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Welding Situation and Development in China[†]

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Abstract

This paper is a survey of the welding industry in China. It describes the basic situations of the Chinese welding industry, and gives forecasts of its development in the near future.

KEY WORDS: (China) (Welding Equipment) (Cutting Equipment) (Welding Material) (Welding Automation System) (Welding Research) (Welding Training & Education)

1. Introduction

Before 1949 there was no welding industry in China, only a few factories used some manual welding or gas welding to repair ships or cars. All welding machines, electrodes and gas were imported from abroad. From 1949, the "First five years economic plan" was carried out in China, and the first car factories, shipyards, heavy machine factories, etc., were founded. The requirement for welding increased rapidly. In 1953, the first welding machine factory started to build, then first welding research institute was also founded in Harbin.

For nearly 50 years, especially in the recent 20 years, Chinese welding industry has developed greatly and become an important branch of Chinese industry. Now welding is widely used for machine manufacture, in shipyard, automobile maker, aviation industry, aerospace industry, oil-chemistry industry, civil construction industry, and so on. Last year, almost 40 million tons of steel constructions were processed by welding technology.

With modernization proceeding in China, Chinese welding industry will face a big market and bright future. But the world economy becomes one family and competition will be greater and more rigorous. Chinese welding industry is also facing a grim struggle.

2. Present Situation of Chinese Welding Industry

2.1 Development of welding equipment

The situation is listed in **Table 1**. The classification of welding equipment is listed in **Table 2**.

In recent years, the development of Chinese welding equipment enterprises has grown fast. Now there are almost 1500 factories and companies producing many kinds of welding equipment. However, most of them are small factories or companies and only 33 specified enterprises are moderate factories. Through technical rebuilding and importing advanced technology from abroad, the output value has increased more than twice in

Table 1 General situation (in 1995)

Unit	Staff	Estate	Output Value	Export	Import
1500	33927	>10 ⁹	>10 ⁹	3.9*10 ⁶ \$	170*10 ⁶ \$

Table 2 Situation of welding power sources

	AC	DC	Auto. or Semi-auto	Others
Number (x10 ³)	154	28.3	11.6	8.5
%	76.0	14.2	5.7	4.1

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last 5 years and already 10 automatic production lines to improve the quality of production have been set up.

Since 1990, many foreign welding companies have invested in China in the joint ventures. Now in Shanghai, Tangshan, Changchun, Tianjin, Chengdu, Mudanjiang, there is founded, or planned, joint-venture welding enterprises to produce many kinds of advanced CO₂ welding machines, friction welding machines, inverter welding power sources, etc.

Analyzing the classification of welding equipment in China shows that 90% of productions relates to AC and DC manual welding power sources, auto and semi-auto welding machines constitute less than 10%. So, Chinese welding equipment industries are still developing, their techniques will be improved and its production developed to meet all the needs. The Chinese welding industry should itself be restructured to adapt to new environments and to point to more advanced stages in the technologies.

2.2 Development of welding materials

The situation of welding material factories is listed in Table 3 and 4.

Now, China is the biggest production country of welding materials, the annual output capacity is near 1.8 million tons. In 1995 the real output was 760 thousand tons. In this output, manual electrodes accounted for 80%, auto and semi-auto wires only occupied 15%. This means that although the requirements for welding materials are large, the automation of welding in China is still at a low level. In next 10 years, the requirement for manual electrodes will still go up, but the requirement of auto and semi-auto welding wires will grow more rapidly. CO₂ welding is an effective welding method, but in China, it has developed slowly. At the end of 1985, the output of CO₂ welding wires was only 4000 tons per year. However, in the last 10 years, it has developed faster and output of CO₂ wires came up to 70 thousand tons in 1995. In the next 10 years, the requirement for it will increase and output values will possibly be up to 150 thousands tons.

Flux cored wire welding is an advanced technique. In 1985, a Chinese factory imported the first flux cored wire production line from UK. Nowadays, there are 16

flux cored wire production lines in China. Among them, 12 lines were imported from USA, UK, Germany. But, the annual output is only 1000 tons now. The main reason is because of its unstable quality, but it will develop greatly in the future.

Now in China, there are many small factories and companies for welding materials. In the market, the supply of ordinary welding electrodes already exceeds the demand, but high alloyed electrodes are an exception. Most of them have to be imported from abroad. So, the structure of the welding materials industry should be reformed by mutual competition in future.

2.3 Development of cutting equipment

The situation for cutting equipment factories is listed in Table 5.

The situation for cutting equipment production is listed in Table 6.

In recent years, Chinese cutting equipment has developed remarkably. The category is approaching completeness. The main production involves gas flame, and plasma arc cutting machines with NC controllers. They have become popular to use. The types of cutting machines are from 2 M to 11 M. In the 1980s, cutting machines, especially large type cutting machines, were all imported from abroad. In the 1990s, Chinese production of cutting machines was able to meet most of demand and some cutting machines, especially, small type and middle type cutting machines are already exported abroad.

Until now, oxygen-acetylene gas cutting has been the main cutting method in Chinese industry. Since 1990, China began to develop oxygen-propane and oxygen-propylene gas cutting instead of oxygen-acetylene cutting and achieved successful results.

There was no liquid oxygen cutting originally in China. In the recent 5 years, foreign gas companies have cooperated with Chinese companies to set up liquid oxygen factories in Shanghai, Taiyuan, Beijing, Dalian and Anshan. They are developing fast and successfully.

At present in China, the high energetic beam cutting, for instance laser cutting and water jet cutting, is not popular, and it is only just beginning to develop.

Table 3 Number of factories producing welding materials

Elect.	CO ₂ GMAW	Solder	SAW Flux	Flux Cored Wire
600	100	300	30	21

Table 4 Annual output (in 1995)

	Electrode	CO ₂ GMAW	Flux	SAW Wire
Output (10 ⁶ tons)	0.6	0.07	0.05	0.04
%	80.0	9.3	6.7	5.3

Table 5 Situation of Cutting Machine

	Welding or Cutting Cutting Machine	Blowpipe
Number of Factories	56	65

Table 6 Annual Output of Cutting Machine

Category	Cutting Machine	Blowpipe	Nozzle
Annual Output	14,000	2.12*10 ⁶	11.58*10 ⁶

Table 7 Situation of Auxiliary Equipment

Category	Auxiliary Machine	Torch and Holder
Annual Output	1,000	0.1*10 ⁶

2.4 Development of auxiliary equipment and automatic welding manufacturing systems

The situation of auxiliary equipment is listed in Table 7.

Until now, the development of auxiliary equipment has been a weak point. Qualities of torch, electrode holder and tip have been variable. The national unified standards are not yet set up. Categories of operator, positioner and roller are uncompleted, their automatic level is also low. Most of auxiliary equipment are manufactured by users themselves. Especially for automatic welding manufacturing systems, much progress needs to be made. According to a report in 1996, there are only 500 welding robots in China (55% are welding robot stations, 45% spot welding robots). The robot industry is just beginning to develop. Just now, in car makers, motor bicycle makers and civil engineering companies, the requirement for automation is growing fast. They need both robots, FMS and CIM. In the approach to the year 2000, Chinese industry needs at least 500 sets of robots. So, the automatic welding manufacturing systems will gradually develop in China.

2.5 Welding situation of manufacturing industry

In the last 20 years, manufacturing industry, such as automobile, ship building, heavy machine, electron and building industry, which mainly making use of welding, has developed by R & D work and imported advanced welding techniques, such as automatic welding machines, welding production lines and welding FMS. The technical level has greatly improved in this industry.

The progress made is as follows:

1. Over 20 automatic production lines for pre-treatment of crude materials have been set up.
2. Advanced NC cutting techniques have been widely applied.
3. High efficiency welding processes have been gradually used in manufacturing industries, such as CO₂ welding, high speed welding, narrow gap welding, automatic TIG welding, inverter welding power sources, flux cored welding, electro-slag welding, high energy beam welding, SMT, friction welding, diffusion and soldering, etc..
4. Welding robots, welding FMS, and special automatic production lines have been built in car factories, heavy machine factories, shipyards, oil-chemistry industry and electronic industry. So the welding automation level has been improved in China at recent years.

In general, the Chinese welding techniques are still

developing. The development of welding automation is just beginning. Looking forward 10 years, it is expected to develop at an even faster speed.

2.6 Situation of welding research units

Now there are 25 welding research institutes and centers in China. Most of the large enterprises, such as machine manufacturing factories, airspace factories, shipyard, electronic production factories and metallurgical factories, have their own special welding R & D centers. The largest welding research institute is located in Harbin, it was founded in 1958.

All the welding research institutes and centers make great efforts to promote and develop advanced welding techniques into practice. Some of them also produce advanced welding apparatus. Their main objectives are to establish the application of new welding processes.

2.7 Situation of welding training and high education

In recent years, the number of Chinese welding workers has increased rapidly from 1200 (in 1982) to 1600 thousands(in 1992). Now it is over 2 million. Most industries have their own training centers according to Chinese welding standards and controlled by the Chinese labor ministry. The CWS has gained permission from IIW to supervise the training for Chinese welding workers according to international welding standards this year.

The situation of universities is listed in Tables 8, 9 and 10. The first welding department was founded in Harbin Institute of Technology in 1950, now there are 42 welding departments in Chinese universities. Until now, the students graduated from welding departments number over 25 thousands.

According to the economic system which is reforming to a free market, Chinese welding high education is also reforming. The contents of education are strengthened in foundation education, ability education, and broadened specialty. So, some of the "welding department" are changing their names to "material engineering department".

However, Chinese universities are still important research bases for welding. National key welding research laboratory was founded in Harbin Institute of Technology, and a national R & D welding center located in Harbin Welding Research Institute.

Table 8 Number of Units

Welding Institute	University	National Key Lab.
25	42	1

Table 9 Situation of Authority

Number of MDA Authority	Number of PhD Authority
20	6

Table 10 Number of Annual Graduate

Bachelor	Master	Ph.D.
2,000	100	20

3. Future of Chinese Welding Industry

The future of welding industry in China will be bright for the reasons given as follows.

1. The market for welding industry will be bigger in the near future. According to "the Chinese ninety fifth years economic plan", the output of steel in the year 2000 will be 120 million tons, the output of oil will be 160 million tons, the output of coal will be 140 million tons, the output of cars will be 3.5 million sets, the output of ships will be 2.5 million tons per year. It seems they can be attainable. In order to reach these targets, it is necessary to be equipped with many kinds of metallurgical equipment, oil and gas manufacturing equipment, power plant equipment, civil engineering equipment, mine equipment, car and ship manufacturing equipment, etc.. So in the year 2000, welding structures will reach 600 million tons. This is forecast to require various kinds of welding machines totally 300 thousand sets of which 1/3 are auto. and semi-auto. types, 1000 tons of materials and 300-400 sets of welding robots.

2. Now the techniques of Chinese welding industry are still backward compared with developed countries, so the potential for development is large. Welding constructions only occupy 40% of total output of steel in China. The manual welding method is still used in most of manufacturing industry. Auto and semi-auto welding techniques are only used in 10-15% of total production. In the near future, it is planned to increase welding automation to 25-30%, and widely apply CAD/CAM, robots, FMS and CIM.

3. The advanced welding technologies are developing at rapid speed now. All of these need to be applied such as high efficient CO₂ welding, narrow gap welding, NC controlled welding, high energy welding, intelligent

welding and welding automation, etc.

4. Suggestions

It can seem that this period offers the best chance to develop Chinese welding industries. Under the situation of the globalization of the world economy, as if it becomes one village, the development of Chinese welding industries will carry forward the world welding industry, and the world welding industries are interested in the Chinese market, so mutual cooperation is most important. The CWS should act as the bridge between China and foreign countries to promote cooperation at every level, including industry, research, training and education.

Now many companies from USA, Japan, Germany, etc., have established some cooperation or joint venture with welding enterprises, also many Chinese research units and universities have set up various kinds of cooperation at different levels with foreign countries. They are generating valuable and important effects for both sides. In order to develop more active cooperation, it is necessary to search for new cooperative ways. For instance, the establishment of an international welding R & D center of more flexible property. Its main functions would be information exchange, market searching, industry advice, educational exchange, technical training, cooperative research, and the organizing of international conferences, etc.

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