STATE-OF-THE-ART AND PROSPECTS OF MARKET OF STEEL AND WELDING EQUIPMENT IN CHINA (Review)

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Generalized data on the state-of-the-art in the ferrous metallurgy and welding engineering industries of China in a period of 2009–2010 are presented, and prospects of their further development are considered.

Keywords: *steel production, welding equipment, economy, statistics*

Steel production. Stable and high rate of the annual average growth of economy of around 10 % remains in the country since 1978 (beginning of the performance of economic reform in China). Steel production is also constantly rising. The annual average increase of steel production made around 7 % in the 1980s, 10 % in the 1990s, and more than 20 % since 2000. 626.6 mln t of steel was manufactured in China in 2010 that exceeded the total output of 15 countries being leading world producers of steel (Table 1). Portion of China in the world steel production has risen from 5.1 in 1980 up to 44.2 % in 2010 during 30 years [1].

High rates of industrialization and urbanization, significant investments in the key branches of Chinese economy, related with high metal consumption such as machine building, motor car, ship, civil and industrial construction, first of all, stipulate the increase of steel production and consumption. Volume of steel consumption in China has risen 3.5 times during ten years since 2001 till 2010 and exceeded 600 mln t in 2010. An index of consumption per capita increased 3.4 times for the same period and made 445.2 kg in 2010 [1, 2].

More than 95 % of steel produced in China is consumed in the domestic market. China exported around 42 mln t in 2010 and imported 17 mln t of finished steel products. Industrial and civil engineering (56 %), machine building (18 %), motor car (6 %), ship (3 %) construction and power engineering (2 %) are the main steel consuming industries in China. Necessity of Chinese economy in a high-quality steel production constantly rises [3].

One of the relevant issues of modern China is an increase of efficiency and competitiveness of ferrous metallurgy. Planned reforming of the industry has been performed since 2004, after «Plan of development of ferrous metallurgy in China up to 2020» was stated. The tasks on solving of a problem of excessive production capacities, fragmentation, technical reequipment of the industry, stimulation of export and environment pollution were set in a state plane of development of Chinese economy for 2011–2015. It is planned to increase a portion of ferrous metallurgy in GDP of the country up to 4 % in 2011 according to the plan indices. At that, steel production capacity is planned to be reduced up to 500 mln t [4, 5].

The total capacities of the PRC on melting of raw steel increased more than 4 times since 2000 to 2009 and achieved 743 mln t that makes 80.4 % from a global addition of capacities for this period according to evaluation of the World Steel Association.

At present time the steel making capacities are 20–30 % higher than the level of actual consumption. It was planned to stop running of the blast furnaces of less than 300 m^3 in volume, converters and electric furnaces up to 20 t in 2010. Stop of running of the blast furnaces of less than 400 m^3 in volume and converters and electric furnaces of less than 30 t are expected during 2011. The out-of-date blast furnaces of total capacity of around 100 mln t/year are to be stopped during 2010–2011. As a result of reform the ten largest state companies will control the steel making capacities to 60 % in 2015 and 70 % in 2020 according to the intended plan. The portion of the five

Table 1. Countries of the world — the main producers of steel in 2010

Country	Rank	Volume of steel production, mln t	Portion in world production, %
China	1	626.65	44.2
Japan	2	109.60	7.7
USA	3	80.59	5.7
Russia	4	67.02	4.7
India	5	66.85	4.7
Republic of Korea	6	58.45	4.0
Germany	7	43.82	3.0
Ukraine	8	33.56	2.4
Brazil	9	32.82	2.3
Turkey	10	29.00	2.0
Italy	11	25.75	1.8
Taiwan	12	19.64	1.4
Mexico	13	17.04	1.2
Spain	14	16.31	1.1
France	15	15.42	1.0

largest steel making companies was equal 32.6 % in 2010 in total output of steel along the country. It increase up to 45 % is planned in 2011.

Construction of the state-of-the-art large metallurgical plants allowed increase the steel output as well as changed a structure of steel making technology and products manufactured in China, promoted implementation of the energy saving technologies. Significant success was achieved in the area of environment control [6]. The last open-hearth furnace was stopped in China in 2001. The portion of steel making in oxygen steel-making converters made 90.2 % (565.4 mln t) in 2010 and it was 9.8 % for the arc furnaces (61.3 mln t). The portion of steel making by means of continuous casting made 97.9 % (613.7 mln t) in 2010. Specific emissions in the atmosphere are reduced 3 times in steel making by means of a converter method in comparison with the open-hearth method. Metal consumption reduces up to 15 % and specific pollutant emissions in the atmosphere decrease 2.5 times during the process of continuous steel making. Significant increase of output of hot-rolled stock is observed. 796.3 mln t of hot-rolled stock were manufactured in China in 2010 and portion of a flat section exceeded that of a rolled one in structure of its production for the first time in 2007. 362.9 mln t of rolled and 408.1 mln t of flat sections were produced in China in 2010. Table 2 shows the data on production of some main types of metal products in China for different years [1].

It is planned that the quality of 60 % of the end steel products, manufactured by the leading large and medium steel making enterprises, will comply with the world standards as a result of technical reequipment of this industry, and Chinese enterprises will be able to satisfy the internal demand in the main types of end steel products by 90 %. One of the main priorities of the industry is to master a production of new types of steel products and goods with a high added value. The Chinese Central Government appropriated around 25 bln of yuans (approximately 4 bln of dollars) for technical reequipment and support of research studies in the industry in 2011.

Table 2. Output of the finished steel products in China, mln t

Type of products	2004	2009	2010
Rolled section	162.9	332.5	362.9
Flat section	127.7	307.7	408.1
Light-section profile (≤ 80 mm)	21.9	39.1	42.5
Rolled stock of round section for reinforcement of concrete structures	57.7	121.5	131.0
Other types of products from hot-rolled sections	23.1	55.4	69.0
Rod	50.2	96.7	105.5
Metal coated plate and strip	6.0	20.7	28.5
Pipes and fittings	21.2	–	57.7
Welded pipes	13.0	30.4	32.4

«Norms of production and running of ferrous metallurgy enterprises» were published by Chinese government in 2010. They determined the specific parameter standards of production and equipment as well as measures of environment protection for metallurgical enterprises. In particular, production of 1 t of steel requires that a blow of foul water does not exceed 2 m^3, atmospheric emission of dust are to be 1 kg and emission of sulfur dioxide should make 1.8 kg according to the norms of environment protection. A technology of dry quenching [7, 8] should be obligatory used at the medium and large metallurgical enterprises for reduction of electricity consumption and pollution of the environment.

Rise of a competitiveness of Chinese ferrous metallurgy [5] is the final aim of implementation of the measures directed to power saving and reducing of emissions, optimizing of commercial structure, increasing of production and closing of outdated capacities.

Welding engineering. Portion of China in the world welding market made 23 % (3.1 bln of dollars) [9] in 2010 according to ESAB evaluation. China takes the first place in the world on the output and consumption of welding consumables. Volume of the Chinese market of welding engineering increased by 14 % in comparison to 2009. Output of welding consumables made around 2.5 thou t in 2009 and volume of welding consumable market in value terms for China was around 1.1 bln of dollars [9]. Table 3 shows the data on output of the main welding consumables in China in 2004–2009.

Structure of welding consumable production in China rapidly changes: production of solid wire and flux-cored wire increases and that for the welding electrode reduces.

Coated electrodes for manual arc welding made around 60 % of all being manufactured in China in 2009 and 40 % of that was welding wires (25 % — solid and 15 % — flux-cored wire).

Output of welding consumables in China will achieve 3.5–4.0 mln t in 2015 according to forecast of China Iron and Steel Research Institute. At that, portion of production of coated electrode for manual arc welding reduces to 22 % , rising of solid wire for CO_2 welding up to 50 % and flux-cored wire up to

Table 3. Production of welding consumables in China, thou t

Welding consumables	2004	2005	2006	2007	2009
Electrodes	1100	1200	1250	1300	1450
Wire	400	480	560	650	1050
Total	1550	1750	1900	2050	2500

Table 4. Export and import of welding and filler materials, thou t (numerator), mln USD (denominator)

Welding consumables	Export			Import		
	2008	2009	2010	2008	2009	2010
Coated electrodes and wire (without solid wire), total	323.7/422.3	336.0/347.4	315.6/352.4	53.0/300.1	51.9/245.0	56.5/293.6
Including:						
coated electrodes for arc welding	191.9/173.8	247.3/191.0	239.7/187.5	6.9/53.5	4.2/35.3	6.0/49.5
brazing consumables	17.1/37.5	20.9/34.8	21.7/43.5	11.6/149.6	11.0/125.4	12.4/161.4
flux, auxiliary materials	19.6/18.5	17.5/14.7	16.0/14.4	23.0/93.5	19.6/84.8	23.6/108.0
Welding consumables, total	360.4/478.3	374.4/396.9	353.3/410.3	85.6/543.2	82.5/455.2	92.5/563.0

15 % are to be observed, amount of wire for submerged arc welding will be around 12 % and materials for nonconsumable electrode welding preserve on 1 % level [1].

Construction, machine building, power engineering (construction of oil and gas pipelines), shipbuilding, railway transport are the main industries consuming welding consumables in China. 40–50 % [11] is a portion of consumption of welding consumables in building.

Export of welding consumables was significantly reduced in 2009 due to the economy crisis, however, indices of export of welding consumables turned to the pre-crisis level already in 2010. The volume of export of welding consumables in China in kind terms more than 4 times higher of the volume of import, however, the volume of import almost by 40 % exceeds the volume of export of welding consumable and filler materials in value terms. China had a negative trade balance in studied group of products in 2010 as well as in the pervious years.

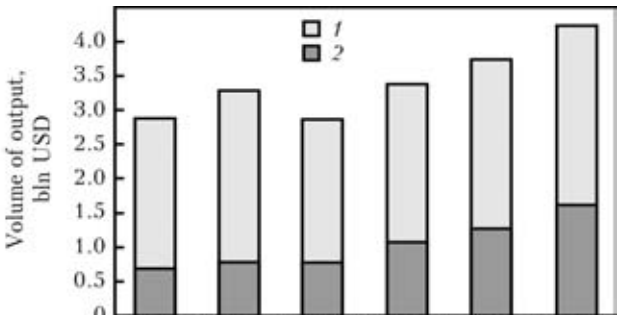
Table 4 gives the data on the volume of export and import of welding consumables and filler materials in value and in kind terms according to the COMTRAD database of United Nations Organization [12]. Analysis of a group of consumables, containing alloyed solid welding wire (code 7217), has no representation in the paper, since COMTRAD database classifies the production on a six-unit code and 721710 class (wires and strips) does not represent a subclass on solid welding wires (positions seven and eight).

Coated electrodes make the main portion of export of welding consumables (45 % in indices of in value terms and almost 70 % in kind terms). The volume of export of coated electrodes constantly rises. Flux-cores wire (30 %), consumables for gas welding (21 %) and for brazing (26 %) form the main portion in structure of the import.

Main types of welding equipment. Serial devices for alternating current arc welding; equipment for direct current arc welding; automatic and semi-automatic machines; machines for resistance welding; special welding and cutting automated equipment can be referred to this type of production, manufactured in China.

The output of electric welding equipment in value terms for China in 2009 made 2.9 bln of dollars that is lower of that in 2008 by 12 %. The output of welding equipment increased up to 3.4 bln of dollars in 2010 during after crisis period. In future the year-on-year increase of production of welding equipment will make 11.2 % up to 2012 on estimate of the Chinese experts. The output of welding equipment in value terms is expected to exceed 4.2 bln of dollars [13] in 2012.

Production of low-class equipment (alternating current welding transformers for arc welding) dominates in the structure of production of Chinese welding equipment, however, a portion of its annual increment is insignificant (around 5–6 %) and constantly decreasing. In contrast, a portion of production of highly technological and power-saving equipment, i.e. inverter power sources for direct and pulse current welding, automatic and semi-automatic equipment with digital control rises steadily (see Figure). Portion of the inverter power sources in value terms during production of welding equipment made 28 % in 2010 that was by 60–70 % lower than that in the developed countries. Increase to 39 % [13] of the portion of inverter power sources in the production structure is expected to 2012.



	2007	2008	2009	2010	2011*	2012*
1	2.2	2.5	2.1	2.3	2.45	2.6
2	0.7	0.8	0.8	1.1	1.3	1.65

Volume of output of welding equipment in value terms in China: *1* — traditional equipment; *2* — inverter sources; * — forecasting data

Table 5. Export and import of electric welding equipment, mln USD

Equipment	Export			Import		
	2008	2009	2010	2008	2009	2010
Electric equipment for welding, brazing, cutting, surfacing in total	583.467	476.617	798.439	1044.182	751.004	1099.107
Electric solderers	36.053	32.056	47.053	6.072	4.670	7.982
Machines and devices for brazing	6.661	4.190	10.681	36.390	34.565	59.265
Machines and devices for automatic resistance welding	36.288	52.483	106.767	195.114	98.498	198.886
Other machines and devices for resistance welding of metals	90.275	51.782	58.460	42.914	13.632	35.387
Automatic equipment for arc welding	25.620	14.586	22.544	131.511	140.192	137.360
Other machines and devices for arc welding	139.373	122.394	250.212	19.040	19.040	13.436
Electric machines and devices for laser and/or another beam or plasma-arc welding; electric machines and devices for thermal metal spraying	119.991	124.805	168.741	481.122	336.917	497.283
Spare parts of machines and devices for brazing, welding or thermal metal spraying	129.205	74.319	133.977	131.918	109.092	142.678

The annual need of China in arc welding equipment counts approximately 380 thou pcs, among them 25 % make the equipment for CO_2 metal-arc welding (MAG) [11].

The level of automation and robotization of welding production rises. Necessity in the robots for arc welding is rated in 2.4–2.5 thou units. Welding robots are widely used not only in motor car construction, but also in machine building, construction and transport machine building (railway and electric transport).

There is an increase of application of the cutting equipment. 2 thou units make the annual necessity in gas, plasma and laser cutting equipment. The main portion (around 95 %) is the machines for plasma and gas cutting. Around 70 % of internal market of cutting equipment is provided by Chinese producers. 30 % make a portion of import of this type of equipment from Japan and EC countries. Necessity in equipment for water-jet cutting is also significant. Annual demand in this type of equipment makes around 500 pcs.

Chinese production supplies 60–70 % of welding equipment to internal market. This index has not changed since 2007 as a result of advancing increase of the steel and metal structure production. Therefore, preservation of a significant volume of import of welding equipment with annual increment is quite natural and has exceeded 1 bln of dollars in 2010.

There is an increase of import of welding robots in China. Japan (80 %), Germany, Austria and Switzerland are the main suppliers. The import of welding robots for arc welding from Japan made 1,765 pcs in 2009 (it increased by 12.1 % in relation to 2008). 400 pcs for spot welding and 150 pcs for laser welding, mainly, for microelectronics (production of mobile phones and computers) [11] were purchased in 2009.

The data on volume of the external trading of Chinese electric welding equipment in 2008–2010 according to the information from the COMTRAD database of the UNO [12] represented in Table 5.

Export of electric welding equipment rises with a substantial rate having the advantage in price. In a period of 2008–2010 the export of electric welding equipment increased by 40 % and import by 5 % regardless the world crisis as can be seen from Table 5. Most of developed countries of the world, including USA, Canada, Germany, France, Russia, Japan, Korea etc. export these production. The equipment for arc welding (direct and alternating current power sources) dominates in the structure of export of Chinese electric welding equipment with 24 %. The equipment for plasma-arc welding and cutting make 20 % and spare part are 22 %. China mainly imports highly technological electric welding equipment for electron beam and laser welding, arc, resistance automatic welding and semi-automatic welding.

Opening of the national internal market and appearance of the leading producers of welding engineering, i.e. Lincoln Electric, General Electric, ESAB, Osaka Transformer Company (OTC), KUKA, Termadyne, Miller etc. in it are tightly related with the rapid development of Chinese welding industry in the XXI century. This allows reorganizing the national welding industry in the country, arranging production of the most state-of-the-art foreign welding engineering, implementing modern methods of management of own production, significantly increasing the level of welders' training.

ESAB Company from Switzerland, the largest in the world producer of welding engineering, actively entered in the Chinese market in 2005. They created company «Shanghai–ESAB Welding & Cutting Systems China Ltd.» for production of welding engineer-

ing and opened a plant for manufacture of automatic welding and cutting equipment. The first ESAB plant on production of solid and flux-cored welding wire with production capacity of 40 thou t of welding wire per year was launched in China in 2006. Another plant on production of welding consumables — flux-cored wire was started in 2008. Capital investments in this enterprise made 30 mln of dollars. Production capacity of the enterprise is 10 thou t of flux-cored wire per year [14].

American company «Lincoln Electric» opened its first plant on production of solid and flux-cored wire in 1989. Today they have five plants on production of welding consumables and filler materials (flux-cored and solid wire, fused flux) and automatic welding equipment in China. Construction of a plant on production of new grades of wires for MIG welding as well as new plant on welding flux manufacture [15] were started in 2010.

National welding industry of China counts more than 1000 enterprises. These are mainly small and medium concerns with the annual output up to 160 thou of dollars. More than ten national industrial companies and companies, for example, Nantong Sanjiu Welding Machine Co. Ltd., Shougang Group, Chengdu Hanyan Weida Automatic Welding Equipment Co. Ltd., Shanghai DONSUN Welding Group Co. Ltd. with annual output around 10 bln of RMB (around 1.6 bln of dollars) exist in the country. These are, as a rule, the large scientific-and-production complexes. Their activity covers the whole range of product life cycle: from development to after-sale service, including staff training.

Reorganization of the industrial enterprises is performed and conditions for increase of a number of large-scale and serial production enterprises are developed for the purpose of increasing the competitiveness of Chinese welding industry in the world market and growing the export of production in the country. Taking into account the peculiarities of small and medium enterprises, the emphasis is made on creation of small, but strictly specialized companies, which can be termed «unique».

Enterprises are obliged to increase a rate of technological reequipment and promote development of the new products due to competitiveness rise. Significant number of enterprises appeared in the welding industry of China which can invest costs in the investigations and development of new technologies and products. Thus, for example, the first national robot for spot welding «165 spot-welding robot» [16] was developed and implemented into production as a result of the joint project of Institute of Robotics Technology of Harbin Institute of Technology and motor-car giant Chery Automobile Co.

Chinese specialists note that «the era of small profit» is to come in China in the nearest future. The increase of the profit due to low cost of raw materials and salaries has been already exhausted. Implementation of high technologies, methods of enterprise management and rise in qualification of workers and staff are the single possible way of profit increase at the enterprises.

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