

〈講 演〉

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 industrial lity 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

* 일본 동경에서 지난 1982년 5월 14일 개최되었던 제 1 회 아시아 표면처리학회에 한국측 대표로 이종남(고려대학교수, 본 공학회 전회장)박사께서 참석하여 기조연설을 한 바 있으며 각국 참석회원들로부터 연설내용이 좋았다는 호평을 받은바 있어 그 내용 전체를 원문 그대로 게재하는 바이다.

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 economics 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 achievemen 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.

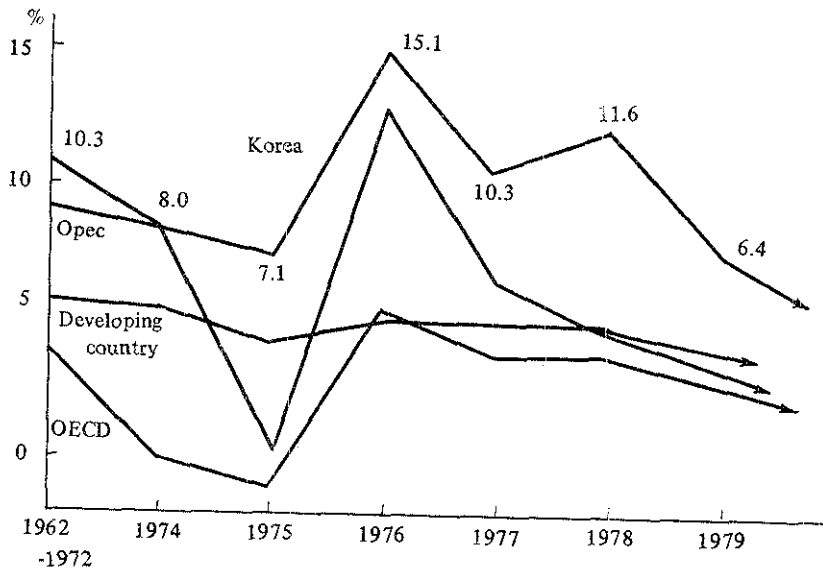


Fig. 1 Comparison of Economic Growth Rates

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,

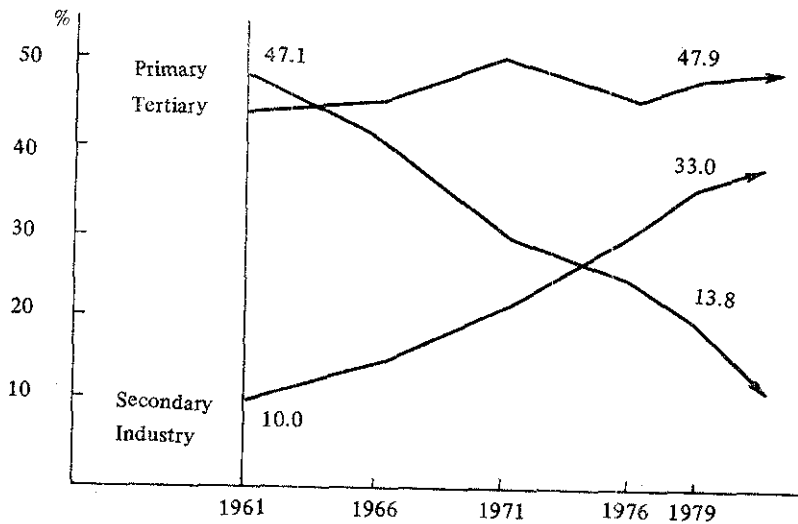


Fig. 2 Changes in the Industrial Structure

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, skillintensive 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 industrization 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.

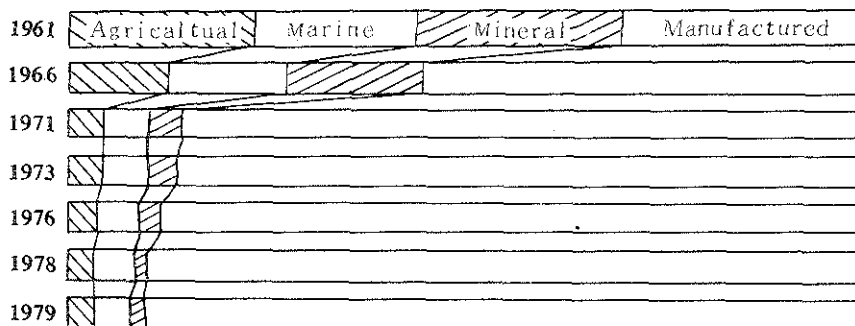


Fig. 3 Composition of Exports by Industry

Table 1. Export Structure by Sector

Year	1966	1973	1976	1979
Heavy & Chemical Industry Products	15.3	28.9	37.0	44.7
Light Industry Products	84.7	71.1	63.0	55.3
Others	-	-	-	-
Total	100.0	100.0	100.0	100.0

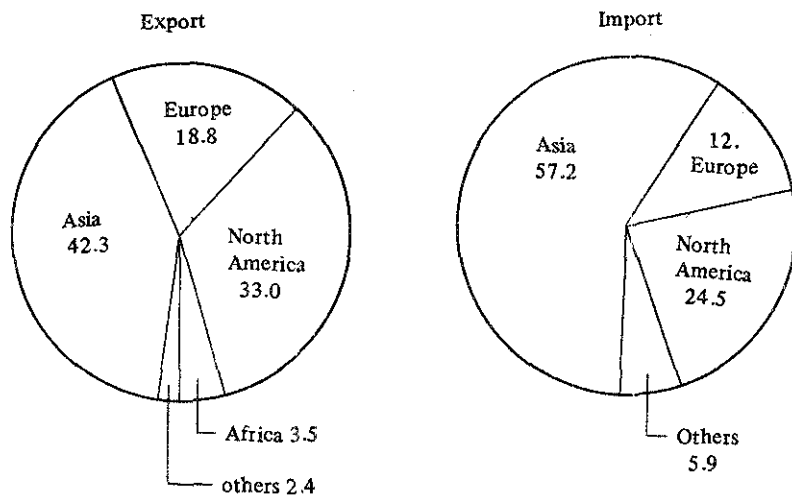


Fig. 4 Composition of Export-Import Market (1979) (%)

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

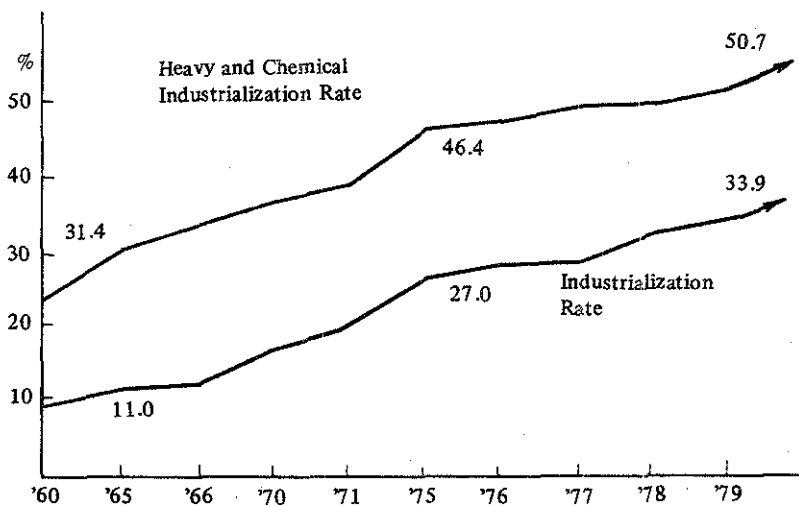


Fig. 5 Industrialization Rate

percent in 1965, with rapid expansion of the chemical industry (primarily oil refining and petroleum products) to 46.4 percent in 1975 and then to 50.7 percent in 1979 with the expansion of the iron, steel and machinery industries. This percentage is now only 10 to 20 percent lower than that of heavy and chemical industries in the advanced nations, which stand at 60 to 70 percent.

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 became 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 result 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

Region	Number of plants	Distribution ratio (%)
Seoul and Kyong-Ki	256	67.5
Busan and Kyong-Nam	80	21.2
Taegu and Kyong-Buk	24	6.3
Ho-Nam	10	2.7
Chung-Cheong	9	2.3
Total	339	100.0

*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

persons	below 10	over 10	over 20	over 30	over 50	over 80	over 100	over 200
No. of plant	72	59	31	20	15	1	1	1
Ratio(%)	36.0	29.5	15.5	10.0	7.5	0.5	0.5	0.5

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 (%)

clerical part	technical part
27.4	72.6

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

college	high school	middle school	primary school
3.6	32.4	49.2	14.8

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

unit: %

self fund	debt	profit		
		self fund	total fund	net sale
27.0	270.6	3.9	1.1	1.2

Table 6. Component ratio of prime cost

unit: %

materials	labour	expenses
52.6	21.7	25.7

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

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 7. Disposition of plant by operation system(%)

hand operated	semi automatic	full automatic
79	20	1

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

Thickness tester	Analysis equipment	Corrosion tester	Hull cell tester	Metallurgical microscope
35.7	46.4	10.7	39.3	7.1

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 (%)

non-ferrous metal	chemicals
58.3	34.5

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 view point 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 petty 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.

4-1-1 Encouragement of Self-regulating of Enterprises

4-1-2 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

* 질의 응답 *

㉠ 두께 1mm의 강판에 5~10μm의 아연도금을 한후에 그 일부를 90°로 꾸부려 가공해야만하는 제품을 취급하고 있다. 현재는 저시안옥을 사용하고 있으나 공해문제 때문에 염화옥으로 바꾸고 싶은데, 시장이 없는지? 이때 주의해야 할일이 무엇인지?

㉡ 5~10μm 정도의 두께라면 전처리를 잘 해서 밀착이 좋은 도금을 함에 주의를 하면 시장이 없다. 주의할 점은 염화옥은 첨가제를 가하면 시안옥이상의 광택이 나오나 그만큼 아연 도금층이 薄하게되어 굽힘가공시 도금층이 균열될 염려가 있으므로 광택제는 필수로 적게하는 것이 안전하다. 그런데 20μm 정도로 두꺼운 도금일 때는 굽힘가공은 무리라고 생각된다.

㉢ 시안옥을 사용하여 주철에 아연도금을 하고 싶은데 좋은방법이 없는지?

㉣ 시안옥만으로 한다면 저시안, 저알칼리옥을 써야되는데 충분히 좋은 결과는 얻을 수 없다. 아무래도 하지도금을 하는것이 좋다. 보통은 니켈도금이나 구리도금 등을 바탕에 올리면 어느정도 시안화 아연도금을 하기쉬우나 가장 좋은것은 염화옥 또는 황산옥을 사용하여 아연도금을 하지도금으로 하는 방법이다. 그런데 카드뮴도금을 하지도금하는 방법이 유효하나 공해문제가 있으므로 일반적으로 쓰여지지 않는다.

㉤ 중시안옥의 자동아연도금장치에 의해 절이식으로 6~7V, 4~5 A/dm²로 13μm 정도의 도금을 하고있으나 4~5일 옥을 사용하지 않고

있으면 다음에 똑같은 조건으로 도금을 하여도 석출상태가 조잡하게 된다. 원인이 어디에 있는가? 액조성은 금속 18~20g/l, M비 2.75~2.85 수산화나트륨 65~75g/l이다.

㉥ 가끔 쉬게된 옥에서는 일반적으로 양극이 부식용해하여 아연의 미립자가 옥 중에 분산되어 있기때문에 조잡하고 꺼칠한 도금의 원인이 되고 또 금속농도가 높게되어 광택이 나지않고 조잡하게 되며 꺼슬리게(타게)되는, 여러 현상이 일어난다.

응급처치로는 시안화나트륨을 보충하여 여과를 시키는 일인데, 그대로는 점차 금속농도가 높게 되어버림으로 될 수 있는데로 도금을 하지않고 있는 동안에는 양극을 꺼내어 놓는 것이 좋으나 그것이 곤란할때에는 아연극을 음극으로 하고 티탄등을 양극으로 하여 0.5V정도의 전압을 걸어주어 아연의 용해를 방지하는 방법을 채택하는것이 필요하다.

㉦ 저시안화아연옥에 50ppm의 구리가 함유되어있는데 이 구리를 제거하는 아주 손쉬운 방법이 없는가?

㉧ 아연분말을 묽은 염산에 산세한 것을 수세하여서 투입하고 충분히 교반한후 여과한다. 그래도 아직 질산침지한 도금에 흑색이나 회색의 얼룩이나 변색이 나타나게 되면 저전류밀도로 공전해하면 제거된다. 그런데 보통 금속 불순물의 제거에 다황화물의 청정제를 사용하고 있는데 이것은 구리성분의 제거에는 그렇게 효과적이 못된다.