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# THE STATUS QUO AND DEVELOPMENT TENDENCY OF CONSTRUCTION MACHINERY AND ITS HYDRAULIC COMPONENTS IN CHINA

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## ABSTRACT

The status and development tendency of construction machinery in china in recent years will be introduced; especially the outputs and performance level of the main products such as excavator, loader, crawler crane, truck crane, road roller and rotary drilling rig. Then the application of new products from internal corporation is analyzed and the research and development tendency of homemade hydraulic components of construction machinery field are also included. This paper introduces not only the national product standards of construction machinery but also the national policies and regulations for energy saving and pollution reduction in China.

## KEY WORDS

Construction machinery, National product standards, Policy, Hydraulic component, China

## GENERAL STATUS

With the development of 50 years, China construction machinery industry can provide products of 18 main kinds, more than 4500 species. It has been an important, large scale and flourished industry, which can meet the needs of home market. In 2006, there were about 1,000 large scale construction machinery factories, of which 130 were foreign-invested factories and joint ventures; 300 enterprises' annual sales over-passed 1,000 thousand dollars; 100 enterprises' annual sales over-passed 10,000 thousand dollars, and their total annual sales were 11.8 billion dollars, 75% that of whole industry's; 23 enterprises' annual sales over-passed 1,250 million dollars, and their total annual sales were 50% of whole industry's. In 2006, 420 thousand construction machines of all kinds were sold out, and the sales were 20 billion dollars, which grown up by 28% compared to that of the last years'. Based on

the sales statistics of the main enterprises and compared to the last year, sales of excavators (48021) grew up by 45.8%, and sales of loaders (126128) grew up by 13.3%, and sales of bulldozers (6063) grew up by 16.2%, and sales of land scraper (2174) grew up by 31.3%, and sales of construction cranes (14081) grew up by 30.8%, and sales of road rollers (8470) grew up by 21.2%, and sales of forklifts (78709) grew up by 35.5%, and sales of rotary drilling rigs (368) grew up by 209%, and sales of long auger borings (479) grew up by 106.5%. As to concrete machines, concrete mixers (12000), concrete draw-pumps (4500), concrete pump vehicles (2500) and concrete mixing stations (1800), all grew up by more than 30%.

On the base of more than 20 billion dollars in 2006, total sales in 2007 was expected to be 25 billion dollars, and products of all kinds were exported to 197 countries and regions, which expectedly made Foreign exchange earnings more than 8 billion dollars, 70% more than 5

billion dollars in 2006. The product exports were about 25% of the total sales, and this tendency is still last yet. It is strongly expected to be 10 billion dollars next year. The situation of China construction machinery import and export showed that the total import increased every year, and it fell down slowly after the peak in 2004, and after increasing every year, the total export maintained general the same from 2005. Then, the structure of export has been improved, the proportion of whole machines rose from 45% in 2000 to 58.8% in 2005. The third, among the exporting enterprises, foreign-invested enterprises and joint ventures have been the main, whose exports taken up to 42% that of the total, state owned enterprises moved back to the second, who taken up 34% of the share, and not-state-owned firms also grew very fast, who have taken up 19% of the total export share. The last one, spare parts and fittings exported to American, Japan and South Korea increased, which shows that China construction machinery spare parts industry starts to enter the global industrial chain. But compared with foreign colleague, the following questions exist in China: big gap in control technology, non standard of corresponding basic parts (spare parts and fittings, components) and shortage of R & D costs.

## MINING MACHINERY

### Production Development

Up to 2006, China's enterprises of hydraulic excavators have more than 30, producing a total of more than 150 kinds of the excavator with quality from 1.3 to 120.0 tons, including the state-owned enterprises, joint-stock enterprises, private enterprises, overseas-owned enterprises and Sino-foreign joint ventures[1].

In 2006, a total number of hydraulic excavators are 50,034 in China, the sales reach 48,021, and the exports sales reach 7887. In 2005 a total of hydraulic excavators (not including mining loader 211), is 34,511 in China, the sales reach 33,642, and the exports sales is 3617. China's excavator product and enterprises in 2005-2006 is shown in table 1 and table 2.

Table 1 Excavator product classification and China's main production enterprises

Product	Manufacturing Factory
Crawler excavator	Komatsu, Hitachi Construction Machinery, Chengdu Kobelco, Caterpillar, Guizhou Zhanyang, Doosan, Hyundai, Sichuan Bonny Heavy Machinery Co., Ltd., Liugong, Xuzhou Xuwa Excavator Machinery Co., Ltd., Sany, Changsha Sunward Construction Machinery Co., Ltd., Yuchai
Tire excavator	Guizhou Zhanyang, Doosan, Hyundai, Chengdu Kobelco Construction Machinery Co., Ltd., Hitachi Construction Machinery

Table 2 China's main products excavator production and sales from 2005 to 2006(unit)

Product Name	Production quantity		Sales (unit)	
	2005	2006	2005	2006
Crawler excavator	32289	47783	30899	45333
Tire excavator	2222	1865	2263	21687
Mining Loader	211	386	480	520
Total	34722	50034	33642	48021

### Marketing and Sales

Since 2000, the Chinese excavator market has grown by the superior speed. In 2000, all the sales of excavators of China's domestic enterprises were 7926, it reached 34,800 in 2003 and it is 4.4 times larger than 2000. In 2003, National excavator sales grew 76% over the previous year. In 2004, the sales of the excavator, compared to 2003, drop a little. National excavator sales in 2006 reached 48,021, and grew 40% compared to 2005. In 2005, production of state-owned and private enterprises of various types of excavators in China's market share is 22 %. In 2006, it reached 26 %.

In the sales of excavators, crawler excavator is much higher than the tire excavator. The market share of 2005-2006 is shown in table 3.

In 2006, the largest sales of excavator between 20 and 22 ton is good, and it is 56% of total sales (64% for 2004). Small hydraulic excavators which quality is less than or equal to 6 ton, in 2006, is 30% of the total sales of the hydraulic excavator, and small excavators increase. In 2006, hydraulic excavators which quality is more than 30 t or equal to 30 t, also increase in sales.

Table 3 Crawler excavators and tire excavator of the market share from 2005 to 2006

Product Name	Market share (%)	
	2005	2006
Crawler excavator	96	94
Tire excavator	3	4.5

### Product Imports and Exports

Exports of hydraulic excavator are 2561 in 2004, 3617 in 2005, and increases 42% than last year. In 2006, exports is 7887, increases 118% than 2005. From 2005 to 2006, China's import and export volume of excavator category in table 4.

## EARTHMOVING MACHINERY

### Production Development

Earthmoving machinery is composed of loader, bulldozer, grader, mine-used self-unloading truck. After many years continuous rapid development, the

development speed of the loader is still keeping. The growth of bulldozer and grader is fluctuant and is higher than loader in 2006. The growth of mine-used self-unloading truck is also high. Some results can be seen in Table 5 and 6.

Table 4 China's import and export volume of excavator category from 2005 to 2006

Product Name	Imports (unit)		Exports (unit)	
	2005	2006	2005	2006
Crawler excavator	17689	27857	3592	7781
Tire excavator	320	530	25	106
Mining Loader	5	3		
Total	18014	28390	3617	7887

Table 5 Product sales of earthmoving machinery in 2005-2006

Product classification	Yield		Sales		Export	
	2005	2006	2005	2006	2005	2006
Loader	111290	131600	105836	126128	2821	4621
Bulldozer	6031	5931	5237	6063	523	1063
Grader	1731	2871	1711	2174	581	706
Mine-used self-unloading truck	431	496	393	475	56	118

Table 6 Business income of China top 10 earthmoving machinery companies in 2006 (10000 dollar)

NO.	Enterprise name	Income
1	Guangxi Liugong Machinery Co. Ltd.	65127
2	China Longgong Holding Co. Ltd.	46474
3	Chengdu Shengang Construction Machinery Co. Ltd.	43092
4	Xiamen Construction Machinery Co Ltd	41387
5	Shantui Construction Machinery Co. Ltd	36508
6	Shantui Lingong Construction Machinery Co. Ltd.	35309
7	Xuzhou Construction Technology Machinery Co. Ltd.	32300
8	Changzhou Co. Ltd.	18912
9	Shandong Shangong Machinery Co. Ltd.	18254
10	Shandong Changlin Machinery Group Co. Ltd.	15560

## CONCRETE MACHINERY

China totally produced about pump vehicles 2,500, towed pumps 4500, concrete mixing carriers 12,000, in 2006. From Concrete Machinery Branch of Chinese Constructional Machinery Industrial Association, products and sales in 2006 are shown in Table7 below.

### Concrete Pump Vehicles

China has had rapid development on arm concrete pump vehicles in recent years, in aspects of stability and

process, though not as good as foreign products. In aspects of cost-effective and after services and others, our products have distinctive competitive advantages, and are more suitable for the actual constructional situation in China. For example, the research and development of concrete pump vehicles in Zhonglian and Sany. Zhonglian has made "concrete pump vehicle" standard, and developed a remote maintainable and positioning system for pump vehicles. Concrete pump vehicles from Sany, whatever in aspects of pumped pressure, pumped displacement or stability, reliability, can be compared to products of famous brands abroad, pump machinery products having had hot sales to the Middle East, North Africa, South Asia and etc.

Table 7 Products and sales of concrete machines in 2006

No.	Products	Enterprises	Yields	Sales
1	Concrete mixers	19	18220	16984
2	Concrete mixing stations	25	1911	1882
3	Towed concrete pumps	15	3865	3686
4	Concrete Pump vehicles	6	1985	1890
5	Concrete Mixing carriers	10	5829	5626
6	Bulk cement carriers	1	1006	1040

The quality of hydraulic system, which is the core part of arm concrete pump vehicle, will directly affect the performance of the host. Hydraulic system of domestic arm concrete pump vehicle based on import of technology, has two kinds of control loops, one is closed-loop hydraulic system of Xuzhong, one is open-loop hydraulic system of Sany. Both open and closed loops with advantages and disadvantages, closed loop has little impact when reversing, little heat produced, simple structure; the most outstanding feature of open loop is that it can easily control the pump displacement according to load, especially when pumping in short distance, the pump capacity being big, taking full advantage of the engine power. Domestic concrete pump vehicles mainly choose hydraulic infrastructures from Europe and The United States, for example, hydraulic pumps and valves from REXROTH, PARKER, HAWE, while hydraulic components relatively seldom from Japan.

With the improvement of conditions, continuous development of arm manufacturing technology, the long-arm, high-efficiency arm concrete pump vehicles are favored by more and more users, and in the next three to five years, demand for arm long below 40-meter' pump vehicle being going to drop, arm long of 45-meter, 48-meter becoming the mainstream, for

example, Sany having developed a 65-meter long concrete pump vehicle, becoming the enterprise manufacturing the longest arm concrete pump vehicle in the world. In addition, intelligent control system technology will become universal accessories of arm concrete pump vehicles. The expansion of pumping capacity and application will also become trend of the concrete pump vehicle development [2].

## CONSTRUCTION CRANE

### Products Development

The construction crane in China includes mobile crane, such as truck crane, all-terrain crane, crawler crane, truck-mounted crane, tire mounted cranes and cross country tire mounted cranes. In the recent years, Chinese construction machinery industry has witnessed a rapid development, as the mobile crane is one of the fastest developing crane types. China construction crane industry in 2006 creates greater glories, and has the historical record of China.

### Marketing and Sales

According to the statistics of the construction crane branch association, sale number of various kinds of the mobile cranes in 2006 is 17403, increased by 34.1% compared with the last year shown in table 8.

Table 8 Sales of the Construction Crane in 2006

Products Name	Sales			Percentage (%)	
	2006	2005	Growth rate(%)	2006	2005
Truck crane	14154	10805	31	81.3	83.2
Truck-mounted crane	2591	1768	46.5	14.9	13.6
Crawler crane	500	237	111	2.9	1.83
Tire mounted cranes	158	171	-7.6	0.9	1.31
Total	17403	12981	34.1	100	100

Note: The data in the column of the truck crane includes full road crane.

From table 8 we can find that the track crane takes the share of 81.3% of the four major cranes; we keep this product structure for many years. But the proportion assumes the declining tendency: 85.26% in 2004, 83.24% in 2005, in 2006 the percentage dropped by 1.94% compared with 2005. But the percentage of the track crane and the crawler crane in various kinds of the products continue to show an upward tendency.

### Truck Crane

The major products of the construction crane of our country are truck cranes. The sale number exceeds 14000 in 2006, which increases by 31% compared with last year; continues exceeding ten thousand for 3 years. Also the production series improved constantly and

realized the marketing of 16 series of products from 8 to 130 tons. Minor tonnage truck crane increases slowly by the extent, while middle and big tonnage truck crane increases are prompt. Table 9 shows the truck crane sale in 2006.

The numbers of the all-terrain crane is small. With years of effort, Xugong and Changsha Zoomlion Co., Ltd, have developed the all-terrain cranes of 25t, 50t, 130t, 160t, 200t, 240t, 300t and have gradually opened the domestic market. The all-terrain crane products in Xugong have expanded into international market. But the production of the cross country tire mounted cranes of our country is almost blank [3].

Table 9 Sales of the truck crane in 2006 (units)

Type(tons)	2006	2005	Growth rate (%)
8-16	7042	6171	14.1
20-55	6671	4383	52.2
65-80	320	187	71.1
100-130	110	58	89.7

### Truck-Mounted Crane

With the rapid development of the petrochemical industry, the petroleum, the chemical industry, the energy sources and large-scale municipal construction, the large truck-mounted crane market has been greatly stimulated. In the past, the large-tonnage truck-mounted cranes rely on imports. During the past two years, Chinese manufacturing enterprises have developed truck-mounted crane products actively. We have been able to produce a total number of 15 series such as 35t, 50t, 70t, 80t, 100t, 150t, 160t, 200t, 250t, 300t, 350t, 400t, 450t, 600t, 900t. The newly developed larger tonnage products have reached the advanced level of the similar products in the world. Also we get a number of independent intellectual property rights, the domestic brands was recognized by the vast numbers of customers. Also, the minor and middle tonnage of the products produced by our country has a competitive advantage with the brands abroad. We soled 500 in 2006, increased by 111% compared with 2005. Our countries' main production truck-Mounted Crane enterprises such as Fushun excavator manufacturers limited liability company, Xuzhou Heavy Machinery Co., Ltd., Zoomlion Heavy Industry Science & Technology Development Co., Ltd., and Shanghai Sany increases rapidly. Currently the entire industry tries to develop the 1600t scale truck-mounted Crane. More and more enterprises will join in the production of the truck-mounted crane. The top 4 enterprises of the truck-mounted crane can be seen from table 10.

### Export of Products

The export of the construction crane had increased rapidly since 2005, and there was a decreasing tendency

of the imports. The entire industry export various of construction cranes and other construction machinery to a total number of 1022 in 2006, which increases about 138% compared with last year; the general amount of money reaches 164 million US dollars, increased by 237% compared with 2005. The Xuzhou Heavy Machinery Co., Ltd takes 61% of the general amount of money of the entire industry in 2006; 76% of the track crane exportation of the whole industry. The crane export in 2006 is shown in table 11.

Table 10 The top 4 enterprises of the truck-mounted crane producers in 2006

Name of the Enterprise	Sales	Export
Fushun Excavator Co. LTD	205	65
Xuzhou Heavy Machinery Co. Ltd	137	35
Shanghai SANY	122	18
Changsha Zoomlion Co., Ltd	32	5

Table 11 Export of construction crane exportation in 2006

Products	Numbers (units)	Sum (10000 US dollars)
Truck crane	770	12008
Truck-mounted crane	124	233.5
Crawler crane	123	4050.9

### HYDRAULIC COMPONENTS OF CONSTRUCTION MACHINERY

Chinese construction machinery products were imitated from Soviet Union Products basically in 1960s. For example, both single-bucket excavators, bulldozers are mechanical transmission, manual manipulation. Equipment moves are all driven by the winch wire rope, ponderous machinery, low productivity, labor-intensive operator. In 1963, Japan displayed a new wheel loader 125A in China, and after the show, the machinery industry department is sent to the Tianjin Construction Machinery Research Institute to research imitation and stripped-down, and then gave the pattern to the Liugong, then Liugong manufactured the first wheel loaders in China. This is the first application of hydraulics in the field of construction machinery. Latter, a loader industry was gradually formed in 1970s, and up to now, the annual output has exceeded 100 thousand. Almost at the same time, fluid drive was applied in the field of bulldozer, grader and scraper, and make engineering machinery products look brand-new, technology have a qualitative leap.

#### Hydraulic Components of Construction Machinery

The development and the industry of the hydraulic components of construction machinery were mainly in the 1970s. After the reform and opening up, in order to

shorten the gap between the advanced world level, Chinese construction machinery industry has introduced more than 170 items of advanced technology, in particular the new bulldozers, loaders key components through-train projects approved by the State Economic and Trade Commission, and 12 domestic enterprises jointly signed with U.S. Caterpillar company for an introduction of the Caterpillar bulldozers, wheel loaders, wheel skidding machinery, three categories of seven types of main manufacturing technology, which includes a hydraulic technology. Hydro-pneumatic and seal industry has also introduced into more than 40 foreign advanced technologies during the "7-5" and "8-5" plan. The formation of specialized production at that time gave a strong impetus to the development of China's hydraulic components, after digestion and absorption; we have fundamentally changed the blank of China Construction Machinery Hydraulic components, although the manufacturing technology level is not very high, but can basically keep up with the needs of the host development. In the 1990s, because of the entry of foreign brands of construction machinery, it further promotes the development of construction hydraulic machinery. Such as: Park Muke (high-pressure pump gear), Eaton (hydraulic steering gear, vane pump, etc.), Naboco, Rexroth (walking, Rotary, up from the motor and reducer), Komatsu Almighty (cylinder), the entry of these enterprises, increased competition in the industry, but also promote the development of the Chinese local hydraulic parts. China's local enterprises also raise their technology continuously, such as the Jinan Hydraulic Pump Factory's Asymmetric compensation radial-type gear pump and GBGJ series of gear pumps, Qingzhou Hydraulic Factory's floating coaxial gear pump, CBZb, CBAa, CBGg series gear pump, Linhai Haihong Factory's valve products are all patent product, and with independent intellectual property, as well as the Xuzhou-hydraulic factory's double-acting cylinder, and so on. All of them have taken a big step forward.

#### Status Quo and Gap

China's hydraulic parts of construction machinery have had a rapid development in recent years, and able to meet the needs of medium pressure and displacement host. For example: the largest sales wheel loader and the second sales forklifts and bulldozers, grader, tire cranes and other machines. At present, and even the hydraulic pilot valve and the corresponding distribution valve in G series of high-collocation loader's, local enterprises have been able to production, resolve instead of imports. However, the medium level hydraulic parts of construction machinery, the quality is not stability enough, leakage occur from time to time, valve locking, cylinder scoring also occur from time to time, problems. China's hydraulic parts of construction machinery is still blankness in the high-tech products, hydraulic components which used in excavators, large-tonnage

truck crane, crawler cranes, concrete pumps, concrete pump truck, rotary drilling rig are still dependent on Imports. Most of them import from German company as: Bosch-Rexroth, Linde, Kawasaki, Toshiba, KYB, Parker, Sawa, Eaton, and so on. Variable displacement pump and motor used in the variable hydraulic system of excavator, integral multi-way valve, high-pressure cylinder and other load-sensing and proportional control components are all urged to be developed.

#### **The Next Work**

To improve the overall quality of corollary parts, it is important to improve the parts of small excavator. One reason is that, the output of the excavators growth fast in recent years, market demand expand, the output growth 10 times in the past 10 years, annual sales is 34,000 sets in 2005, and 45,000 sets in 2006. Second, because excavator has a high technology, the corollary parts also have a high requirement. Third, because the key corollary parts almost dependence on foreign countries to offer, so the price is high, and delivery time can not be guaranteed. These restrict the development of excavator industry. Forth, if we make a breakthrough at the corollary parts of Excavator, the corollary parts of other machines would be solved easily.

The difficulty of corollary parts of excavator is variable hydraulic components. The pressure and flow are comparatively small in small excavators system. It is relatively easy to solve. Branch of Construction Machinery Organization have already held two seminars about corollary parts of small Excavator. In the meeting, corollary parts Branch have put forward the strategic objectives for conquer the small-scale hydraulic excavator: the first step, expect in three to five years, that is, during the 11th Five-Year Plan, conquering components used in 10t within 30 MPa variable system; in another three to five years to conquer the components used in more than 10t the system pressure more than 30 MPa system.

#### **PROSPECT OF CONSTRUCTION MACHINERY**

Construction machinery industry is investing-pulling type, which have closer relations with total fixed asset investment scale, especially infrastructure construction and real estate investment. China is still a developing country, and it should be sustained at least 15 to 20 years or more for large-scale infrastructure construction and urban development. During the "11th Five-Years Plan" (2006-2010), investments exceed that in the "tenth Five-Years Plan" (2001-2005) in transportation, water power, electric power, energy base construction, environmental protection, urban construction, national defense building, which will effectively drive the stable development of the construction machinery industry.

China's mechanization level of building operations is still far lower than developed countries, if it is counted by the number of engineering machinery per country's

land area or per capita, the gap between developed countries and China will be father. For example, in 2005 China's market sales of earthmoving machinery was about 16 million units, 1.2 per 10,000 people; contrast to 7 per 10,000 people in North America; Germany 3; Sweden 3.1; Netherlands 2.8; Belgium 3.7 Taiwan; Denmark 8.

The country's land area of China is 25 times that of Japan's and Chinese population is 13 times that of Japan. In 2005 China's total sales of grabs, shovel loaders, cranes were only 2.3 times that of Japan. Now the number of grabs in use in Japan is about 570,000 units, which is about double that of China. So in the process of becoming the economic power of modernization, the market forecasting capacity of engineering machinery is quite large.

From the worldwide economic development, Japan's and the European engineering machinery market finishes years' hovering and goes to recovery, the development of North American market is strong, the markets grow fast in the Middle East, Latin America, Southeast Asia, Central Asia and other regions, it is forecasted that the world engineering machinery market will be the steadily increasing in the next five years, which will be a good opportunity for Chinese engineering machinery enterprises to expand overseas.

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