
<th>Distribution ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seoul and Kyong-Ki</td>
<td>256</td>
<td>67.5</td>
</tr>
<tr>
<td>Busan and Kyong-Nam</td>
<td>80</td>
<td>21.2</td>
</tr>
<tr>
<td>Taegu and Kyong-Buk</td>
<td>24</td>
<td>6.3</td>
</tr>
<tr>
<td>Ho-Nam</td>
<td>10</td>
<td>2.7</td>
</tr>
<tr>
<td>Chung-Cheong</td>
<td>9</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>339</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*more than 1,000 small firms are not represented here.

2-2 Scale of Metal Finishing Plants

Plant scale by employee is shown in Table 2. Their distributions are as follows: under 10 persons-36.0%, 11 to 20 persons-29.5%, 21 to 30 persons-15.5% 31 to 50 persons-10.0%, and over 50 persons-9.0% respectively. This means that most of metal finishing plants belong to a home industry scale of operation.

Table 2. Plant scale by employee

<table>
<thead>
<tr>
<th>persons below 10</th>
<th>over 10</th>
<th>over 20</th>
<th>over 30</th>
<th>over 50</th>
<th>over 80</th>
<th>over 100</th>
<th>over 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of plant</td>
<td>72</td>
<td>59</td>
<td>31</td>
<td>20</td>
<td>15</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ratio(%)</td>
<td>36.0</td>
<td>29.5</td>
<td>15.5</td>
<td>10.0</td>
<td>7.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>
2-3 Man Power

Employee status by function and academic background is shown in table 3 and 4, in which we can find that most employees are lacking in professional knowledge, and thus their operation is not conducted by trained technicians. But the number of specialists is increasing year by year because of the improvement of the working conditions by mechanizing plants, which makes it easier to secure manpower.

Table 3. Disposition of employee by function (%)

<table>
<thead>
<tr>
<th>Clerical part</th>
<th>Technical part</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.4</td>
<td>72.6</td>
</tr>
</tbody>
</table>

Table 4. Disposition of employee by academic background (%)

<table>
<thead>
<tr>
<th>College</th>
<th>High school</th>
<th>Middle school</th>
<th>Primary school</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>32.4</td>
<td>49.2</td>
<td>14.8</td>
</tr>
</tbody>
</table>

2-4 Management

Many metal finishing plants are conducted as individual enterprise, over 90% of them, and thus lots of plants are faced by technical and managerial problems. Considering the financial structure and business status of this enterprise, their profit is very low compared with other business as shown Table 5 and 6, which seems to be owed to the lack of managerial technique; high cost of materials such as pure metal and chemicals, low productivity, high production cost, and lower operation ratio due to the unbalance of capacity in interprocesses etc.

Table 5. Financial structure

<table>
<thead>
<tr>
<th>Self fund</th>
<th>Debt</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.0</td>
<td>270.6</td>
<td>3.9</td>
</tr>
</tbody>
</table>

2-5 Facilities and Testing Apparatus

As shown in table 7 and 8, Most of plants belong to the hand-operated system, and their testing apparatus is not yet enough. It is due to the small and petty scale of plant. Therefore, technical guidance and assistance of public organization will essentially be needed for the improvement of technical level, and also it is more desirable that plant should be modernized with new process, so as to produce more qualified products with lower cost.

Table 6. Component ratio of prime cost

<table>
<thead>
<tr>
<th>Materials</th>
<th>Labour</th>
<th>Expenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.6</td>
<td>21.7</td>
<td>25.7</td>
</tr>
</tbody>
</table>

* Physical productivity per year averages 11,000 dollars equivalent to one-third of advanced country's.

Table 7. Disposition of plant by operation system (%)

<table>
<thead>
<tr>
<th>Hand operated</th>
<th>Semi automatic</th>
<th>Full automatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>79</td>
<td>20</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 8. Disposition of plant by testing apparatus (%)

<table>
<thead>
<tr>
<th>Thickness tester</th>
<th>Analysis equipment</th>
<th>Corrosion tester</th>
<th>Hull cell tester</th>
<th>Metallurgical microscope</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.7</td>
<td>46.4</td>
<td>10.7</td>
<td>39.3</td>
<td>7.1</td>
</tr>
</tbody>
</table>

2-6 Raw Materials

Domestic production ratio of metals and chemicals for metal finishing is shown in table 9. In particular, 65% of chemicals is yet supplied by imports. The metal finishing industry has been seriously hampered by the high cost of imported chemicals so far. However, domestic production ratio of raw materials is expected to increase year by year. Finally, major materials imported will be gradually substituted by domestically manufactured ones, because Korea has a relative abundance of non-
ferrous metals.

Table 9. Local production ratio of raw materials (%)

<table>
<thead>
<tr>
<th>non-ferrous metal</th>
<th>chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>58.3</td>
<td>34.5</td>
</tr>
</tbody>
</table>

2-7 Technology

Even though technical development in the metal finishing industry has a very low rate compared with those of foreign industrial countries, it seems to be very encouraging that the understanding about technical development is greatly promoted and improved. Considering the scale of plants, it would be necessary to develop the related technology jointly with public organizations such as universities or public research institutes from the viewpoint of utilizing professional knowledge and improve efficiency and secure investments.

3. Problems faced by metal finishing industry

The basic problems faced by metal finishing industry in Korea can broadly be grouped as follows:

3-1 Disturbance of Circulating System in Business

Since the metal finishing industry is made up subcontracting system for its customer industries, constantly. Furthermore, there are too many of petty scale plants (more than 1,000), and then they compete in some limited market for the same products. Finally the circulating system in business is to be disturbed and thus it leads to a falling off of quality.

3-2 Lack of Technical Man-power

In small metal finishing plant, techniques and skill of workers are of great significance. In these plants, the target has to be placed on quality rather than quantity, and adoption of standard working systems and techniques can greatly help to enhance productivity. However, a number of plants are suffering from an inability to attract and retain young skilled workers.

3-3 Lower Productivity and Quality

Productivity and quality to meet the increased requirement of customers in accordance with the development of related industry are serious problems.

Therefore new processes promoting systematic production and new technologies are essential to produce low cost and high quality products.

Metal finishing plants in Korea are so small in scale that most of them are not fully equipped with technicians to operate them. Therefore the establishment of a public research laboratory is necessary in an industrial complex for metal finishing so that they can utilize the facilities in common.

3-4 Public Nuisance

Metal finishing plants produce a great quantity of pollution and thus have a variety of troubles in working and social environment. In general, the working environment in a metal finishing plant is inferior to that of other industrial plants. This problem leads to rejection of employment in metal finishing plants, and thus presents difficulties in securing a fresh and qualified person. It is a serious problem to secure the specialist and skilled workers.

3-5 High Cost of Raw Materials

The major part of production cost is occupied by materials. Therefore, emphasis should be placed on material control for production cost. In particular, since most of the raw materials such as pure metal and chemicals have been imported from foreign countries Delivery as well as quality is not guaranteed consistently. Finally it affects production cost and the quality of products.

3-6 Lack of Management Technique

Most of the small pitty plants are managed by owners who have little education and training, and thus many of these plants are faced with a great number of problems in rationalizing the management. The training at management level should preferably be arranged for a periodic term and deal
with specific management aspects. This will enable them to recognize the importance of quality, cost and productivity in more tangible terms.

4. Direction for Upbringing of Metal finishing Industry

To promote their economic position and competitive power through the improvement of the industrial structure and efficiency, a number of steps should be taken. Especially, to meet the increasing requirement for metal finishing products, the metal finishing industry should be modernized and rationalized deservedly. For this purpose, following items are considered as the directions and measures for the upgrading of metal finishing industry.

4-1 Consolidation of petty and Small scale Plants

To improve the productivity and quality of metal finished products, petty and small-scale enterprises will be protected, complementarity between small and large-scale enterprises will be encouraged, and linkage with large-scale enterprises through specialization and systematization will be promoted. Administrative guidance of the government will be taken to encourage the business mergers and gradual enlargement in scale through the following items.

4-2-2 Encouragement of Self-regulating of Enterprises

4-2-2 Systematization and Specialization of Plants

4-1-3 Introduction of cooperative system

4-2 Modernization of Metal Finishing Plants

In an effort to improve the structure of metal finishing industry, financial support for the modernization of production facilities, especially for the replacement of old and obsolete equipment, will be expanded. Policy measures will be taken to emphasize the following items.

4-2-1 Modernization of Facilities

4-2-2 Rationalization of Management

4-2-3 Designation and Concentrative Support of Model Plant

4-3 Establishment of Specialized Metal Finishing Industrial Estate

To achieve regional dispersal of polluting plants currently operating in urban area, specialized estate for metal finishing plants and common service and testing apparatus to enhance standardized production, quality improvement and product specialization will be established in their estate. For this purpose, emphasis will be placed on following items.

4-3-1 Support of an Existing Complex for Metal Finishing Plants

4-3-2 Governmental Backing up

4-3-3 Improvement of the System of Taxation

4-4 Prevention of Public Nuisance

Effective anti-pollution process such as closed system will be adopted in order to control the pollution resulting from the antiquated process, and also polluting plants located in large cities are to be gradually relocated through the following measures.

4-4-1 Adoption of Closed System

4-4-2 Research and Development of Zero Pollution Process

4-4-3 Relocation of Polluting Plants

4-5 Upgrading of Technical Level

Industrial technology will be improved through the introduction and local adaptation of advanced foreign technology and through increased research and development as well as training of technicians by the following measures.
4-5-1 Local and Overseas Training of Technician

4-5-2 Domestic Production of Raw Materials

4-5-3 Public Testing Laboratory for Common Use in Estate of Metal Finishing Industry

4-6 Strengthening of Function of Association of Metal Finishing Industry

To establish the self-regulating consultative system, the function of association of metal finishing business will be strengthened by administrative measures as follows:

4-6-1 Strengthening of Self-function of Association

4-6-2 Set up an Industry Wide Statistics Gathering and Analyzing Section

* 질문 응답 *

두께 1mm의 강판에 5 〜 10μm의 아연도금을 한쪽에 그 일부를 90°로 구부러 가공비교로 하지 않는 제품을 취급하고 있다. 현재는 저간한 온도에서 이온화유로 바꾸고 싶은데, 가장이 있겠는가? 이제 주의해야 할 점이 무엇인가?

5 〜 10μm 정도의 두께라면 전처리를 잘 해서 밀착이 좋은 도금을 얻기 위해 주의를 기울이면 좋다. 주의할 점은 이온화유의 전기적 저항이 낮아지면 그 반응이 아연 도금층이 듯하게되어 용해가시 도금층이 굽어질 열기가 있으므로 정확하게 일정무게로 제한하는 것이 안전하다. 그런데 20μm 정도로 두꺼운 도금일 때는 용해가공은 무리하고 생각된다.

시안옥을 사용하여 주철에 아연도금을 하고 싶은데 좋은 방법이 없다?

시안옥으로 한다면 저간한 저방울, 저방울유를 씻어내는데 끊임없이 좋은 결과는 얻을 수 없다. 아 무리도 저방울유를 하는 것이 좋다. 보통은 니켈 도금이나 구리도금 등을 바탕으로 용접할 어느정도 시안화 아연도금을 하기하나 가장 좋은 것은 이온화유 또는 황산을 사용하여 아연도금을 하지도 글루고 하는 방법이다. 그런데 카드뮴도금을 하지도금하는 방법이 유용하나 공해문제가 있으므로 일반적으로 쓰지어지지 않는다.

중간산의 자동아연도금장치에 의해 점이 식으로 6〜7V, 4〜5A/dm²로 13μm 정도의 도금을 하고 있으나 4〜5일 온도 사용하지 않고 있으면 다음에 특감은 조건으로 도금을 하여도 석출상태가 조잡하게 된다. 원인이 어디에 있는가? 연조감은 금속 18〜20g/ℓ, M비 2.75〜2.85 수산화물로 65〜75g/ℓ이다.

가공 취심의 용액에는 일반적으로 양극을 부식용하여 아연의 미립자만 용해에 분산되어 있기 때문에 조잡하고 가공한 도금의 신인이 되고 또 금속농도가 높게되어 왕래가 나지 않고 조잡하게 되며 기술자가 (타게)되는, 여러 현상이 일어난다.

용접처리로는 시안화나트륨을 보충하여 여과를 시키는 일인데, 그때도 점과 금속농도가 높아지면 제한적으로 될 수 있는데도 도금을 하지 않고 있는 동안에는 액상의 금속이 놓일 것이 좋으나 그 것이 균형할때에는 아연금을 용과로 하고 티탄 등은 양극으로 하여 0.5V 정도의 전압을 걸어주어 아연의 용해를 방지하는 방법을 채택하는 것이 필요하다.

저간화아연은 50ppm의 구리가 함유되어 있어서 이 구리를 제거하는 아주 섬세한 방법이 없는가?

아연분말을 뭉은 영상에 산재한 것을 수색하여 후일하고 풍부한 표면상에서 검단한다. 그때도 아직 정신착한 도금에 흡착이 되는 것들은, 속성성이 나타나게 되면 저전류밀도로 공전하여 제거된다. 그런데 보통 금속 분말의 제거에 다양한금의 정성제를 사용하고 있는데 이것은 구리성분의 제거에는 그렇게 효과적이 못된다.